

Smart Engineering Technology and Management

(Proceedings of ISCMCTR – 2023)

Editors

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PREFACE

In the ever-evolving landscape of academia, the International Student Conference on Multidisciplinary and Current Technical Research (ISCMCTR-2023) stands as a testament to the vigor and enthusiasm of the emerging generation of scholars and researchers. As we present the proceedings of this momentous event, held on May 20-21, 2023, we take pride in showcasing the diverse array of research contributions that have emerged from the conference. The pages that follow capture the essence of intellectual exploration, collaboration, and innovation that defined ISCMCTR-2023.

Unveiling the Tapestry of Multidisciplinary Research

The ISCMCTR-2023 conference proceedings serve as a tapestry interwoven with the threads of multidisciplinary research. As we delve into the content of this volume, readers will encounter a rich array of scholarly works spanning various fields. From engineering to social sciences, from computer science to environmental studies, the contributions reflect the conference's commitment to exploring the interconnectedness of diverse domains. This compilation serves as a valuable resource for researchers seeking inspiration and insights across disciplinary boundaries.

Championing Current Technical Research

At the heart of ISCMCTR-2023 is a dedication to advancing current technical research. The papers included in this volume showcase the latest trends, methodologies, and breakthroughs in their respective fields. The conference proceedings offer a snapshot of the cutting-edge research presented by students who are poised to become the driving force behind future advancements. We believe that the dissemination of these findings will not only contribute to the academic discourse but will also inspire new avenues of inquiry and exploration.

Highlights from the Proceedings

The contents of this volume are organized to reflect the thematic diversity of ISCMCTR-2023. Readers will find sections dedicated to key conference tracks, each offering a collection of papers that delve into specific areas of study. The inclusion of full-length papers, abstracts, and poster presentations ensures a comprehensive representation of the breadth and depth of research shared during the conference. This structure aims to provide readers with a seamless journey through the intellectual landscape covered by ISCMCTR-2023.

Gratitude and Acknowledgments

The creation of this proceedings volume would not have been possible without the collective efforts of numerous individuals. We extend our heartfelt gratitude to the authors who contributed their research, the conference organizers who meticulously orchestrated the event, the reviewers who dedicated their expertise,

and the sponsors who supported this endeavor. Each of you has played a pivotal role in shaping the success of ISCMCTR-2023.

Looking Ahead

As we present the proceedings of ISCMCTR-2023, we envision this volume as a catalyst for further exploration and collaboration. May the ideas presented within these pages spark new inquiries, foster interdisciplinary connections, and inspire future generations of researchers. We invite readers to immerse themselves in the wealth of knowledge encapsulated in these proceedings and join us in celebrating the vibrant tapestry of multidisciplinary and current technical research.

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TRACK : 1



Utilisation of Solar Energy for Wastewater Treatment

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▶ ABSTRACT ◀

According to a recent United Nations report, “Overcoming the water and sanitation crisis is one of the most significant human development challenges of the early twenty-first century.”

There is an estimate that one among six people lack the safe drinking water access in the entire world along with a similar pattern seen in the sanitation. This situation is going to keep getting worse where 50% of the population of the world is going face shortage of water by the year 2050 which in turn will affect the food access and economic development.

At the UN conference of 2012 in Rio de Janeiro, a vision of sustainable development was formulated for the social, economic and sustainable future of the world keeping in mind the current generation and the future generations [1]. The methodology adopted in this paper is a quantitative and qualitative analysis using data from primary and secondary sources to look at the efficacy of solar wastewater treatment.

“The water treatment using solar energy is a promising way of helping the global water problem. About one third of the population on earth faces scarcity of water and close to two thirds would face the same by the year 2025” according to UNEP [2]. In recent years, the semiconductor-based photocatalytic procedure has demonstrated considerable possibilities as a low-cost, environmentally conscious, and long-term treatment technology that is compatible with the “zero” waste scheme in the wastewater sector.

This process can help in effectively removing organic matter, disease causing microbes and this has been tried and tested over time [3].

Keywords: *Solar Water Treatment, Water Stress, Wastewater, Sustainable Goals.*

INTRODUCTION

The solar photocatalytic method is a very effective and sustainable method that can be used to treat the organic matter in the water.

A good option of water treatment should satisfy multiple aspects in terms of energy efficiency, costing, the amount of chemical product used and environmental safety. It should also help in effective recovery of the water after treatment where the wastewater does not harm the environment and the replication and can be deployed easily on various scales and sizes. There are various methods already in use such as the electrical dialysis, membrane based filtration, reduction based on electrochemical properties, deionization using electric methods which try to get to the goals in different ways.

But these processes consume a lot of energy in different forms along with the chances of pollutants getting mixed in the different phases and end products.

The solar energy based wastewater treatment uses the photo reactors which use light as source of energy. Along with the solar energy a suitable and effective catalyst is used for the degradation of the polluting agents found in the water. There is evidence of the effective nature of the advanced oxidation based on the solar energy which is helpful in removing the micro-pollutants from the water. The core aspects of this process is the availability of solar radiation and effective catalyst.

The solar photocatalytic process has numerous benefits over the other oxidation processes. This process when used at the tertiary phase can help in achieving a less energy consuming option for removal of the organic matter and break it into simple components of water and CO₂. This process also helps in the oxidation of the inorganic compounds into smaller particles which wouldn't be harmful and remove microbes. TiO₂ has been effectively used due to it being cheap, non-toxic and easy recovery. The UV radiation is used to make this work and this also reduces the dependency on the chemicals for the treatment making this a very good method of wastewater treatment.

RATIONALE

There is a lot of research being done in laboratories to develop newer supporting agents to improve the performance of catalysts, but the replication of lab-to-plant approaches is still being explored. The phenomenon of the catalysts turning immobile after the constant and regular use in solar photocatalytic process and the possibility of recovering it need to be studied well.

The dependency on the conventional power sources reduces considerably with the use of photocatalytic water treatment. The organic matter and the microbes are completely broken and degraded during the process but the waste during the process needs additional processes for removal.

Photocatalysis is now showing great promise for treating a wide range of wastewater streams, including toxic landfill leachates.

The leaching elements aren't very nature friendly and cause damage to the nature. The phenomenon of the homo/heterogeneous process have been observed in depth and discussed. The multiple associated parameters have been taken into consideration and analysed.

The efficacy of this particular form of water treatment has been studied for over two decades and the research shows a promising image with good outcomes.

Water treatment methods that are based on the solar power can be the viable option to the water woes on global level. This paper looks at and reviews the technologies that have been developed and put to the test in recent times. Solar-powered water treatment methods are a good alternative to focusing on the global water woes and scarcity and dealing with the reduction of using fossil fuels in the long run for water and energy conservation. Solar treatment methods can be very site-specific. A lot of remote regions can very well utilise advanced oxidation and solar photocatalytic technologies where funds aren't readily available for skilled workers and technology

operations. “Though there are a lot of processes that can be readily used but are not available on the market for the public to use, there are solar processes that can be developed and improved over time” [4].

The UV-based and natural-light-based reactors have been looked at in depth. The advanced reactors have been analysed and studied extensively. The operation of the plants, the cost of operation, and various applications have also been studied in depth. The barriers have also been looked at, which are limited to scientists and the industry of water applications.

The relation between the new catalysts and the design of the reactors haven't been noticed yet and need to be looked thoroughly. This paper looks at the core aspects of the reactor design for a good wastewater treatment plant based on solar energy. There seems to be a gap between the theoretical and practical aspects of this method where the transition from theory to the on ground application requires a prolonged period of efficacy study and economic aspect. A lot of effort is required to bring the method to normal use within the use of everyone. “The ongoing research and development into the LED based catalysts and the cost effective LEDs which can work at the required aspects of the photo catalysts could be the possible breakthrough in the working of the treatment process” [5].

The advanced oxidation process (.A-O-P.) using the monocrySTALLINE TiO_2 as a catalyst is a very effective form of water treatment. This catalyst can oxidise a lot of organic matter into simple products like water and CO_2 .

This particular form of water treatment has been studied and researched over time and earliest studies starting in the 70s and the studies are still going on. The unique nature TiO_2 is one the major reasons for the keen interest where it offers a simple operation, cost efficiency and nature friendly aspect. The inferences drawn can be:

The TiO_2 based treatment has been successfully used for the removal of a large range of pollutants and compounds, with the studies and approaches being focused on the real world application of this process. The advanced researches looking at the partial Photocatalysis as an area of interest [6].

CASE STUDY

Case Study 1: Solar Photocatalysis as a Wastewater Treatment Method for Removing Emerging Pollutants, Spain

The effluent water from a treatment facility was taken for solar energy based treatment. The initial results suggested that there were new emerging pollutants of about 10 different types which included the antibiotics such as the ofloxacin, erythromycin, diclofenac among other types of medicines and they were measured in ng/l. The solar catalytic process was found to be largely effective in the treatment of these pollutants with very little presence of these elements after the treatment. Along with this the removal of fecal matter and the microbes causing diseases were removed to about 100%.

The new emerging pollutants are a source of concern for the government and other bodies. The emerging pollutants are composed of different kind of products such as the medicines, disinfection byproducts, sunscreens and other elements which have recently surged in the usage among people. These elements find their way into the natural water bodies such as lakes and rivers because they are in low amounts in the effluent water from the treatment facilities.

The TiO_2 based solar water treatment is a promising method for the advanced oxidation where there is a process which produces highly oxidizing element in the presence of radiation and catalyst.

DISCUSSION OF THE FINDINGS

The table at the bottom shows the amount of presence of the merging pollutants up to 15 ng/l starting from .03 ng/l at the entry of the treatment facility and the exit of the facility from the sedimentation tanks at the end. There was some reduction in the quantities but the major pollutants above one g/l were not removed. The pollutants were ofloxacin, erythromycin, and diclofenac among other pollutants. This is a major concern where these new

pollutants are passing through the treatment facility and finding their way into the natural water bodies and harming the nature in different ways such a bio-magnification.

Use	Compound	Concentration ($\mu\text{g/l}$)		Removal (%)
		Influent	Effluent	
Antibiotics	Erythromycin	0.03	0.03	(-)
	Trimethoprim	0.14	0.11	(19)
	Ofloxacin	0.16	0.25	(-)
	Enrofloxacin	0.22	0.26	(-)
	Clarithromycin	0.10	0.07	(28)
Analgesic	Acetaminophen	1.57	0.03	98
Anti-inflammatory	Diclofenac	2.84	0.87	70
Psychiatric drug	Carbamazepine	0.04	0.07	(-)
Stimulating	Caffeine	15.79	0.20	99
Fungicide	Thiabendazole	0.09	0.11	(-)
Insecticide	Acetamiprid	0.05	0.05	(-)

Fig. 1: Chemical Structures of Emerging Pollutants.

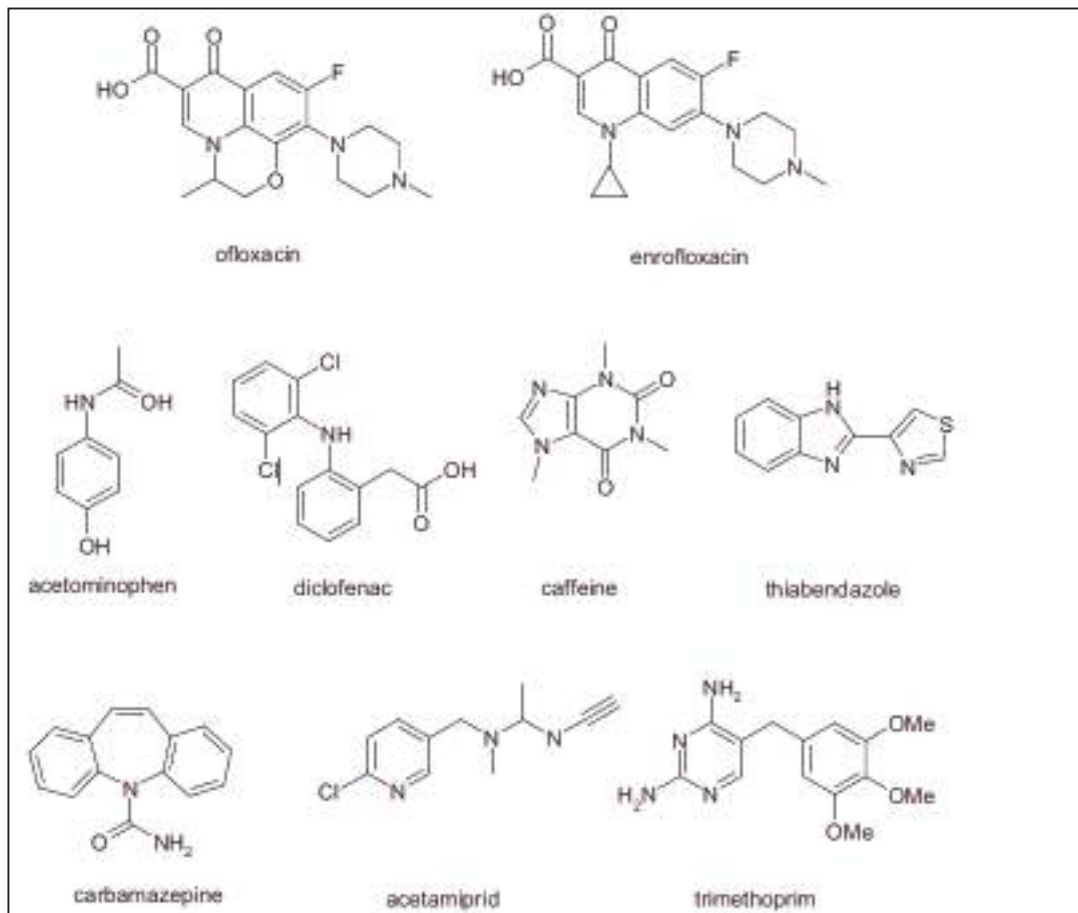


Fig. 2: Concentration of Influent and Effluent Emerging Pollutants

CONCLUSIONS

Solar Photocatalysis with TiO_2 has been shown to be an effective tertiary treatment. After 3 hours of irradiation, the concentrations of emerging pollutants had decreased to values below their quantification limit in most cases.

The treatment results after an hour of treatment shows that there is significant reduction in the outlet water with close to 100% of removal in fecal matter and coliform count.

There are different methods for the removal of the humic acids and caffeine which can be removed using the photo-fenton based process.

The initial studies and results suggest that this process could be less effective than the photocatalytic process but a lot more of research is needed to determine whether it can be used with the hydrogen peroxide at low quantities where a lower temp. might favour this process.

Case Study 2: In Rural India, Low-Cost Titania-Based Photocatalysts for Enhanced Solar Disinfection (SODIS) were Tested in the Field, West Bengal

The new type of solar process based catalysts have evolved and developed which have been discussed with the chances of being used along with the solar disinfection methods, showing the efficient degradation of organic matter and pollutants. There needs to be a lot of caution as the studies and researched are largely based out of laboratories with ideal forms and methods that may miss out the on-ground conditions and limiting aspects. To make sure that this does not happen, the study was done on ground using the water from rural setup and in-situ testing and analysis to draw comparison with previous work on new catalysts.

THE EFFECT OF WATER

The solar water treatment is an emerging alternative for the degradation of small pollutants of micro nature from the water. The study was done in remote village in the state of West Bengal with the analysis and observations made to look into the efficacy of the process for bacterial degradation. The inferences and results have been used to look into the practical and usability aspects on larger scales.

The World health organization reports that about one third of the world population doesn't have access to safe drinking water which causes about five lakh deaths which can be stopped. This pushes us towards finding new methods which are simple in nature, easily accessible, cost effective and are also required as a part of the sustainable development goals which implies- accessibility of water and sanitation for everyone by the year 2030.

Traditional industrial water treatment technologies typically use chlorination as a disinfection method, though UV and ozone treatments are becoming more common. The use of Chlorine as a disinfecting agent has multiple drawbacks such as the need of skilled people, the harmful byproducts, tastes of the water and inability of remove the eggs of parasites in the rural context. A more effective approach is the UV based treatment method which uses a lot of energy along with the requirement of regular maintenance and changing the lamps on a timely basis for the method to work properly.

A case study of a very simple process used by around 50 lakh people around the world is the solar disinfection which has proposed in 1980s and is recognized and promoted for use by the world health organization. A study conducted in the year 2010 states that the bacteria responsible for causing diarrhea is removed significantly after the radiation of the sunlight is exposed, also leaving behind some bacteria as a few children fell sick despite this.

The further improvement and enhancement of this process would be helpful in the developing countries. When the solar radiation and intensity is high then all the bacteria can be removed within six hours and followed by a day or two to stop regrowth of the bacteria in the water sample. This could be a promising alternative of water treatment.

COLLECTION OF WATER SAMPLE

The collection of the water for testing was done around the villages near the IIT Kharagpur campus in the Medinipur (dist.) of West Bengal. The number of samples taken for testing were five and were found to be good for the analysis purpose.



Fig. 3: Images of the Water Sources that were used in this Investigation

CHARACTERIZATION AND ANALYSIS OF SAMPLES

The samples of the water were tested for the bacterial cultures and dissolved solids to find the degree of the pollutants and contaminants in the samples before and after performing the treatment. Around forty L of water was spread into the dishes having an agar medium (Agar M001) which was non selective in nature. The test was performed for a duration of about one hour and the samples were then taken away from the sun to stop the regrowth of the bacterial count.

The dishes used in the test were covered in paraffin oil and were put inside the incubation chambers overnight at a temperature of around thirty seven degree Celsius. The dishes were taken out of the chamber and since the agar medium was non selective, the general contamination count was done irrespective of the species present in the sample. This was then transformed in the colony forming units per mL. The cleaning was done of the apparatus that could be used again with ethanol and the dishes were only used once per test. This move helped in keeping the contamination in control and the subsequent changes that could have been caused due to the other factors.

MASS TRANSPORTATION CONSTRAINTS

To make sure that the study was not compromised and the results were accurate, a secondary lab based test was done which took into the consideration the transportation aspect and the agitation of water. There were two bottles of half liters each containing chlorophenol and titanium dioxide.

The bottles were exposed to a light of three seventy mm wavelength at 0.5 volts and the observations were made regularly at intervals of half an hour while the total time of the study was about five hours. One of the samples was kept stable throughout while other was agitated at every 10-15 minutes to keep mixing the water sample.

DISCUSSION OF THE FINDINGS

TDS, Salt, and Conductivity are Solid Content Parameters.

The total dissolved solid content of the drinking water should not be above one thousand ppm and the normal range in between three hundred to six hundred ppm and anywhere below this range might be very low with the required mineral content. The excess or the less amount of dissolved solids can both cause bad health conditions thus the optimum levels are required. The dissolved solid content in all the water samples was less than the higher limit which was possible reason for the bad health conditions and the hard and unhealthy nature.

It is to be noted that during the study it as found that the solar water treatment has very little effect on the dissolved solids or the salt content for any of the samples. The safety and potable nature of water should be a cause of concern and need to be worked upon in depth along the taste and colour/odour.

Bacterial Composition

Bacterial content, specifically colony-forming units per ml (CFU ml¹), is one of the most useful and important metrics for monitoring water quality, as the presence of pathogens can cause serious illness, with poor sanitation highlighted as a significant problem in India.

The World Health Organisation states that the E.coli content of any water sample should be zero, “Ideally, drinking water should be free of any microorganisms known to be pathogenic.”

“The presence of E. coli concludes and confirms the fecal matter.”

CONCLUSIONS

The case studies and the inferences from them put a solid ground for the treatment methods analysed where they could reduce the bacterial count to different extents implying that these methods can be used as a good option for water treatment in the rural context using the solar energy as good source. The study and inferences show that the photocatalytic water treatment is a better option to treat water in comparison to the solar disinfection method and the titanium dioxide as catalyst enhances the rate of disinfection and degradation of organic matter and bacterial content of the water. The better performance of the titanium dioxide over regular titania points out to the hypothesis of the studies used for the catalyst development.

The fact that the complete removal of the bacteria was not achieved during the five hour period, this could also be related to the moving of large amount of water for testing. The lab results also showed that the regular agitation of water could sort out this problem to a larger extent which could result in a better removal of the pathogens and bacteria. The agitation of water using rotation of the water sample with the presence of intense sunlight radiation and the catalyst titanium dioxide could reduce the time taken from five hours to around sixty minutes.

ANALYSIS AND DISCUSSION

The semiconductor and catalyst based solar water treatment has come out a good alternative in the recent times which is cost effective, friendly to the nature, and could help in developing a low waste solution in the upcoming future in the wastewater treatment sector. The AOPs approach to removal of the organic matter and pathogens from the wastewater has been studied and researched in depth. The main hindrance in the large scale application of the process is the difficulty of removing the catalyst from the water after the process.

The catalyst and semiconductor based treatment using the UV radiation has been increasingly growing owing to the advantages in terms of the chemicals used and the minerals. This is crucial because a certain section of the organic material is mineralised instead of changing forms. The addition of the process and operation this could be the easily accessible and adoptable option in the time to come. “This photocatalytic process effectively removes a wide range of water contaminants, including pesticides, herbicides, and detergents, as well as pathogens, viruses, coliforms, and spores” [7].

The time period of the last twenty to twenty five years has been important in the field of construction, research and overall efficacy improvement of the process. The most crucial aspect of the process is the ability to remove and degrade the organic matter using the oxidation process in advanced stage. The inferences point out to the basic aspects of the solar photocatalytic treatment and putting the emphasis on the stationary and moving aspects of the process in order to be effective.

The crucial point of the study is to look at the different reactors for the solar water treatment, also analysing the performance and efficacy of the system.

The solar energy is a very vast source with around six hundred terawatts of energy with an effective usable energy of sixty terawatts but currently we are able to harness only a minute fraction of less than 1 terawatts. The amount of energy harnessed currently only has small percentage of contribution in the overall requirement of energy with constant improvement over time. The different processes of the desalination, removal of toxic substances using the solar energy are the most common uses in the sector of wastewater treatment. “The solar energy used for the separation of the metals and other compounds synthetic in nature in an emerging technology” [8].

The demand for potable water has been going up steadily as the population explodes. The pollutants from the industries and the agricultural sectors are also a cause of concern and need attention. The pollutants are present in different amounts in the water and are hazardous in nature to the nature and the health of mankind. The need arises to separate the human wastes from the water before it is being reused or discharged into the water bodies.

There is a wide range of pollutants causing water pollution which are often from the industries, or the agricultural sector in form of pesticides. “The amount could be minute but it possesses a huge amount of associated risk to the soil, water, flora and fauna and could result in altering the natural ecosystem” [9].

CONCLUSION

This study aims to examine and look at the challenges and aspects that can alter and impact the usage of photocatalytic process to treat the water from different sources. The depths and scientific approach required to study the methodology for degradation, applicability have been considered and covered to answer the necessary questions pertaining to this issue. This also covers and examines the different wastewater sources such as from homes and factories, the related methods of treating and disposing along with the environmental impact of applying these processes on different scales.

The key inferences, results, findings and recorded values are the main outcomes of the current study:

- The solar wastewater treatment is a very effective method of removing the organic pollutants using degradation in the water. There are several concerns which are being looked upon including the economic aspect of implementation, catalyst use and recovery and the way in which solar energy is available with interruptions. These points are crucial in determining the large scale implementation of the process.
- This process is based on the use of reactors of solar energy and operate on the radiation and light. The important part is also the catalyst being used which should be highly efficient for the degradation process to be high.
- The oxidation process based on advanced means is effective for the degradation of the pollutants of micro scale where they are different from the pollutants of macro scale with varying chemical properties. The key aspects are the availability of the radiation and catalyst.
- The main advantages of using this method is that it doesn't need the traditional sources of power to operate which bring down the greenhouse emissions. This process is effective in degradation of the organic matter from the water but the removal of the waste would require additional steps such as the sedimentation and desalination.

This review article critically examines the wastewater treatment techniques developed over the last few decades using solar energy and radiation. Based on the results of the review and examination, the following recommendations for future work are made:

- The use of Nano-technology has paved way for the development of economically viable solar-thermal process in the times ahead. The reduced greenhouse emissions along with the use of solar energy to treat water would be beneficial in reducing water scarcity at the global level. The transformation of the solar power without external energy is possible in the process where biomass is used in the evaporating systems. But it needs a lot of work and before it can be used effectively.
- There is a need for continuous research and development of the solar energy based photocatalytic process and the electrochemical methods. The effectiveness of these methods of catalysts based treatment and the advanced oxidation using solar energy have been highly efficient in the experiments and tests but they need a lot of real on ground testing and development.
- The non-continuous nature of the solar power implies that the treatment can only work during the daytime and might not perform ideally during the nighttime. There is a huge scope of research and development in the area of low-cost energy and storage options in the solar wastewater treatment sector.

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Use of Constructed Wetland Systems for Wastewater Treatment

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▶ ABSTRACT ◀

Water is absolutely necessary for life to exist on this planet. The demand for fresh water is increasing as a result of population growth and urbanisation, and fresh water resources are becoming increasingly polluted. The assessment of home waste water potential using a built wetland is one such method.

Water contamination is the main cause of mortality and disease around the globe.

Water pollution is caused by various sources like chemical from fertilizers, pesticides, industrial waste, sewage, waste water, mining activities, marine dumping, accidental oil spills, fossil fuel combustion, and radioactive waste. Cholera, dysentery, typhoid, hepatitis A, and other diseases are caused by water contamination.

A wetland is a unique ecosystem which remains saturated by water either permanently or seasonally. These wetlands have the potential of treating municipal wastewater, industrial wastewater, and agricultural effluents along with runoff storm water. Other benefits of manmade wetlands for treatment include lower construction costs than other treatment solutions, due to use of natural processes and local materials, simple construction techniques, process stability, and so on, simple operation and maintenance, and process stability.

Keywords: *Water Treatment, Water Contamination, Wastewater, Wetland.*

INTRODUCTION

India is a populous country where industrialization and speedy urbanization have led to migratory influx from rural areas to urban areas resulting in chaotic growth of urban areas. There has also been an increase in resource usage as a result of the increasing population density in these places, which has resulted in excessive contamination of the water bodies there. Because of the uncontrolled growth of these settlements, many of them lack central sewage treatment facilities and proper sewer networks.

As a result, waste waters from these regions are either dumped directly into surface water bodies or discharged after partial or inadequate treatment. As a result, water bodies are becoming increasingly polluted. These locations should either be connected to a central sewage treatment facility (CSTF) or have some decentralized treatment facilities to alleviate the situation. One of the possibilities that can be used at a decentralized level is a constructed wetland. The use of manmade wetlands for the treatment of waste water from partially developed areas or small towns is highlighted in this study.

Constructed wetlands (CONSTRUCTED WETLANDSs) and other modifications to classic wetland layouts, such as recirculating gravel filters, have been recognized as promising wastewater treatment methods. Research found that the creation of built wetlands resulted in the significant removal of nitrogen and other contaminants as wastewater flowed through the wetland. Constructed wetlands have evolved over time into a relatively robust, low-energy, low-maintenance, and low-cost system for treating contaminated waters from a variety of sources, including industrial waste, agricultural waste, and storm water runoff. These artificial systems use physical, chemical, and biological principles to mimic the activities of natural wetlands in treating water [1].

Constructed Wetlands are unusual in that they are both a simple and ecologically safe treatment procedure as well as a living organism that is constantly evolving to sustain diverse species and contribute to the global diverse ecosystem. Constructed wetlands provide habitat for native and migratory wildlife while also balancing land development and the demand for green cover. The following are some of the new innovations and directions in the constructed wetlands:

1. The potential for wetlands to be used as a food source

Some potential uses for Constructed Wetlands in the near future have recently been discussed in the scientific community and engineering associations. Agriculture programs can make use of constructed wetlands.

2. Wetlands as climate change mitigation and adaptation

The greenhouse gas influence on climate change has piqued the scientific community's curiosity in the past decade. Constructed wetlands and natural wetlands can both help mitigate the negative effects of greenhouse gases. Carbon, which is a key component of greenhouse gases, can be contributed to and utilized by plants. Recent research, on the other hand, has shown that specific microbes can be utilized in carbon fixation.

RATIONALE

Numerous studies conducted over the last few decades on the effectiveness of wetlands in treating wastewater have generated quantitative data that has been used to increase treatment efficiency through design and operation strategies. The Constructed wetlands is divided into two types: free water systems and subsurface flow systems. Subsurface flow systems are also known as "rock reed filters", "root zone systems" and "vegetated submerged bed systems. These types of wetlands induce sub surface flow by a permeable medium with the water to be treated being below the surface. In contrast, free-water surface systems are designed to imitate natural wetlands. In this type of wetlands water flows over the soil surface at shallow depths. Both subsurface flow and free-water surface wetland treatment systems are typically built in basins [2].

In the early 1950s, the first studies with wetland macrophytes for wastewater treatment were conducted in Germany. After these studies, constructed wetlands have been considered a reliable method of wastewater treatment for a wide range of wastewater.

Artificial wetlands can be classified under two heads- first vegetation type and second hydrology. Under the head of vegetation type- there can be emergent, free-floating, floating leaves and submerged wetlands. Whereas under the classification by hydrology comes- subsurface flow and free water surface wetlands. Subsurface flow wetlands can further be classified on the basis of flow of direction (vertical and horizontal). Merging various forms of above-described wetlands form hybrid wetlands which can be used for improved treatment performance.

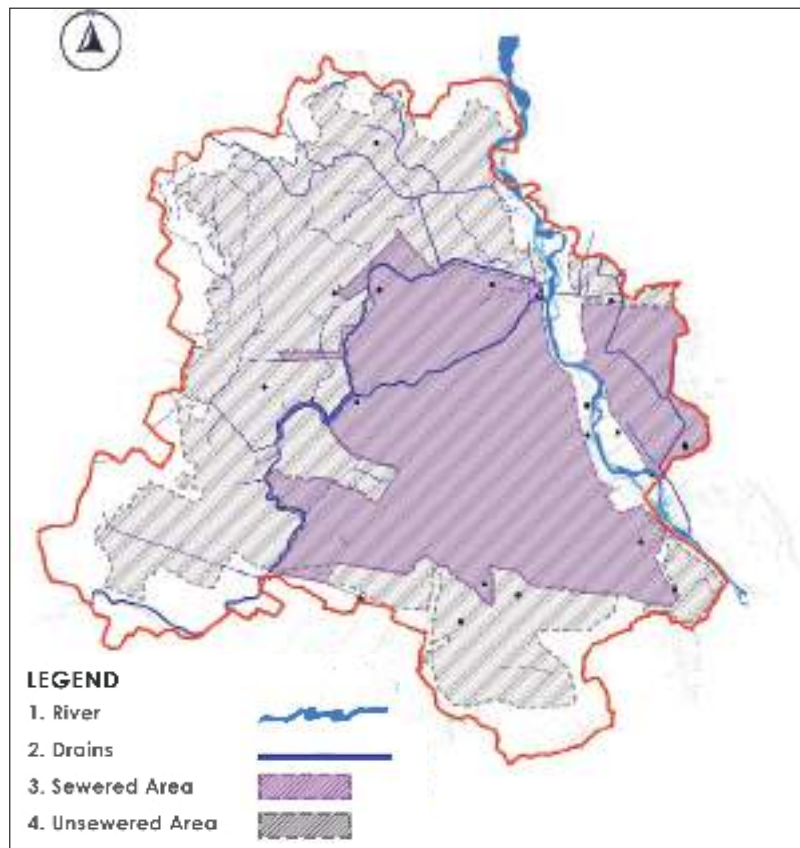


Fig. 1: Sewage Coverage Status in Delhi

BACKGROUND

This paper examines the wastewater problems that arise in locations without a sewer network, as well as the usefulness of this natural technique in resolving them, by examining several noteworthy case studies in this subject.

Following a thorough review of the literature and case studies on constructed wetlands, it was discovered that the outflow characteristics of constructed wetlands meet the CPCB guidelines.

Constructed wetlands consume low to no energy input, thus they have cheaper operation and maintenance costs in comparison to traditional systems of treatment. Constructed wetlands have dual/ multipurpose utility. They provide ecosystem services like carbon sequestration, flood control and habitats for diverse wildlife species.

Constructed wetlands are an environmentally acceptable method of eliminating contaminants from wastewater. They have been used for treatment of wastewater from municipalities, petroleum refineries, agricultural effluents, drainage from acid mine and other types of waste water. The continuously increasing science of microbiology has seen a remarkable number of breakthroughs during the last decade.

Furthermore, an attempt was made to forecast future improvements in the domain of constructed wetlands and to promote these advances by defining significant unsolved constructed wetlands challenges. Through the standardization of essential design components, guidelines are being developed for the fast-growing Constructed Wetlands field. This study assesses the present state of technology in constructed wetlands and makes an attempt to define the performance metric nomenclature to unify the constructed wetland ecosystem which has been expanding rapidly. It also gives an overview of current constructed wetlands developments and makes recommendations for future study and development [3].

CASE STUDY

To understand the parameters and efficacy of the selected system in depth, case studies were taken up, consisting of different scales and methodologies.

Case Study 1: Neela Hauz Biodiversity Park, New Delhi

Neela Hauz (area: 9.63 acres), Year of commencement: 2012

Neela Hauz is a natural depression that once received all of the drainage from the surrounding forests and supplied potable water to southern Delhi. The lake was 7 hectares in size which was reduced to less than 3 hectares after urbanization took over. It was reduced to a dump for raw, untreated sewage from neighboring colonies. Shortly after, the lake was dumped with the construction debris from Aruna Asaf Ali Road Bridge which was built across the lake. A case was filed before Hon'ble High Court of Delhi against government by the residents of Jawahar Lal Nehru University (JNU) and adjoining colonies requesting the restoration of Neela Hauz lake to its former glory.



Fig. 2: Dead Neela Hauz Lake (Before Restoration)



Fig. 3: Neela Hauz Present State

RESTORATION

DDA decided to rename Neela Hauz Lake, Neela Hauz Lake Biodiversity Park as requested by the local community.

The restoration work was carried out by Centre for Environmental Management of Degraded Environment (CEMDE) in collaboration with the Biodiversity Park. After desiltation work for three years, the extracted sediment was used in making cement for landscaping on embankments.

On November 11, 2016, the Hon'ble Lt. Governor of Delhi, Shri Najeeb Jung, inaugurated the Neela Hauz Biodiversity Park. 4000 students and locals planted approximately 10,000 individuals of 90 native species from ten communities. The raw sewage and treated sewage that previously entered the Yamuna River by the way of Neel Hauz Lake and Sanjay Van are now treated by a constructed wetland system.

Constructed Wetland

The constructed wetland at the Biodiversity Park is notable for having two oxidation ponds, a channel with gradient containing boulders and a mesh/sieve for filtration, 3 tanks for physical treatment (first treatment tank with stone as filters, second treatment tank with bigger pebbles from river bed and third treatment tank with smaller pebbles from river bed), gravel ridges (20 mm) and furrows with 25 plants on aquatic species.



Fig. 4: Wetland Constructed to Convert Sewage into Clean Water

Results and Discussion

In constructed wetland, a mosaic of sites with varying oxygen levels exists, triggering a variety of degeneration and elimination processes. This wetland took two years to become functional with no energy input. Today this constructed wetland converts one million liters sewage water per day in clean water with a BOD of less than 4mg/liter per day, comparable to tap water.

A detailed analysis of water from Neela Hauz Biodiversity Park has been shown below. This analysis is done to assess the treatment effectiveness of the wetland [4].

This constructed wetland runs on a zero-energy model as it uses elements like gravel, pebbles from riverbed and aquatic plants to clean the water.

Alongside, the water flow across the gradient. The process uplifts the quality of water to a good level- same as the quality of river water achieved by natural processes.

	Inlet	Outlet
pH	7.8	6.78
Conductivity ($\mu\text{S/cm}$)	1254	606
Dissolved Oxygen(mg/l)	0	3.4
TDS (mg/l)	600	298
Phosphates (mg/l)	103	14
COD (mg/l)	80	0.7
BOD (mg/l)	40	4
Chlorides (mg/l)	163	118

Fig. 5: Effectiveness of Treatment Wetlands

Case Study 2: Kothapally Village

This case has been chosen for study to understand a constructed wetland for treatment of wastewater generated from rural areas. The location of this constructed wetland allows to understand ways to improve efficiency of water use and management of waste water with limited resources and in semi-arid tropical (SAT) villages.

For treatment of wastewater generated from 100 households, a constructed wetland was installed in Kothapally village in Telangana. *Typha latifolia* and *Canna indica* were used to seed the Constructed Wetlands. During the study period, the average COD, sulphate, and inorganic nitrogen removal efficiencies were 65 percent, 60 percent, and 67 percent, respectively (one year). Total coliform removal efficiency was consistently greater than 80%. The treated wastewater is collected in a farm pond and used to irrigate nearby agricultural fields of 0.6 hectares.

Water availability around the year helped the village in reducing the vulnerability of drying of kharif crops, providing them with a crucial means of irrigation. The biomass harvested from the wetland act as fodder for livestock. Farmers who used treated wastewater in their crops earned an extra Rs. 70,000 (US\$1,000).

CONSTRUCTED WETLAND

This constructed wetland was designed taking into account the volume of water supplied to the households of village by community taps from an overhead tank. As per the calculation, the design flow was taken as 20 cubic meter per day. It is to be noted that there's a lot of bathing and washing going on near the community tap. Individual household wastewater discharges were drained to the main drain pipeline via PVC pipes. The underground drainage pipe results in very little percolation or evaporation loss. The brick-masonry structure (20 meter by 4 meters by 1.5 meter) with lining of plain cement concrete (PCC) at the bottom was used in this subsurface horizontal flow type constructed wetland. This unit's total construction cost was \$9895.

Falling-head tests revealed that the bed porosity was 0.53. The calculated pore volume was 63.6 m³. As a result, the hydraulic retention time was approximately three days. On a typical day, the constructed wetland was observed during the peak flow period of 5 a.m. to 7 a.m. in the morning.

Figure 6 depicts the general layout as well as the specifics of its filter media. The constructed wetlands' filter bed was made up with three layers of aggregate, each having a thickness of 30 centimeters. Going from bottom to top, 40-millimeter aggregates were used in the bottom, followed by 20-millimeter aggregate in the middle and lastly 10-millimeter aggregate on the top. These stratified layers were then covered with a 15-centimeter thick coarse of sand.

The wastewater drain for inlet was set up with a layer of 40-millimeter aggregate and the constructed wetlands used the bottom-up wastewater flow direction. Water was allowed to enter the constructed wetland from the bottom of the inlet side and exit from the top of the outlet side with a 10 mm gravel layer.

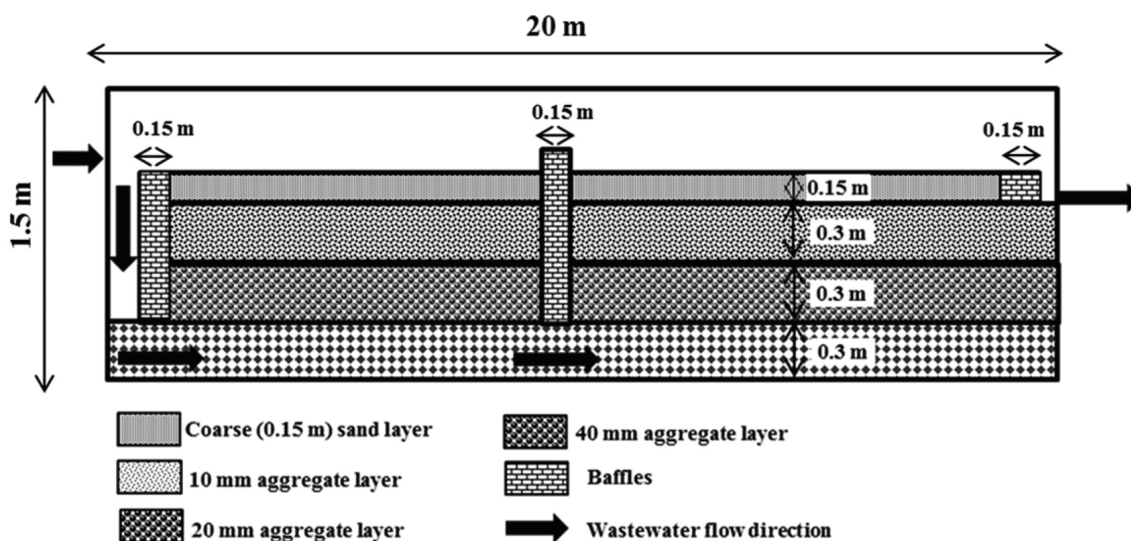


Fig. 6: A schematic of the Constructed etland in Kothapally

RESULTS AND DISCUSSION

Characteristics of the Wastewater

Irrigation water quality is classified as Class E in the guidelines for irrigation prescribed by pollution control board of India- CPCB (Central Pollution Control Board) Class E water must have a pH of 6.0–8.5, an electrical conductivity (EC) of less than 2.25 dS/m, a sodium absorption ratio (SAR) of less than 26, and a boron concentration of less than 2 mg/L (CPCB 2020). Throughout the study period, the chemical composition of the constructed wetlands' effluents remained well under the permissible limits. Except during the monsoon season, there was little seasonal variation in the wastewater's characteristics.

Performance of the Constructed Wetlands

Chemical oxygen demand (COD), total suspended solids (TSS), sulphate, phosphate, nitrate nitrogen and ammoniacal nitrogen concentrations all showed significant variation between inlet and outlet concentrations. These were chosen as performance indicators for the built wetland. The average inlet and outlet concentrations of the samples of waste water collected during the study were used to assess the removal efficiency of the water present in the wetland. The samples demonstrated a high TSS removal efficiency ranging from 94 percent to 98 percent during the stabilization phase. Sedimentation and physical screening accounted for 98 percent TSS removal efficiency observed during the stabilization phase. As the macrophytes established themselves, there was a significant increase in COD and inorganic nitrogen removal [5].

Reuse of the Treated Water

If untreated wastewater with an average ammoniacal nitrogen concentration of 34.6 mg/L is released into water bodies, it has a significant eutrophication potential.

The average efficiency of nitrogen removal for this constructed wetland was found to be 61 percent. Furthermore, the use of nutrients in wastewater leads to growth of weeds, specifically during the stages of post-germination and early phase of crops.

Sustainability of the Constructed Wetlands

Constructed wetlands require no energy, in the form of electricity or chemicals or any sort of skilled provision but contrary to the general notion of these being “maintenance free”, they require maintenance. Harvesting of plant biomass and cleaning of debris from the drains and bar screens allows the decentralized wastewater treatment (DWAT) remain smoothly functional. This part can be overlooked and remain undiscussed in the haste of getting approvals from stakeholders which can put the entire implementation scheme at risk in long-term. The Gram Panchayat used an awareness campaign to gain support for regular drain cleaning.

All these maintenance tasks required labour of 3 human days for every 45 days which has a cost of around 900 INR (US\$ 14). For this purpose, beneficiaries of harvested biomass and treated wastewater formed a user group.

ANALYSIS

The Central Pollution Control Board (CPCB) has specified certain standards for the disposal of treated waste water into surface water, and it is critical to check the quality of wastewater against these standards before finally disposing of the treated wastewater [6].

Lessons from Kothapally Village

Constructed wetlands require no energy, in the form of electricity or chemicals or any sort of skilled provision but contrary to the general notion of these being “maintenance free”, they require maintenance. Harvesting of plant biomass and cleaning of debris from the drains and bar screens allows the decentralized wastewater treatment (DWAT) remain smoothly functional. This part can be overlooked and remain undiscussed in the haste of getting approvals from stakeholders which can put the entire implementation scheme at risk in long-term.

All these maintenance tasks required labour of 3 human days for every 45 days which has a cost of around 900 INR (US\$ 14). For this purpose, beneficiaries of harvested biomass and treated wastewater formed a user group. The user group included members of the gram panchayat. User

Parameter	Unit	Permissible limit for disposal to surface water
pH	-----	5.5-9.0
TSS	mg/l	100
TDS	mg/l	2100
COD	mg/l	250
BOD	mg/l	30

Fig. 7: Permissible Limits for Water Disposal

groups assisted in delineating roles and responsibilities for DWAT maintenance; additionally, members ensured the DWAT unit's long-term sustainability by convergence with various government schemes like the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) and the Swachh Bharat Mission (SBM).

Apart from the tangible benefits of increased efficiency of wastewater treatment, improved fodder availability, there are intangible benefits like reduced environmental pollution and occurrence of vector-borne diseases and pests. As villages like Kothapally have high vulnerability to diseases due to lack of access to safe drinking water, this constructed wetland ensures wellbeing of the villagers on this front. It also addresses the issues related to health and hygiene, wastewater treatment, nutrient recycling of soil and reduces agricultural water demand, creating a win-win situation for all.

Lessons from Neela Hauz

Lake water has a pH level of around 7, and chlorides and sulphates are less than the permissible limits as shown in figure 8. With a dissolved oxygen (DO) level of more than 3.4 mg/l, biochemical oxygen demand (BOD) level of less than 4 mg/l, and chemical oxygen demand level of 0.7 mg/l, Neela Hauz lake supports a wide range of species including 100 identified aquatic birds species.

Water analysis		
Parameter	Before CWS	After CWS
Acidity level (pH)	7.8	6.78
Biochemical Oxygen Demand (BOD)	40	4.0
Chemical Oxygen Demand (BOD)	80	0.7
Dissolved Oxygen	0	3.4
Phosphates	103	14
Total Dissolved Solids (TDS)	600	298

Fig 8: Water Quality Parameters

According to Professor C.R.Babu (Project In charge of the Biodiversity Park Programme of Delhi Development Authority)- "no energy is consumed in the process. Physical materials for filtration like gravel, pebbles from riverbed and aquatic plants with special purifying properties are used in this wetland to clean water".

CONCLUSION

Scarcity of water is becoming a recurring issue in most of the Indian cities, turning out resource allocation is turning out to be a huge challenge. The lack of clean water and its increasing demand across all the economic sectors also make these resources contested.

Per capita water availability has gone down with increasing population, from 1816 cubic meters in 2001 to 1545 cubic meters in 2011. According to the most recent census of India, only 70 percent of urban households have access to piped water supply whereas rest depends on other sources like wells, ponds, untreated sources etc. Several cities also have the average per capita water supply below 135 liters per day (as recommended by CPHEEO) [7].

India uses its treated sewage for purposes like horticulture, flushing toilet, farm forestry, fish culture, industrial use and other incidental uses. For usage of sewage, CPHEEO has guiding principles to achieve treated sewage quality for different uses [8].

The research looked at the aspect of operation of wetlands for the treatment from domestic sources. The current research attempted to look at the operation of wetland system as a method to treat the domestic wastewater and the high degradation and removal efficacy of the system shows the reliability and the scope of using this system at different scales and typologies. This is a very cost effective method costing less than rupees 7-8 Lakhs with minimal maintenance. This system was also able to generate revenue of around 60000-70000 rupees in the starting 12 months and the advantage extending to the overall wastewater management and utilisation post treatment.

These wetlands are a very good substitute for the conventional treatment systems for the degradation and removal of organic content as well the nutrients that are acquired. Since these are manmade and artificial in nature but utilise the natural principles and ways of treating the water using the microbes, soil and other components. These are familiar to the naturally occurring wetlands but with a more handling and operational control. Since the beginning of the 20th century these wetlands have been used and made in different sectors for treating the wastewater generated [10].

This kind of system provides treatment options for different scales and typologies starting from domestic and going up to large city based options. They are not only a source of treatment but also engage a lot of people thus helping in economic benefit of people.

The last fifty years have been crucial in development and evolution of the wetland systems which has been continuously improving and helping in treatment of wastewater from the domestic, industrial and agro sector. These systems are very helpful and effective in removing suspended solids and organic content, while phosphorous removal is still to be looked at.

The wetlands are a very energy efficient type of system requiring very less or almost zero energy for operation and maintenance. These systems not only help in treatment but also take care of excess waters during flood, sequestration of carbon and improvement of flora and fauna of the area [11].

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Use of Solar air Conditioning Systems for Indian Region

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▶ ABSTRACT ◀

Since a few years ago, there has been a significant rise in the need for air conditioning throughout the summer, particularly in the housing and tertiary industries. India has a significant deal of potential for the efficient use of solar energy because it is a tropical country. Most of India has between 300 & 330 days of sunshine annually, which is equivalent to more than 5,000 trillion kWh of energy and can be used to generate heat and power (MNRE). There is an urgent need to reduce greenhouse gas (GHG) reduction and move toward low carbon development pathways since India currently ranks fourth in the world for primary energy consumption (USEIA). When compared to their conventional counterpart, solar air conditioning systems offer several advantages. The use of solar air conditioning systems reduces the need for grid electricity, lowers operating expenses, and has a positive influence on the environment by reducing GHG emissions, among other things. Additionally, solar air conditioning systems operate more effectively in the hot summer months when cooling demand is at its height; as a result, these systems can aid in lowering electrical peak loads as-associated with traditional grid power-based cooling systems. Solar AC systems have the benefit of employing completely safe working fluids like water or solutions of specific salts, which makes their use a huge business prospect. They are both ecologically friendly and energy-efficient [1].

Keywords: *Solar Air Conditioning, Solar Cooling, Energy Efficiency.*

INTRODUCTION

The amount of energy the sun provides each day is equal to the whole annual energy needs of the entire planet. An increasing number of nations are currently using solar power to produce electricity in response to the rising impact of climate change.

Any AC system that relies on solar energy is considered as solar air conditioning. Passive solar, pv, or solar thermal energy conversion techniques can all be used to achieve this. Solar cooling solutions, in particular, utilise solar thermal energy produced by solar collectors to give power thermally driven cooling equipment. A typical solar thermal AC system made up of solar collectors, a storage tank, a control unit, pipelines, pumps, and a thermally powered cooling device makes up a solar cooling installation. When the energy provided by the collectors is insufficient to meet the cooling load, a conventional energy source serves as a backup, typically.



Fig. 1: Conventional Cooling vs Solar Cooling

Based on variables like land availability, solar radiation, etc., one can evaluate the potential for solar energy generation in a given place. Solar energy potential in the country is estimated to be over 750 GWp, according to the National Institute of Solar Energy (NISE).



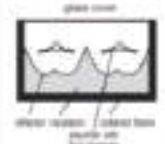

Collector type	Solar air collector	Flat-plate collector	Stationary parabolic compound collector	Vacuum tube collector (VTC)
Short cut	SAC	FFC	CPC	EHF, EDF, SVC, ETC
				
				
Principle	Direct heating of air	Heating of a liquid (water, water-glycol)	Heating of a liquid (water, water-glycol); radiation concentration without tracking	Evacuated glass tube for reduction of thermal losses; EHF: evacuated tube with heat pipe; EDF: evacuated tube with direct flow; SVC: Dybala-type evacuated tube with concentrator reflector
Main application area	Pre-heating of ventilation air	Domestic hot water preparation	Domestic and industrial hot water preparation	Domestic and industrial hot water preparation
Prevalent application in solar assisted air conditioning	Open cooling systems, e.g. desiccant cooling systems	Desiccant cooling systems; Thermally driven chillers (single-stage) with selective absorbers	Thermally driven chillers (single-stage)	Thermally driven chillers (single-stage); Thermally driven chillers (double-stage); SVC

Fig 2: Types of Solar Collectors

Component wise a solar AC system can be categorized into 4 parts:

1. Solar collectors (photovoltaic (PV) and thermal),
2. Processing machine,
3. Air distribution and heat rejection system, and
4. Energy storage

SOLAR COLLECTORS

Solar collectors are used to capture solar energy and transform it into heat or electricity. Based on their output energy, the solar air conditioning system's collectors can be split into two groups:

SOLAR PV CELLS (II) SOLAR THERMAL COLLECTORS

- **Solar PV cells:** In solar (photo voltaic) PV cells, incident solar energy is converted into DC (direct current) electricity, which is then produced by the PV cells. Solar cells are arranged in series and bundled in a protective laminate to produce more current; this structure is known as a solar panel or module.
- **Solar thermal collectors:** Solar thermal collectors produce useful low- and high-temperature heat output by utilising solar radiation. The two types of collectors for solar thermal energy are non-concentrating and concentrating. The area of absorber, or the area of the collector that absorbs heat, is equivalent to the collecting area, or the region where solar radiation is blocked, in the non-concentrating type. The area of absorbing in concentrating type collectors is less than the collecting area. Concentrating collectors come in the parabolic trough, dish-style, and linear Fresnel types that are commercially available.

PROCESSING MACHINE

Solar heat is needed to power the cooling process in solar AC systems. So far, the following categories can be used to classify solar air conditioning systems:

- **Closed systems:** These are thermally driven chillers that produce water which is either distributed via network of chilled water to the designated rooms to perform decentralised room installations, such as fan coils, or used in air handling units to give conditioned air (cooled, dehumidified). Absorption chillers, which are the most prevalent on the market, and adsorption chillers, which are less frequent but are becoming more popular for solar air conditioning;
- **Open Systems:** provide total air conditioning by giving cooled & dehumidified air in accordance with the desired comfort levels. Since it comes into contact with the atmosphere, water is always the “refrigerant.” Desiccant cooling systems with a spinning dehumidification wheel and solid sorbent are the most popular types of systems.

AIR DISTRIBUTION AND HEAT REJECTION SYSTEM

Coils or air-conditioning units are used to remove heat (latent and sensible) from the space after the creation of chilled water or refrigerant. The term “air distribution system” refers to these elements and processes as well as the piping and duct network. By replacing the hot, humid interior air in the room with fresh air, cooling and dehumidification are achieved. All-in-air system is the name given to this procedure. Utilizing the cold units already present in the space is another method of cooling (hydronic or decentralised systems).

Any cooling and heating engine operation needs to include a step called heat rejection. Commonly, either an air-cooled or a water-cooled system is used to achieve heat rejection. Hot fluid is passed via a condenser coil in an air-cooled system. Transfer of heat from fluid to the enclosing air reduces the fluid's temperature; the effect is boosted by the use of fans. Evaporative condensation takes place inside the heat exchanger in a water-cooled system, such as a water tower. Water absorbs heat, which it subsequently releases into the atmosphere. Since water can absorb more heat than air, wet cooling systems are more compact and smaller than air cooling systems [2].

ENERGY STORAGE

Heat and electricity devices storage are an essential part of solar AC systems even though they are not directly involved in the cooling cycle. Being a variable energy source during the day & the seasons, storing the generated heat and electricity plays a crucial role in ensuring a steady supply of generating heat energy to operate the cooling system for a few hours, occasionally for an entire day. The system is made more consumer-friendly by the addition of storage facilities.

Methods of Energy storage could be categorized into two primary types,

1. Electrical storage
2. Thermal heat storage.
 - One of the main technologies utilised for electrical energy storage is electrochemical storage, or batteries. However, as batteries used in PV applications withstand both deep cycling & extended states of low charge throughout its daily regular operation, batteries used for storing PV electrical output differ only slightly from ordinary batteries. A common example of a PV electricity storage system is lead acid batteries.

To store solar electrical or thermal energy, however, requires additional financial outlays, a need for space, and increased electrical and thermal losses. Therefore, reducing the cost of solar energy storage through system design that maximises storage volume and efficiency represents one of the main problems for front technology developers.

APPLICATION MARKETS

The Brands used in Indian Markets:

- Thermax Ltd.
- Sharada Inventions
- Surya Shakti Private. Limited.
- Arka technologies Private. Limited.
- First Esco (India) Private. Limited.
- Clique Developments Ltd.
- Mamta Energy Pvt. Ltd.
- Energetic Consulting Private. Ltd
- SLT Energy Ltd.
- Taylormade Solar Solutions (TSS) Pvt. Ltd.
- Kirloskar Pneumatic Company Ltd. (KPCL)

CASE STUDY

Solar Air-Conditioning Systems at Turbo Energy Ltd., (TEL), Chennai

The TVS group of firms includes Turbo Energy Limited (TEL), which is situated at Paiyanur, 52 kilometres from Chennai. Many Indian automakers rely on TEL as a top provider of turbochargers. The business has implemented a number of green measures, and their administrative building is LEED Platinum certified. The business has 400 employees and a large facility that is 50 acres in size.



**Fig. 5: Solar Parabolic Concentrator
Generating Heat at 180 Deg C**

For its administrative building, which is 24000 square feet in size and located on the Paiyanur campus, TEL has an air conditioning load of 130 TR (Tons of Refrigeration). The company came up with the creative concept to adapt to renewable energy.

For air cooling, use (solar). Vapor Absorption Machines (VAM) use heat as input rather than energy to produce cooling that is comparable to centralized air-conditioning systems. Solar thermal concentrators can be used to power VAM with solar thermal energy.

The system uses a Scheffler Parabolic Dish and a Solar Parabolic Concentrator to generate hot water for operating VAM with capacities of 90 TR and 40 TR, respectively.

Scheffler Parabolic Dish

In order to collect the solar heat energy, 60 Scheffler Parabolic dishes have been erected over a 960 m² area. The concentrator dish, receivers, tracking system, and supporting structure make up the entire system assembly, which has an automatic dual axis tracking mechanism for greater efficiency.

The VAC, which produces chilled water utilised for the building's AC, receives feed from the Parabolic dish, which produces pressured hot water at a temperature of 140 °C. Fresh air intake is tuned to lower A/C load using carbon dioxide control instruments and to manage indoor air quality.

To meet the building's air-conditioning load, the solar parabolic dish generates 90 TR. Thermax, Pune, provided and installed the system, which has an efficiency range of 45–60%.

Benefits

- Annual savings of electricity are of 154 MWh
- Carbon Emission reduction is around 150 tonnes per annum.

Scheffler solar dish	Description
No of dishes	60
Size of dish	16 m ²
Total area of the reflector	960 m ²
Hot water generation temperature	140 °C
Application	Air-conditioning
Electrical output	450 units / 24 hrs

Project Cost	INR 12.5 million
Subsidy by MNRE	INR 3500/m ² & AD benefit up to 80% in the First Year.
Payback Period	7 - 9 years
Savings	INR 1.0 - 1.3 million / annum

Fig. 4: Project Details

Scheffler Parabolic Concentrator

TEL has added two more ARUN 160 systems, which are double axis tracking Fresnel parabolic concentrators with a 40 TR capacity, in order to handle the increasing load on the air-conditioning system.

Each dish's 169 sqm aperture consistently face the sun and has a gap absorber at point focus. For the vapour absorption device, the dishes produce 5 m³/hr of pressured hot water at 180°C (VAM). The hot water is returned at a temperature of 160 °C. Through the Arun dishes, the water is circulated using a centrifugal type circulating pump. A single pump is adequate to circulate water through both dishes because the dishes are set up in parallel.



Fig. 5:

Nitrogen pressurisation is used to maintain the system’s pressure at 15 bar in order to prevent the production of steam in the circuit. For this reason, the circuit’s expansion tank is connected to the nitrogen cylinders. The vapour absorption machine may be run on the two dishes’ combined average heat output of roughly 1,00,000 kcal/hr [3].

Operating parameters	System specifications
Water flow rate to dish = 5000 L/hr	No. of Dishes: 2
Pump inlet pressure = 12 bar	Technology: ARUN 160
Pump discharge pressure = 15 bar	Area of concentrator: 169 sq. m. / dish
Hot water outlet temperature from the system = 180 °C.	Capacity: 80-100 kWth per dish
Chilled water outlet - VAM = 8 °C.	Heat generation capacity: 115 X 10 ⁶ Kcal/day
Chilled water inlet - VAM = 12 d	Average solar radiation: 0.8 KW/m ²
Project Cost	INR 7.5 million
Subsidy	INR 2.02 million + AD benefit up to 80% in the First Year.
Payback Period	5 - 8 years
Savings	INR 1.0 - 1.3 million / annum

Fig. 6: Project Details

Benefits:

- Electricity savings are of around 300 - 350 MWh/yr.
- Reduction of GHG is around 130 tonnes per annum.

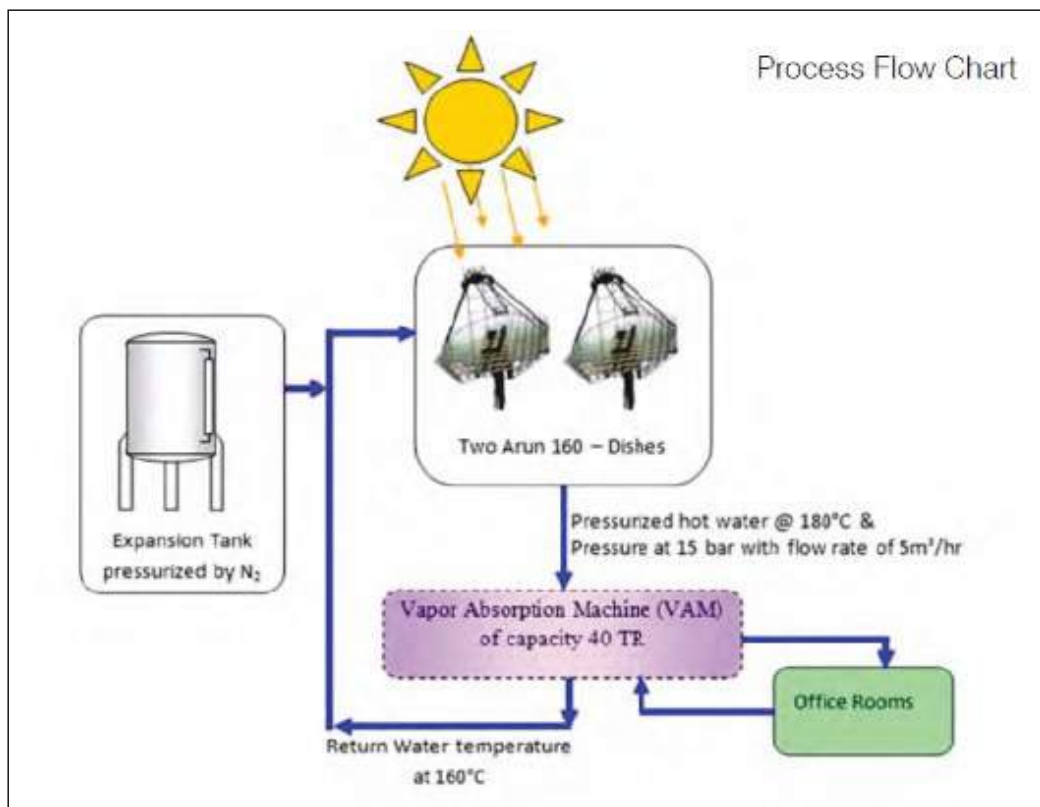


Fig. 7: Process Flow Chart

COST ANALYSIS

Investment and Running Cost

- Compared to installing a traditional system, installing a solar-assisted air conditioning system requires more technical skill. Additionally, some component costs are still expensive because current manufacturing levels for some components, like adsorption chillers, are significantly below those of large-scale industries. In conclusion, the systems' investment costs are significantly higher than those of traditional system solutions. This is less true for desiccant cooling systems because the ventilation system is the major expense in both the conventional and solar assisted systems, & the higher cost of the collector system is partially offset by the lack of a chiller in the traditional system design.
- In comparison to conventional cooling systems, installing a solar AC system requires a much greater initial expenditure. The international energy agency (IEA) estimates that the cost of installing solar AC systems would be 2 to 5 times higher than that of installing traditional cooling systems with equivalent capacity. When compared to traditional cooling systems, solar air conditioning systems are relatively inexpensive to maintain and operate, despite the greater initial investment cost. For instance, filter replacement is a key component of maintenance for desiccant cooling chillers.
- For medium- to large-capacity systems, the anticipated cost of investment for solar thermal cooling systems ranges from \$1,600 to \$3,200 per kiloWatts of cooling (IEA). Single effect LiBr chillers cost about €1,000 per kW cooling, while double effect LiBr chillers cost about INR 97,572/kW cooling. "Pre-engineered" solar kits are now readily available to consumers thanks to more recent developments in the solar cooling business. Although these systems are primarily sold in European markets, there may be a sizable demand for these "solar kits" in emerging nations like India. These kits are estimated to cost around € 3,000/kWcooling, and they were designed with a 35 kW cooling capability in order to reach the widest possible audience (IEA).
- Installing a solar AC system costs roughly INR 0.15 million per TR, compared to a conventional HVAC system's cost of between INR 0.05 million and 0.1 million per TR (Business Standard). The solar heat collectors must be replaced every 4 to 5 years and are roughly 10% of the system cost, but the operation and maintenance are extremely inexpensive. Without depreciation and government-provided subsidy benefits, the overall payback period is therefore expected to be four to five years. An average size (25TR) solar air conditioning system has a 25 year lifespan on average (Mamta Energy).
- MNRE has established fixed standard costs for concentrated solar thermal (CST) systems in order to promote solar air conditioning systems in India. CST systems with manual tracking are priced at INR 7,000/m², single axis tracked systems are priced at INR 18,000/m² of dish area, and two axis tracked systems are priced at INR 20,000. MNRE has established a benchmark price for flat plate collector of INR 8,500/m² for home users and INR 8,000/m² for commercial users. The benchmark price for evacuated tube collectors is INR 11,000/m² for non-commercial users and INR 10,000/m² for commercial users. To all beneficiaries in the general category states, MNRE offers a 30% capital subsidy on the standard cost or a loan at 5% interest on 50% of the standard cost. In the special category states like Himachal Pradesh, Jammu & Kashmir, Uttarakhand, and the north eastern states including Sikkim, these subsidies rises to 60%.

Interventions to Minimize the Payback Period of Solar Air-Conditioning Systems

Making solar air conditioning systems commercially feasible is a key driver for rapidly scaling them up. However, geographical location, technological accessibility, and local application "environment" all have a significant role in the economic viability and payback period of these systems. The following are a few actions that could shorten the payback period for themselves:

- Co/Poly-generation, in which the one phase's output energy is used as the source of energy for the next phase's process (for example, steam and waste heat), can be used for a variety of purposes, such as process

cooling and heating, among others. The payback period could be shortened by using this method of energy production and consumption.

- The cooling system should be designed and planned to meet the needs of the customers in order to minimise energy and financial waste.
- The payback period can also be greatly shortened thanks to technological advancements in solar collectors, chillers, and storage units.
- Mass production of small- to medium-sized solar air-conditioning systems and associated parts [4].

PARAMETERS- DESIGN AND SIZING

Decision Scheme for Solar Air Conditioning Technologies

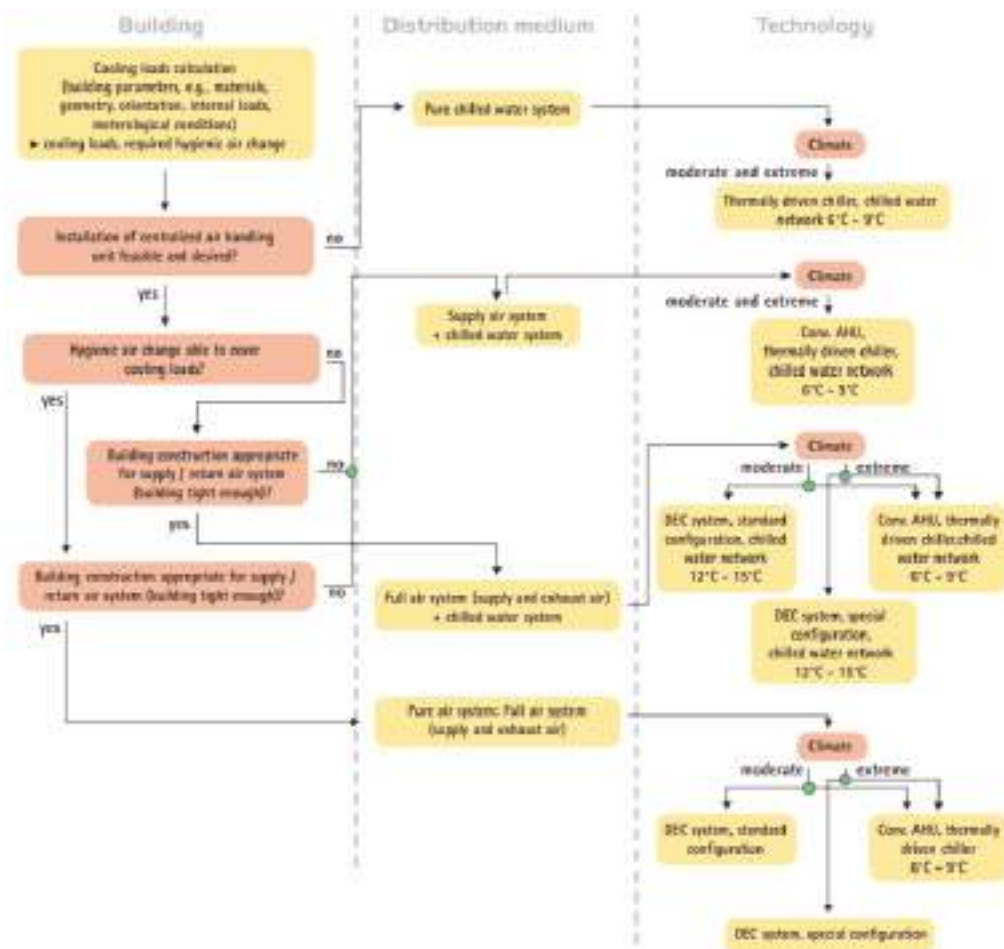


Fig. 8: Decision Scheme for Solar Air Conditioning Technologies

An arrangement of broad “thumb” rules for the design & sizing of a solar air conditioning system has been derived from fundamental considerations and lessons learned from demonstration projects:

- In order to obtain considerable primary energy savings, a thermally driven cooling system with a low thermal Coefficient Of Performance & a backup fossil fuel heat source needs a high solar percentage. This must be ensured through good system design, such as adequate large solar collecting areas, adequate large storages, and other steps to maximise the utilisation of solar heat.
- An alternative is to use a standard chiller as a backup system. In this design, the amount of cold delivered by the conventional unit is reduced by any unit of cold supplied by the solar thermally driven chiller. Even at

low solar fraction values, this design enables some primary energy savings. Therefore, the primary function of the solar system is to lower electrical energy usage.

- Any replacement of fossil fuels with fuels from renewable energy sources, like biomass, will reduce the prime energy consumption of the thermally powered system when a heat backup using fuels is applied.
- Solar thermally autonomous systems always function at their maximum with a 100% solar percentage since they don't need any other cold source.
- Even when a fossil fuel heat backup source is used, systems that have a thermally driven chiller with a high Coefficient Of Performance thermal might be constructed that have a smaller solar component. The rationale is that, from a primary energy perspective, the heat from the fossil fuel burner is also transformed at a high COP thermal, competing with a conventional system.

The Feasibility Study Parameters

The utmost assuring solar air conditioning technology and the layout of the system can currently only be chosen quickly and easily using software that is simple to use.

Due to this, it is strongly advised to do a feasibility study at the start of the planning phase, under the direction of a competent engineering office.

In a feasibility study the following steps may be analyzed:

- Choosing the most assuring solar air conditioning technology and the layout of the system, as well as determining the cooling and heating loads and creating time array of the loads.
- The components' pre-sizing, such as the solar collector field size and the heat- and cold-storage facilities.
- Evaluation of control measures' impact on system performance
- The computation of efficiency and utilisation values, such as the cooling system's Coefficient of Performance, the solar thermal system's solar portion for covering loads, the net collector efficiency, etc.
- Estimation of financial essential figures and of the fundamental energy savings.

Hardware, environment, and financial limitations all affect how big cooling system components should be. Under conceivable unfavourable conditions of high humidity and low or inconsistent solar insolation, the cooling unit must be sized to give the maximum cooling demand. Depending on how much of the cooling load will be met by solar energy, a collection area will be needed. Under unfavourable conditions of high humidity and limited insolation, very large collector areas may be necessary for 100% solar cooling. While there is no precise calculation method for solar cooling, the equation below can be used to approximate the required collector area-

$$A = \frac{\text{Cooling load/COP}}{I_r T_1 [\eta]_{\text{collect}} [\eta]_{\text{delivery}}}$$

where: Cooling load = the portion of the total cooling load provided by solar calculated using ASHRAE techniques or others.

COP = Coefficient of Performance of the cooling unit. COP is the ratio of heat energy removed to energy supplied from external sources. Manufacturing data is recommended for determining COP (3413 Btu = 1 kWh).

$I_r T_1$ = average instantaneous solar insolation on collector surface (i.e., at tilt angle).

$[\eta]_{\text{collect}}$ = average collector efficiency under design conditions.

$[\eta]_{\text{delivery}}$ = delivery efficiency which takes into account heat exchanger efficiency and thermal losses.

Fig 9: Estimate of the require collector area

The collector area necessary to supply the cooling load majority is often bigger than the collector area of typically sized heating-only systems. Due to the heat engine's higher thermal efficiency, which should be taken into account in the previous calculation, area of collection for heat engine systems are bigger than those for absorption cooling systems.

CONCLUSION

- Solar cooling is now both feasible and dependable. An effective, wise, and environmentally beneficial option to employ sources of renewable energy to meet the air conditioning needs is to utilise solar thermal energy for cooling.
- These systems promote being an efficient replacement for conventional cooling systems, which are wasteful in terms of energy use and greenhouse gas emissions. Despite the clear success that solar cooling technologies have attained, there are still a number of obstacles, such as the high installation cost and the poor performance. A good alternative to traditional fuel or electricity for comfort cooling needs is a solar-based vapour absorption machine.
- Since no refrigerant is utilised in these systems, it is concluded that desiccant cooling technology is both environmentally beneficial and energy efficient.
- Solar cooling application can be done with low prices where:
 - (i) Where solar radiation is at its best throughout the year and there is a constant and high appeal for thermal energy, solar cooling can be used at minimal cost.
 - (ii) The efficiency or the adequacy of a solar AC system will be as high as the temperature and the solar radiation of the site where the system's installation will take place.
- In terms of the air conditioning, it is important to first evaluate the cooling capacity because this will give a general note of designing and building the system with sufficient electrical energy supplied to it. The dependability and adequacy of the system for greener solutions to the world's energy demands will be improved with the consideration of these many variables.
- Solar cooling is a system type which can be sized and adopted to the climate of the place where its installation will take place and the needs/requirements of the people living or benefitting from a particular place.

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Sewage Wastewater Characteristics & Its Management in Urban Areas

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▶ ABSTRACT ◀

Sewage is a combination of water and waste which contains organic and inorganic solids from various establishments such as commercial, industrial or residential etc. As a result, wastewater treatment is essential. Yes, the sewage treatment plant (STP) is responsible for removing dangerous toxins in the most cost-effective manner while also providing a better environment. Physical, chemical, and bio-logical techniques are used to remove contaminants and produce treated wastewater (or purified effluent) that can be safely discharged into the environment.

Sewage treatment is simply another term for wastewater treatment. While the former refers specifically to domestic wastewater, the latter covers both domestic and industrial wastewater. In most cities, the sewer system transports a percentage of industrial wastewater. To the sewage treatment facility, which has typically been pre-treated at the industries. Decreasing pollutant load is the purpose of this pre-treatment step. If the sewage system is a combined one, stormwater will be directed to the treatment facility alongside wastewater. Sewer water can be carried to treatment facilities by pipes and through a natural flow facilitated by gravity. A bar screen typically features in the primary phase of wastewater treatment. It filters out coarse particles, depositing them in bins for later disposal. Prior to advanced treatment, fat and oil are extracted.

Keywords: *Sewage Treatment Plant, Water Treatment, Wastewater, UASB STP.*

INTRODUCTION

With the rapid urbanization of the country, there has been a corresponding increase in the demand for and use of water, one of the most important sources of livelihood. Nearly 80% of the water provided for household consumption is disposed of as wastewater. Most of the wastewater is discharged untreated and either sinks into

the ground, where it contaminates the groundwater, or is discharged into the natural sewage system, polluting downstream regions. As a result, it is critical to treat wastewater with current technology in order to recover as much useable water as feasible. According to research, the expected sewage is 38,254 (based on 2008 estimates) (MLD). Against this, only 11,787 MLD treatment capacity exists. As a result, existing treatment capacity only covers 30% of current sewage production. Similarly, industries create around 13,468 MLD of effluent, of which only 60% is processed.

RATIONALE

Government can mitigate the health risk by reducing the waste by treating the wastewater and the waste which is disposed to the environment which in turn improves the health of environment Today there is a rapid increase in interest in making provisions and installing more sewage treatment plants to treat water and reuse it to meet basic human needs. It's hardly unexpected that there's so much curiosity.

Apart from producing clean and reusable water the wastewater treatment also produces other benefits such as it has the ability to reduce the waste generation of the country, ability to produce natural fertilizers and can also generate energy using Biogas such as methane.

METHODOLOGY



Fig. 1: Methodology

CASE STUDY

Case Study 1: 14 MLD UASB STP Plant In Mirzapur, India

Reasons for selecting Case Study:

Selected STP is a 14 MLD UASB sewage treatment plant in Varanasi that was built in 1994.

The Ganga, India's greatest river, is polluted, posing serious risks to human health and the environment.

Mirzapur is a commercial city on the banks of the Ganges, with carpet making as its principal industry.

Selected STP is a 14 MLD UASB sewage treatment plant in Varanasi that was built in 1994 as part the Ganga Action Plan.

The Ganga, India's greatest river, is polluted, posing serious risks to human health and the environment. Mirzapur is a commercial city on the banks of the Ganges, with carpet making as its principal industry.

How UASB STP Works

- An anaerobic (oxygen-free) sludge blanket, called UASB, is a anaerobic (oxygen-free) fermenter used in wastewater treatment.
- Wastewater travels upwards through the blanket and is digested (degraded) by anaerobic microbes, resulting in a blanket of suspends granular sludge. By flocculation, the up flow along with gravity's settling action. The aggregates eventually coalesce into thick, compact biofilms known as "granules."
- As a result, biogas with high methane concentration is produced, this may be used as a source of energy/ electricity that helps in covering the operational cost or export.

Design Features & Process

- The essential characteristic of the contemporary approach is taken for the designing of UASB, the reactors are subdivided into multiple smaller sections for flexibility of operations.

- The primary unit of treatment that includes UASB and the FPU, delivered in similar size modules.
- Since the operations of reactors are independent, while troubleshooting the flow can be directed to other reactors without interfering with the working of STP.

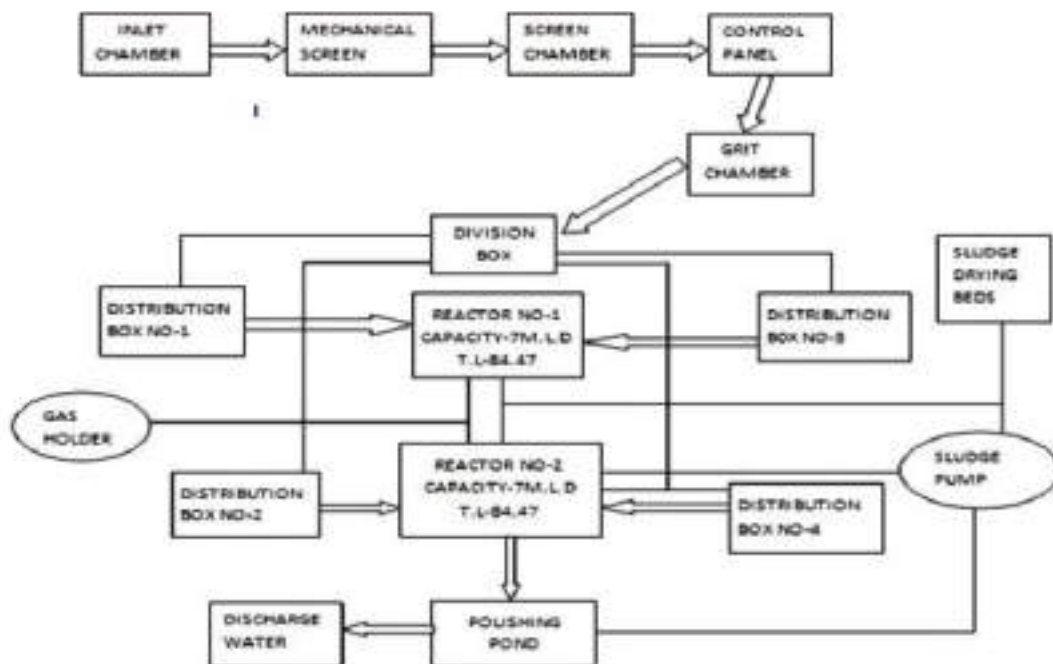


Fig. 2: Graphical Representation of UASB at Mirzapur

Inference

- During Inflow, effectiveness of solids settling is determined by velocity of wastewater in the reactor.
- The height of the sludge blanket on the bottom of reactor has a beneficial influence on the efficiency of solid retention in the chamber. Because of the higher liquid velocity at the apertures, if the sludge height is too near to the openings, sludge will be swept into the settling compartment.
- A “UASB” resembles a big septic tank on its side. It operates without the use of electricity, much like a septic tank. Nonetheless, it is more efficient than the septic tank. With options open for employing additional treatment methods.

Case Study 2: Design of UASB for Municipal Sewage (45 MLD)

The Reason of my Selection of Case Study

- To propose a long-term municipal sewage treatment system to address Tirupati’s 45 million litres per day (MLD) sewage generation by 2030.
- Hydraulic design for different STP components in general, and UASB particularly.
- Calculate the costing of the operations..

Introduction

- In 1972, the UASB was created to handle medium and high-strength waste water.
- At the bottom of the UASB is a feeder intake distribution mechanism, and at the top is a 3-Phase separator.
- At lowest portion of reactor, an anaerobic sludge blanket is maintained, and incoming wastewater is pushed to percolate upwards through this blanket.

- The GLSS separator separates the sludge and biogas from the wastewater.
- The sludge's ability to settle is improved by the lack of mechanical mixing and sludge recirculation.

Evaluation of Design Features

1. Hydraulic Retention Time = 8 to 10 hours
2. SRT = 30–50 days
3. 5–10 kg COD/m³-d organic loading on sludge blanket
4. BOD/COD removal efficiency = 85%/60 %
5. Flow regime: Constant rate via pumping
6. Up-flow Velocity = 0.5 m/hr. (Average)
= 1.0 m/hr. (Peak)
7. Sludge production = 0.15 – 0.25 kg. Of solids/ kg. BOD
8. Sludge drying time = 12 days (Monsoon)
= 8 days (winter)
= 6 days (summer) (Rupendra, 2016)
9. Production of Gas = 0.2 to 0.3 m³/kg.
10. Gas quality: CH₄- 65 to 68%
CO₂ -30 to 35%
H₂S- 0.5 to 1.0%
11. Gas utilization: Boiler fuel: 1 m³ of gas is equivalent to 1.2 kWh of electricity.

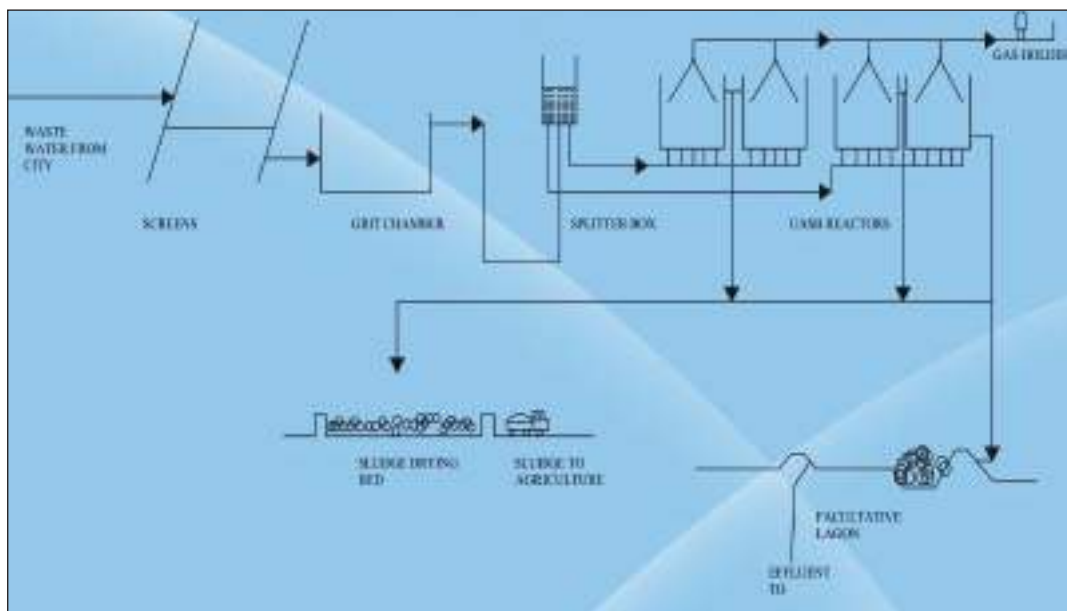


Fig. 3: Design Layout

CONCLUSION

UASB has the lowest capital, operating, and maintenance costs compared to other treatment facilities.

- BOD and COD removal efficiency- 85%and60%
- Methane gas is used to generate energy.

- For every 1 kilogramme of cod removed by anaerobic method, 1.16 kWh of energy is created.
- Less biomass (sludge) generation.
 - Life Cycle Cost UASBR < SBR < MBBR
 - BOD Removal ASP > SBR > UASB > MBBR
 - COD Removal ASP > MBBR > UASB > SBR
 - TSS Removal ASP > SBR > UASB > MBBR
 - Nitrate Removal MBBR > SBR > UASBR

Case Study 3: Study of Delhi Pilot Project of Natural STP, Bawana, New Delhi

Design of STP

- A sedimentation tank is used in a natural sewage treatment plant (STP), where the sewage is allowed to settle so that the complete suspended particles may be removed.
- The STP of Bawana District (Industrial) was built in July of last year and has 4 chambers and different beds of varying sizes of pebbles.
- The STP, which is approximately 300m long and 5m broad made up of concrete, is made up of a sedimentation tank in which the sewage is allowed to stand for the settlement. It cleans sewage running through the Ghoga drain and connects to the Bawana drain, using natural materials such as stones and aquatic plants.
- Water is then pumped through four chambers and several compartments, each with a different size bed of pebbles.
- Every day, at least four different species of fast-growing aquatic plants feed on organic detritus in the water, purifying about 10 lakh gallons of sewage.
- A view of an experimental sewage treatment plant (STP) at Bawana, New Delhi, made of stones and plants.



Fig. 4: STP at Bawana Delhi

Wastewater Treatment and It's Disposal

The size and capacity of WTF's are determined by the estimated volume of sewage produced by various building types connected to the sewer systems along with projected in-flow and infiltration.

The choice of weather centralized or clustered is influenced by factors like no. of customers served, location, site constraints, sewer connections, average & peak flow, wastewater characteristics, regulatory effluent limits, cost associated and maintenance. Discharge into a surface water body is most popular way of disposing of wastewater in large cities and towns. Suburban and rural areas opt for subterranean disposal.

In order to avoid the water quality from declining, 2 types of requirements are important: Effluent standard and stream standard. Stream standards are the limitations on the quality of contaminants permitted in streams, river and lakes. Water from different locations should be treated as per local legislative criteria. The limits stem from a classification of the water's maximum useful usage. Stream standards control a number of water quality benchmarks including dissolved oxygen, coliforms, turbidity, acidity, etc. The wastewater has to be treated from a STP and is focused of effluent regulations. These standards often govern characteristics like suspended particles, acidity, BOD, etc.

The three stages of advanced treatment for wastewater are primary, secondary and tertiary. Also, about 60% of all suspended particles and about 35% of BOD are eliminated after 2st treatment, but dissolved contaminants are left behind.

During 2nd treatment, about 85% of the suspended particles and BOD are eliminated. Over 99% of the impurities in the sewage can be eliminated by tertiary treatments, leaving behind an effluent as pure as drinking water. Tertiary care is often twice as expensive as secondary care, It is only applied in certain situations.

The last step before sewage effluent is released back into a body of water is disinfection, for the removal of pathogens and its effluents. Disinfection is often accomplished by mixing liquid hypochlorite solution or chlorine gas into the tank. An additional chemical to dechlorinate the wastewater may be added since residual chlorine are harmful to aquatic life.

Stages of Sewage Treatment Plant

Sewerage and sewage treatment is a discipline about environmental engineering where fundamental engineering principles are used to tackle problems related to the collection and treatment of sewage, Environmental concerns and biochemistry are applied to the treatment, reuse, and disposal of sewage after treatment. Safeguarding the public health in a way that balances economic, social and environmental issues is the ultimate objective.

Knowledge of the following topics is required to safeguard public health and the environment:

- Constituents of concern in sewage,
 - The effects of these elements on the environment when sewage is spread.
 - The alteration of these elements in therapeutic procedures, as well as their long-term destiny.
 - Techniques for treating sewage that can be employed to eliminate or change its characteristics
 - The alteration of these elements in therapeutic procedures, as well as their long-term destiny
- First, some common terminology is defined in order to provide readers an overview of the topic of sewage treatment.
- An examination of the difficulties that must be overcome in the conceptualization and creation of wastewater management systems, as well as the present state and future directions of sewerage and sewage treatment technologies.

DESIGN

Brief of the Project

- Name of the project : Ruby Grand Apartments
- Location : Agaram Main Rd, Tiruvanchery, Selaiyur, Chennai, Tamil Nadu
- Project Type : Housing
- Site Area : 3.5 Acres
- Population : 589

Design Considerations

During the design of a sewage treatment unit, the following factors are taken into account:

- The design duration should be between 25 and 30 years.
- The design should be based on the average residential flow rather than the hourly sewage flow.
- To ensure uninterrupted functioning throughout plant maintenance and repair, various small units should be administered for each treatment, rather than a single large unit.
- If necessary, bypasses and overflow weirs should be installed to stop the particular process.
- At every location and step, self-cleaning velocity should increase.
- The treatment units should be designed to be cost-effective, as well as easy to maintain and operate.

Designing of Storage Tank

Ruby Grand has a population of over 589 people, according to the March 2017 census.

Water requirement = 135 LPCD.

Population = 589

The quantity of water supplied = $135 \times 589 = 79.500$ KLD

$$\begin{aligned} \text{According to CPHEEO, 80-85 percent of water is converted to sewage} \\ = 79.50 \times 103 \times 103 \times 80/100 = 63.6 \text{ KLD} \end{aligned} \quad (1)$$

The amount of water that becomes sewage - 63.6KLD. The maximum sewage flow rate is, (Peak factor) = 3

$$\text{PF} = 3 \times 63.6 \text{ KLD} = 191 \text{ KLD} \quad (2)$$

A circular storage tank is employed in this case. The PF of sewage is 191 KLD. Volume (tank) = capacity / cu. m = $191 \times 103 / 103 = 190$ cu.m The rectangular storage tank has a capacity of 190 m³/day.

The tanks are separated into three tanks due to the huge capacity of the tank. Volume = $190 / 3 = 63.33$ cu.m. Volume = 64 cu.m (approx.) As a result, supply three tanks with a total volume of 64 cu.m. The depth of the storage tank should be 2m -4m, according to IS 3370 part-4.

Assume that the circular tank's depth is 4 metres.

Water is only held for 12 hours in the circular storage tank.

$$\text{As a result, the storage tank's volume is } V = 64/2. = 32 \text{ cu.m.} \quad (3)$$

The circular volume formula is used to compute the diameter of the circular tank.

$$\pi / 4 \times d^2 \times 4 = 32 \quad 0.785 \times d^2 \times 4 = 32 \quad D^2 = 32 / 0.785 \times 4 \quad D = 3.19 \text{ m.} \quad (4)$$

As a result, supply three circular storage tanks with a diameter of 3.19 m and a height of 4 m.

Design of Detritus Tank

A settling tank with a constant level and brief retention period is called a detritus tank, or square degritter tank. A grit-washing procedure in order to get rid of organic material from these tanks. There are two design choices for removing and sorting grit from the sump: A rake and a grit auger. Detritus tanks are designed to maintain a detention duration of 3 to 4 minutes while minimising turbulence. A well-distributed flow into the settling basin is required for proper detritus tank performance. The projected overflow rate is adjusted based on input and exit turbulence as well as short circuiting by applying a DF of 2.0

The sewage flow rate to the grit chamber is between 0.2 and 0.3 metres per second. Assume that the flow velocity is 0.2m/sec. When compared to the grit chamber, this tank has a longer detention duration.

Detention period is 3- 4 min. Considering a three-minute detention period, peak flow at 3 times the avg. flow. Thus, supply 3 detritus tanks:

Avg. flow $q = 0.138$

detritus tank's length is governed by,

Length = velocity

Detention time = $0.2 \times 3 \times 60$

Length = 36m

Cross sectional area = discharge/velocity = $0.138/0.2$ A = 0.70m² (5)

detritus tank's total depth ranges from 2.5 to 3.5 metres.

Assume the tank is 3 metres deep.

Width = area / depth = $0.70 / 3 = 0.233$ m consider B = 0.25 m (6)

As a result, three detritus tanks measuring 36 m x 0.25 m x 3 m are used, one of which is maintained on standby. A 0.3metres free board should be supplied at the top, and a 0.45m dead space depth for debris collecting should be provided at the bottom.

Complete depth of the tank = $3 + 0.3 + 0.45 = 3.75$ metres

The tank will be 0.3m at a depth of 3.3m, with the sides sloping down to form a 36m long elongated trough with 0.15m width at the bottom and rounded corners.

Semiconductor photocatalytic technology based on UV or solar light has grown in popularity due to its advantages in the use of a wide range of disinfectants or additional chemicals, as well as the features of its mineralization. Since resistive organics are mineralized rather than changing into a different phase, these are particularly significant.

In the past 20 years the development in design has been very crucial for the study of the photocatalytic process. As a sophisticated oxidation process one of the most significant use of this technology is the breakdown of organic contaminants in the water and air. The basic idea of photocatalysis are outlined in this overview, with an emphasis on significant kinetic and mechanistic elements as well as certain prerequisites for effective photocatalysis.

Main part of this review describes in detail various solar reactors for photocatalytic water treatment, including a comparison of their overall performance.

The entire installed capacity of solar power is only 0.005TW, in spite of its 600 TW gross potential and 60 TW technological feasibility. Even though the amount of energy consumed today is still very little, development in solar thermal systems have been getting better over time. Common wastewater treatment techniques include solar photocatalysis, solar desalination, solar disinfection, solar detoxification, and solar pasteurization. One of the novel technique is the separation of synthetic compound and heavy metals from liquid waste using sun radiation.

Usage demand for drinking water is increasing exponentially as the population grows. Pollution from industries and agriculture is increasingly affecting the most important source of drinking water. The presence of toxic contaminants, even trace amounts, poses a significant risk to the ecosystem and the human health. As a result, before being discharged or used, human pollutant must be effectively separated from wastewater. Other pollutants that have become major sources of wastewater contamination include industrial effluents and synthetic pesticides. Although in small quantities, discharge of these effluents has a significant risk to freshwater and marine fauna, resulting in serious ecological balance disruption.

CONCLUSION

- There is a strong urge and need of introducing a STP in the building.
- It is a step toward more environmentally friendly and sustainable design.
- The conversation and recycling of water and reusing it within the building is a demanding requirement of today.

- Understanding the stages involved in the treatment of sewage water in STP, i.e., Preliminary, Primary, Secondary and Tertiary.
- The grit chamber and oil grease trap are components and units of the preliminary treatment. Primary treatment units include equalisation tanks and collection tanks, while secondary treatment includes aeration tanks, secondary clarifiers, and settling tanks.
- There are various treatment methods based on the basis of varied secondary process of treatment few examples are as follows:
 - i. Active sludge treatment
 - ii. MBBR
 - iii. MBR
 - iv. SBR
 - v. Up-Flow Anaerobic Sludge Blanket reactor
- The upcoming advance treatment are:
 - i. BIOFOR
 - ii. SAFF
 - iii. FBAS (FIXED BED BIOFILM ACTIVATED SLUDGE PROCESS)
 - iv. Bio-towers
 - v. HYDRO PLUME
 - vi. Eco-bio Blocks
- The sludge holding tank receives any excess sludge from the secondary treatment tank.
- Each STP unit is built for a different capacity. They vary due to various factors such as :
 - i. Varying Settling time
 - ii. Velocity speed
 - iii. Area
- Finally, tertiary treatment can be accomplished using a pressure sand filter, an activated carbon filter, chlorination, or UV radiation, as well as ozonation.
- The sewage may now be utilised for irrigation and flushing. Water is further treated with softeners for other sensitive use.

Car washing, flushing, landscape irrigation, and basement and bathroom cleaning are the most common uses for this water. The intention is admirable, and the reuse solution is sensible. The concept should be embraced wholeheartedly. The major benefit of utilising treated water is that it reduces the amount of fresh water consumed and the expense of fresh water, especially if it comes from a costly source such as tankers.

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Resolving Conflicts in Road Construction: Understanding Key Factors and Selecting Effective Methods

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▶ ABSTRACT ◀

Due to the parties' inability to resolve disputes, India's construction industry is weak and suffering swiftly and efficiently. Our goal is to examine the primary reasons why disputes arise in the road building sector. Disputes are now a common occurrence in the road building sector. They can become more serious if not dealt with right away, causing schedule delays, claims that need legal action to be handled, and destroying corporate relationships. One of the key elements that lowers the attainment rate of a project is conflict. To finish the road building plan in the required time, budget, and quality, it is crucial to understand the reasons for disputes and their methods of resolution. In order to gather information regarding the causes and modes of dispute settlement in the road construction sectors, this study performed a questionnaire survey. 210 valid responses to the questionnaire survey were received and based on the decisions of the study Negotiation method is identified as the most suitable dispute resolution method. The study's findings indicate the main reasons why disputes arise in the road building sector. The study's findings also included an analysis of the dispute-resolution techniques used in road construction projects, including litigation, adjunction, conciliation, and arbitration.

Keywords: *Road Construction Industries, Dispute Resolution, Adjunction and Conciliation.*

INTRODUCTION

Construction disputes arise when stakeholders to a project disagree about a variety of factors, such as design, construction, cost, schedule, and quality. Construction disputes can happen at any level, from planning to design to execution[1]. They may include the owner, general contractor, suppliers, subcontractors, architects, engineers, and other project participants[2].

Road construction disputes can occur for a number of reasons, including:

- **Design Issues:** Road construction projects sometimes experience disagreements due to design concerns. This can occur due to errors or omissions in the design plans, changes or modifications to the design that are not properly communicated or documented, or misunderstandings or disagreements regarding the design plans[3]. These disputes can result in delays, cost overruns, and damage to relationships between the parties involved[4].
- **Contractual Issues:** Disputes can also arise due to contractual issues in road construction projects. This can occur due to differences in interpretation of the contract documents, ambiguous contract language, or a lack of clarity in the roles and concerns of the parties included[5]. These disputes can lead to delays, increased costs, and potential claims for damages[6].
- Disputes can also arise due to contractual issues in road construction projects. This can occur due to differences in interpretation of the contract documents, ambiguous contract language, or a lack of clarity in the roles and concerns of the parties involved. These disputes can lead to delays, increased costs, and potential claims for damages[7].
- **Quality and Workmanship Issues:** Quality and workmanship issues can also be a significant cause of disputes in road construction projects. This can occur due to disagreements over the quality of objects used, the workmanship of the construction, or differences in standards or expectations[8]–[10]. These disputes can lead to delays, additional costs, and potential claims for damages[6].
- **Change Orders:** Disputes can arise over change orders, which are written requests for changes to the contract documents, such as changes to the scope of work, materials, or schedule. These disputes can occur when there is a lack of settlement between the parties regarding the scope or cost of the change or when the change is not properly documented or approved[11].
- **Force Majeure Events:** Disputes can also occur due to unforeseen events, such as natural disasters or other “force majeure” events. These events can disrupt the project schedule, result in additional costs, or even result in termination of the project[12].
- **Claims for Additional Compensation:** Disputes can occur when one party makes a claim for additional compensation, such as for unforeseen conditions or changes to the scope of work.
- **Schedule Delays:** Disputes can arise when there are schedule delays, which can result in additional costs or claims for damages[13].

Dispute Resolution Methods

The adoption of various conflict resolution techniques is widespread worldwide [14]. These conflict resolution approaches’ applications, processes, and procedures were simple to use in the construction sector. current standard dispute resolution procedures utilized in the construction sector[15].

Based on the above discussion, the main objective of this paper is to provide an analysis of factors affecting the dispute, and selection of dispute resolution methods in road construction industries. In next sections of paper, literature review, methodology, results and conclusion are provided. In order to gather information regarding the causes and modes of dispute settlement in the road construction sectors, this study performed a questionnaire survey. 210 valid responses to the questionnaire survey were received.

LITERATURE REVIEW

Emre Cakmaket Al [13] recommended employing an analytical network method to analyze the root causes of conflicts in the building business. The primary reasons of disagreements that arise in the construction sector are being examined by this approach. Literature research has been conducted to determine the typical construction conflicts in order to accomplish this goal. The major types of the disagreements, which were drawn from a cross-section of the literature, were identified, along with the primary reasons of building disputes. In order to evaluate their relative relevance, a study was done utilizing the analytical network process (ANP) technique.

A. A. Elziny et al [7], focus on the issue of dispute resolution in Egyptian building projects. This paper offers a thorough survey of the body of knowledge on dispute analysis. This study's goal was to develop an expert system that could assess how well corporate projects' general conflict resolution processes are working. The most significant cause of disagreements was "contract management," followed by "contract papers," "finance difficulties," "project-related issues," and "other sources," such as force majeure and a violation of construction regulations. The research finds that owing to a variety of factors, including concerns relating to the owner and contractor's management of the contract, the contractor's time schedule, and necessary updates, the contract management may be seen as the primary element that might impact the occurrence of conflicts [16], [17].

According to Zhang Yang [15], a contract is the backbone of every effective conflict management strategy. Contracts for construction projects are legally binding documents that outline the rights and responsibilities of the contracting party (the owner) and the construction company (the contractor) in the course of completing a specific construction or installation project in accordance with industry standards.

Mitkus S. et al. [14] investigated what leads to customer and contractor disagreements in construction. This study's authors concluded, after reviewing articles on building project disagreements, that the modern scientific literature tends to attribute disagreements to easily observable, external factors. The analysis of a construction contract agreement is based on the premise that the agreement is the result of dialogue between the parties. According to studies, the primary root of construction disputes is a too vague or ambiguous contract that might be construed differently by each party [18]–[20]. This suggests that poor lines of communication between those involved in a building project are the leading source of disagreements. If construction contract agreements were well drafted, they would serve as a formidable defence mechanism against disagreements. This article identifies unjust construction participant conduct and psychological defence mechanisms as additional reasons of construction industry disputes. The purpose of this survey [5] was to examine the causes of disputes in the building sector. The research identified three sources of conflict: behavioural issues, contractual issues, and technological issues. Behavioural variables that contribute to conflict include failing to double-check work for constructability, incomplete or unclear documentation, and a lack of open dialogue between team members. Meanwhile, issues with the contract can cause conflict, including a delay in possession transfer, a lag in interim payments from the client, or ambiguous language. Yet, causes that lead to disagreements because of technical issues include the contractor's incompetence and the architect's or engineer's tardiness in giving instructions. Based on their research, Iyer et al. [21] concluded that the key problems that caused the development of the present system were the gaps in contract papers that led to conflicts. Although a completely foolproof contract agreement would alleviate most of the problems, such a thing does not exist. In huge contracts, errors and contradictions may arise for a variety of causes outside the purview of the contract's drafter [22], [23].

Research Methodology

The step-by-step procedure to achieve the objectives of the study is given below:

Step 1: Identification of Questions for Questionnaire Development

In order to achieve the objectives of the study, following 25 questions were identified based on literature review and discussion with experts

Table 1: Please Use Given Rating Scale to Rate Given Factors (Table 2) Related to Dispute in Road Construction

Degree of Severity	Rating Point
Very High	5
High	4
Medium	3
Low	2
Very Low	1

Table 2: Identified Factors Related to Dispute in Road Construction

Factors Group	Factors	Reference
Client Related Factors	Dispute caused by variations initiated by the owner;	Priyanka Siddhpuri <i>et al.</i> (2019), Ajit Kumar Sinha (2019), Omar K. Sabri and Olav Torp (2022) ([1]–[3])
	Dispute caused by late giving of possession;	
	Dispute caused by payment delays;	
	Dispute caused by change of scope;	
	Dispute caused by quality related issues;	
Contractor Related Factors	Dispute caused by technical inadequacy of the contractor;	Priyanka Siddhpuri <i>et al.</i> (2019), Ajit Kumar Sinha (2019)
	Dispute caused by delays in work progress;	Omar K. Sabri and Olav Torp (2022)
	Dispute caused by delay due to temporary stoppage;	([1]–[3])
Questionnaire for Importance of Factors Affecting Selection of Dispute Resolution Methods	Importance of “bindingness” affecting the selection of dispute resolution methods;	R.G. Maraleet <i>et al.</i> (2017), Ajit Kumar Sinha (2019), Omar K. Sabri and Olav Torp (2022), Sujal Patel, Anand Patel (2017) ([1], [2], [4], [5])
	Importance of “economy” affecting the selection of dispute resolution methods;	
	Importance of “confidentiality” affecting the selection of dispute resolution methods;	
	Importance of “control” affecting the selection of dispute resolution methods;	
	Importance of “remedy” affecting the selection of dispute resolution methods;	
	Importance of “enforceability” affecting the selection of dispute resolution methods;	
Questionnaire for Comparison of Dispute Resolution Methods	Negotiation method of dispute resolution is;	R.G. Maraleet <i>et al.</i> (2017), Omar K. Sabri and Olav Torp (2022), Ajit Kumar Sinha (2019), Sujal Patel, Anand Patel (2017) ([1], [2], [4], [5])
	Mediation and Conciliation method of dispute resolution is;	
	Arbitration method of dispute resolution is;	
	Adjudication method of dispute resolution is;	
	Dispute Resolution Board method of dispute resolution is;	
	Litigation method of dispute resolution is;	

Step 2: Development of Questionnaire

The questionnaire was divided into two sections labeled P-1 and P-2. P-1 included information on the respondent, such as their name, age, and experience, while P-2 included questions that were pertinent to the goals of the study. 210 replies were gathered for questionnaire survey.

Step 3: Validity and Reliability Test of Questionnaire Responses

Validity of Questionnaire

Additionally, experts were asked to estimate the percentage of questions that seemed to be related to their field of specialization. The average of the percentages provided by several experts is referred to as “average

congruency%.” (ACP). However, it is essential to keep in mind that the ACP is just one of several ways that the quality of the questions can be measured. Other aspects, such as the questions’ clarity, validity, and dependability, must also be taken into consideration if one is to guarantee that the questions will be successful in accomplishing the purposes for which they were designed[14].

Reliability of Questionnaire Data

Using Cronbach’s alpha coefficient is one method that may be utilized in order to evaluate the reliability of a research instrument such as a questionnaire. Cronbach’s alpha is a statistical method that determines how well a group of items or questions in a questionnaire agree with one another. It provides a measurement of how closely connected the elements are to each other, or how accurately they measure the same construct[24].

The alpha coefficient of Cronbach can take on values between 0 and 1, with higher values suggesting greater internal consistency. It is widely accepted that a value of 0.70 or higher is acceptable for most research purposes; however, the particular cutoff may vary depending on the nature of the research question and the environment of the study[25].

In a nutshell, Cronbach’s alpha is a measure of the reliability of data that is extensively used in research, specifically in the context of the development and validation of questionnaires. Researchers can use it as a helpful tool to guarantee that their research instrument is trustworthy and valid, as well as evaluate the internal consistency of their data collection process[11].

Step 4: Frequency Analysis

A statistical method known as frequency analysis is used to assess and compile the findings of a survey or questionnaire. The replies to each question are counted and presented in terms of the proportion of respondents who selected each response option during frequency analysis.

The goal of frequency analysis is to present a summary of the distribution of answers to each survey or questionnaire question. Researchers may be able to spot patterns or trends in the data and learn more about the attitudes, habits, and opinions of the respondents as a result. Microsoft Excel, SPSS, and SAS are just a few of the software applications that may be used to perform frequency analysis.

Step 5: Hypothesis Testing

The Kruskal-Wallis test, a non-parametric statistical analysis, is used to compare three or more independent groups to see if any differences exist that merit further research. It is widely used as an alternate to the one-way ANOVA when the basic normality assumption and equal variances are not fulfilled[21].

The Kruskal-Wallis test makes no assumptions about the data distribution, in contrast to the one-way ANOVA, which presumes that the data are regularly distributed. Instead, it uses the data’s ranks to determine whether or not the groups’ medians are equal.

Step 6: Relative Importance Method

In order to unify the responses, the relative importance method is used. The factors of each group were ranked after the measuring of their relative importance index (RII), which is given by:

$$RII = \frac{\sum W}{A \times N} \quad (1)$$

Where $\sum W$ is the total answer, or the total rating of the factor provided by respondents, A is the highest possible rating, which is 5, and N is the total number of respondents. The factor with the greatest RII value is rated as one.

RESULTS AND DISCUSSION

Resolution of construction contract disputes is crucial since it prevents prospective legal action. When one party disobeys the terms of the agreement in any manner or when there is a basic misunderstanding between the parties,

construction conflicts may arise. To achieve this goal, necessary data is gathered via the use of a questionnaire. SPSS, a statistical software program for data investigation, is used to analyze the acquired data[12].

Validity and Reliability of Questionnaire

Research technique provides the metrics to assess validity and dependability. The computed value of ACP is 92%, which is well over the suggested 90%.

Reliability refers to how well the results of a measurement can be duplicated. This is essential if the measure will be utilized in a continual fashion to detect shifts. Cronbach's alpha was used to measure the consistency of respondents' ratings on a 5-point scale. The SPSS Cronbach's alpha calculation results are shown in Table 3.

Table 3: Cronbach alpha

Reliability Statistics	
Cronbach's Alpha	N of Items
.803	20

As shown in Table 3, the Cronbach's Alpha is calculated as 0.803, therefore, the data obtained from questionnaire survey can be considered as reliable.

Ranking of Factors

Ranking of factors along with mean and RII values are shown in Table 4.

Table 4: Ranking of Factors

Sr. No.	Factors	Mean	RII	Rank
Factors Affecting Dispute in Road Construction: Client Related Factors				
1	Dispute caused by quality related issues;	3.119	0.624	1
2	Dispute caused by late giving of possession;	2.938	0.588	2
3	Dispute caused by variations initiated by the owner;	2.910	0.582	3
4	Dispute caused by payment delays;	2.881	0.576	4
5	Dispute caused by change of scope;	2.862	0.572	5
Factors Affecting Dispute in Road Construction: Contractor Related Factors				
6	Dispute caused by delays in work progress;	3.267	0.653	1
7	Dispute caused by delay due to temporary stoppage;	2.929	0.586	2
8	Dispute caused by technical inadequacy of the contractor;	2.890	0.578	3
Factors Affecting Selection of Dispute Resolution Methods				
9	Importance of "confidentiality" affecting the selection of dispute resolution methods;	3.195	0.639	1
10	Importance of "control" affecting the selection of dispute resolution methods;	3.190	0.638	2

11	Importance of “bindingness” affecting the selection of dispute resolution methods;	3.038	0.608	3
12	Importance of “economy” affecting the selection of dispute resolution methods;	3.019	0.604	4
13	Importance of “enforceability” affecting the selection of dispute resolution methods;	3.014	0.603	5
14	Importance of “remedy” affecting the selection of dispute resolution methods;	2.857	0.571	6
Comparison of Dispute Resolution Methods				
15	Negotiation method of dispute resolution is;	3.029	0.606	1
16	Dispute Resolution Board method of dispute resolution is;	2.995	0.599	2
17	Mediation and Conciliation method of dispute resolution is;	2.971	0.594	3
18	Litigation method of dispute resolution is;	2.943	0.589	4
19	Adjudication method of dispute resolution is;	2.895	0.579	5
20	Arbitration method of dispute resolution is;	2.762	0.552	6

Based on the ranking of factors given in Table 4,dispute caused by quality related issues and delays in work progress are found as topmost dispute causing factors in road construction projects. Also, confidentiality is found as the topmost factor affecting the selection of dispute resolution methods. Moreover, the negotiation method is found as the topmost dispute resolution method for road construction industries. Based on Table 4, the mean value chart and RII chart is shown in Figure 1 and Figure 2, respectively.

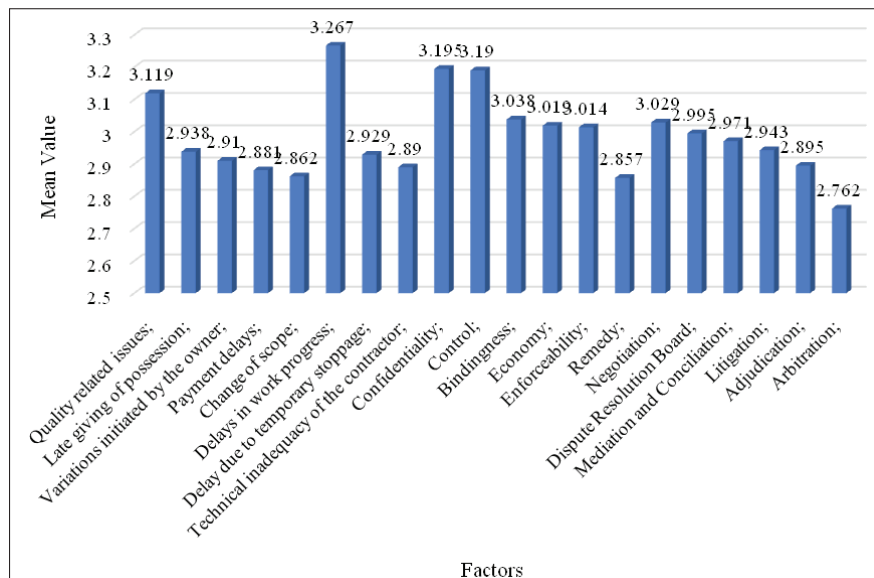


Fig 1: Mean Value Chart

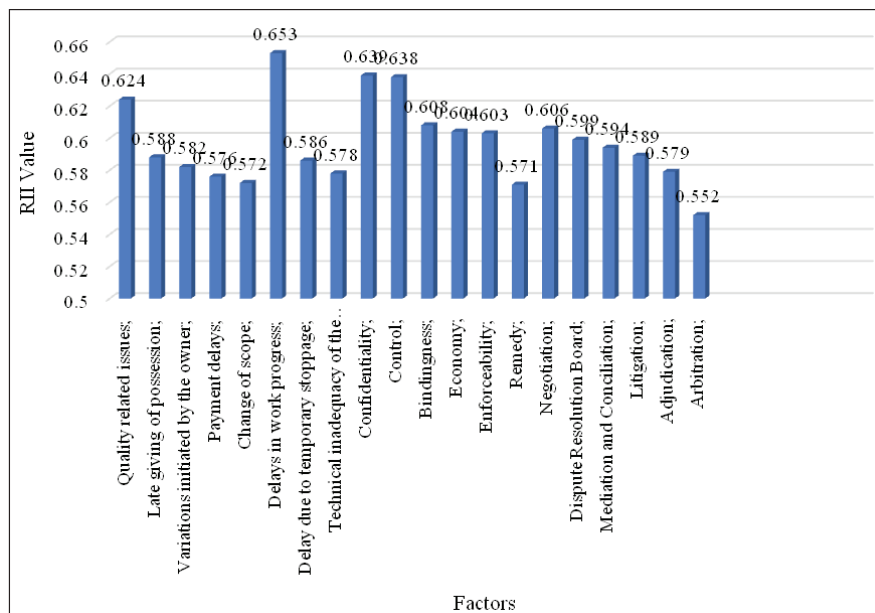


Fig. 2: RII Value Chart

Findings

Construction-related disputes are a major source of concern for the road construction sector. To comprehend how these dispute resolution techniques behave, a thorough investigation is required. The theories covered in this study explore the selection criteria and philosophical foundations of dispute resolution techniques. Therefore, the study investigated the major causes and impacts of disputes and related dispute resolution approaches in the road construction projects of India. For this purpose, 210 responses were collected, and analysis of collected data illustrate following major points:

- The questionnaire is found to be valid as the ACP value was estimated as 92%.
- The data collected from questionnaire survey is found to be reliable as the Cronbach's Alpha is estimated as 0.803.
- In this questionnaire survey, most of the respondents were from consultant group.
- In this questionnaire survey, most of the respondents were General Manager.

Based on the RII method, following important points can be highlighted;

- Dispute caused by quality related issues is found as most important client related dispute affecting factor.
- Dispute caused by delays in work progress is found as most important contractor related dispute affecting factor.
- Confidentiality is found as the most important factor affecting the selection of dispute resolution methods,
- Negotiation method of dispute resolution is found as the most preferable dispute resolution method.
- Dispute Resolution Board method of dispute resolution is found as the second most preferable dispute resolution method.
- Mediation and Conciliation method of dispute resolution is found as the third most preferable dispute resolution method.
- Litigation method of dispute resolution is found as the fourth most preferable dispute resolution method.
- Adjudication method of dispute resolution is found as the fifth most preferable dispute resolution method.
- Arbitration method of dispute resolution is found as the sixth most preferable dispute resolution method.

Based on hypothesis testing, following results were obtained:

- There is no significant difference between the factors affecting the dispute in road construction based on the responses of client, contractor and consultant.
- There is no significant difference between the factors affecting the dispute in road construction based on the designation of respondents.
- There is no significant difference between the factors affecting the selection of dispute resolution methods based on the experience of respondents.

The results provided the impact level of dispute causes. Furthermore, the results highlighted preferred dispute resolution approaches applied in these projects. Due to the relative importance of causes, impacts and resolution approaches of disputes, owners, contractors, and consultants can prioritize their plans and strategies for successful resolution of disputes.

CONCLUSION

This study has made a significant contribution to the road construction industry by identifying the factors affecting disputes and determining the most suitable dispute resolution methods based on the preferences of industry professionals. The use of a reliable questionnaire and the collection of 210 responses ensured the dependability of the data.

The following conclusion can be drawn from the following study:

- The findings of the study show that quality-related issues are prominent in client-related disputes, while delay in work progress is prominent in contractor-related disputes. The study also revealed that confidentiality is the most important factor in selecting dispute resolution methods. The Negotiation method was found to be the most preferable method followed by dispute resolving board, Mediation, Conciliation, Litigation, Adjudication, and Arbitration.
- The ACP value of the questionnaire was estimated as 92%, indicating a high level of accuracy in the data collected. The Cronbach's Alpha factor of 0.803 also indicates that the data is reliable. These findings demonstrate the importance of the questionnaire and the effectiveness of the research methodology.

The study's findings have practical implications for the road construction industry, emphasizing the need for industry professionals to adopt a standardized approach to dispute resolution methods. By doing so, disputes can be effectively managed and mitigated, and positive working relationships can be maintained among all parties involved. Overall, this study provides a valuable contribution to the field and can serve as a foundation for future research in this area.

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Power Over Ethernet—An Emerging Power Supply Technology

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▶ ABSTRACT ◀

Over the past 150 years, electricity has evolved from a scientific wonder to a luxury for the rich to a daily need in both developed and developing countries. Electricity is as crucial for daily life as water is for survival. Our way of life grinds to a standstill without electricity. For social, political, and economic activities to take place, modern society demands a smart, simple, safe, dependable, and cost-effective electric power infrastructure. The infrastructure should be efficient, flexible to expand, economical to maintain and operate.

However, developments in digital technology have sown the seeds of change throughout the previous decade. A whole desktop environment may now be carried out in a single direct current (dc) Ethernet connection, due to a significant reduction in power consumption of digital devices and the growth and improvement in capabilities of Power over Ethernet. Power over Ethernet comes out as an emerging technology which supplies low-voltage direct current (DC) electricity to devices connected to a LAN through Ethernet connections. It supplies power and data through a single cable, thus cutting the cost of installation of electrical cables. This study reflects on the use of PoE, its advantages and disadvantages and the advancement it has brought in the electrical services and explore power over Ethernet as an emerging technology to supply power and data through a single cable.

Keywords: *Electricity , Power Over Ethernet, DC Current*

INTRODUCTION

In the 21st century, every element of our life is getting better by making connections meaningful through smart gadgets, smart grids, smart cities etc. in the same way, our buildings are also getting smarter. HVAC, smart façade technologies, lighting, building automation are all part of making smart and intelligent buildings.[2] In recent years, it has become more popular to integrate wireless communication technologies (like Bluetooth, Wi-Fi) to

allow linked LED lighting systems. Alternating current (AC) line voltage is used to power such luminaires in this system. However, low-voltage direct current (DC) systems are also gaining popularity due to their ability to minimise installation costs and AC-DC power conversion losses. Power over Ethernet is one such technology that allows low-voltage DC power and communication to be delivered through an Ethernet connection, also known as a LAN cable or Category cable. [5] The advantage of PoE technology is that it can transfer both power and data over a single wire. Ethernet's availability as a data-transfer technology is extremely appealing. It's simple to use, easy to set up, and works well with existing platforms. Generally, in the field of building management, this involves system installation and alteration, both data-system specialist as well as an electrician are required for the job. With the introduction of Power over Ethernet (PoE), the difficulties of installation, reconfiguration, and operation of the entire building management system become significantly easier. Beyond its traditional use in telephone and networking equipment, PoE technology is finding its way into lights and a variety of other applications. PoE linked lighting systems have been developed particularly in office spaces by a number of major LED producers making it a potentially disruptive technology.[2]

Although Power over Ethernet (PoE) technology was initially intended to power low-wattage communication devices like IP telephones and access points for wireless communications, it is now able to sustain loads that are comparably more powerful thanks to its developing standards and technology.. That is why it has gained popularity in led lighting industry. Another reason for its use in LED lights is the development of LED technology. The improved luminous efficacy of LED'S has led to a significant increase in making POE LED luminaires that will have input power needs that are within commercially accessible PoE limitations.[3].A PoE switch can be installed to power multiple devices at the same time, and those devices, whether IP phones, Wi-Fi access points, or luminaires, can be easily connected to the switch using standard Ethernet cables, either at the time of installation or later when the office space is reconfigured. These PoE devices can be included in other networked building systems so that it increases the building's total energy efficiency and operation as the powered devices are networked. [1]

The benefits have been noted in projects like The Edge, an Amsterdam multi-tenant office complex with 650 PoE switches. Employees adjust lighting and temperature using a smartphone app, while site managers maintain a comprehensive picture, allowing them to enhance operational efficiency and reduce CO2 emissions. Over the course of 20 months, the cost per employee was reduced by more than €1,800. Some benefits of a PoE network are:

- Same network used for data communications as well as supplying power
- Ease in installation
- cheap installation
- Easy and flexible network management
- smart power technologies
- Uses DC power
- Reliability
- can easily perform power/energy management [2]

BASICS OF POWER OVER ETHERNET (POE)

Power over Ethernet (PoE) is an efficient way of supplying low-voltage direct current (DC) electricity to devices connected to a LAN through Ethernet connections. Starting with the basics about POE, it is necessary to know about the On-site data centre and LAN. The onsite data centre which is the main part of the space's information network, with all work spaces, office machinery (printers and fax machines), wi-fi points, and VoIP phones attached to it and to one another through the local area network (LAN).[4]

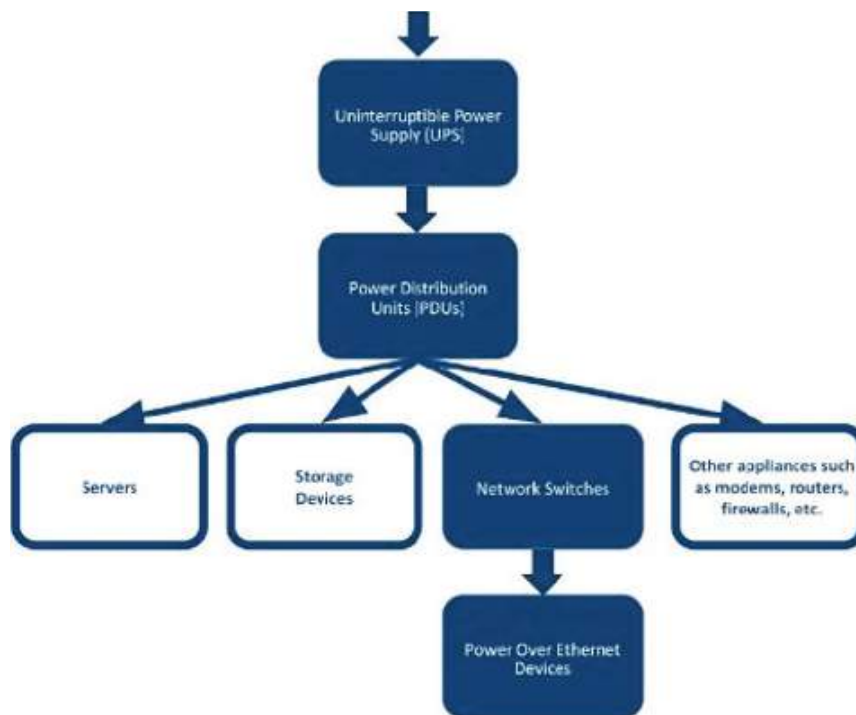


Fig. 1: Electricity Flow Chart in Small Embedded Data Centres of POE Devices

Source: https://www.researchgate.net/publications/339055006_Power_Over_Ether-

The network switches, which enable direct connections to the IT and telecoms equipment spread across the office, are the most significant devices in the SEDC when it comes to PoE. Switches that enable PoE transform the AC power they receive into low-voltage DC power, according to the NEC class 2 standard of 48 volts DC. The Ethernet cables that run from the ports of the network switches to the PoE devices around the office offer both data and power. The power sourcing equipment (PSE) are the network switched and the powered devices (PD) are the POE devices like VoIP phones, wi-fi access points and POE LED luminaires.[4]

All switches cant be POE swiches.To utilize non poe swiches, a PoE power injector which acts as a mediator can be connected and used to supply power.it used AC power line. PoE splitters can also be used which do not reuire AC power to operate.. PoE injectors and splitters are less expensive options for updating old equipment. A UPS is used to back thee PoE devices.[4]

ETHERNET CABLES

The network switch are linked to the devices through the cables on the LAN. These cables follow the Telecommunications Industry Association (TIA) norms, which are based on bandwidth of signal, and crosstalk performance levels and are classified by different categories. Utilised is cat cable, which has 8 wire set up as 4 twisted pairs. Depending on the data transfer rate, 2 of the pair that are twisted are often set aside for data transfer, and the rest 2 pairs acting as spares. The 2 extra twisted pairs are utilised to send less voltage DC to the PDs so that PoE equipments can be powered, even though all 4 twist pairs are required for PoE when PDs receive power with higher wattages. Cat6a cables and Cat 5e cables are appropriate for greater data transfer rates. Since these cables can transport power without creating a lot of heat, they are recommended for PoE. For longer routes than 100m (328'), a POE extender is used.[4]

POE STANDARDS

In the year 2000, Power over Ethernet (PoE) was introduced. IEEE 802.3af-2003, is the first POE standard set by the Institute of Electrical and Electronics Engineers in the year 2003, in which the max power load was

15.4 W DC pulled from each port of a network switch and transfer through twisted-pair Ethernet cable. From 2000's,, there has been quite upgradation in the POE standards which enables higher amounts of max power to be taken from the network switch (also called as the power source equipment, or PSE) to different PoE powered device (PD). [4]

Because of the increasing amounts of low voltage DC power, a wider range of devices can now be powered by PoE. LED lights, LCDs, , ceiling fans, and window shades/actuators, HVAC controllers are just a few of the PDs available today.[3]

Table 1: Comparison of PoE Standards

	POE	POE+	UPOE	High power POE
IEEE Standard version	802.3af (802.3at Type 1)	802.3at Type 2	802.3bt Type 3	802.3bt Type 4
Year	2003	2009	2017	2019
Max. power allowed in PSE	15.4 W	30W	60W	100W
Power available to end device	12.95W	25.5W	51W	71W
Voltage range at PSE	44-57V	50-57V	50-57V	52-57V
Twisted used pairs	2	2	4	4
Supported cabling	Cat-3/ Cat-5	Cat-5	Minimum Cat-5e	Recommended Cat-6
applications	Phones, wireless access points	LCD displays, HVAC controllers and sensors	LED lighting, thin-client computers, smart building devices	Laptops and TV's , LED bay lighting, mini fridges

Source: 1)https://www.researchgate.net/publication/339055006_Power_Over_Ethernet_PoE_Technical_Overview2(PDF) The Demonstration of (PoE) Technologies in commercial and Institutional Buildings (researchgate.net)

SYSTEM ARCHITECTURE

- **PoE System:** the mechanism in which final devices (e.g., luminaires) gets all the input power via Ethernet cables from a PoE switch, which act as direct or indirect PoE loads, with emergency power supplied independently through an energy storage device.
- **PoE Controller:** It is a gateway used for communication via Ethernet cable for smooth PoE system working and is able to work as one in some circumstances.
- **PoE Switch:** equipment which is able to deliver power and two-way communication through Ethernet cable to Powered Devices.
- **Direct PoE Load:** when power and two way communication is recieved from a POE switch directly through Ethernet cabling. It is the direct POE load sensors, or luminaires, and LED drivers are some of direct PoE loads in lighting systems.

- **Indirect PoE Load:** when power is received indirectly via a direct POE load; lighting system examples are sensors and luminaires.

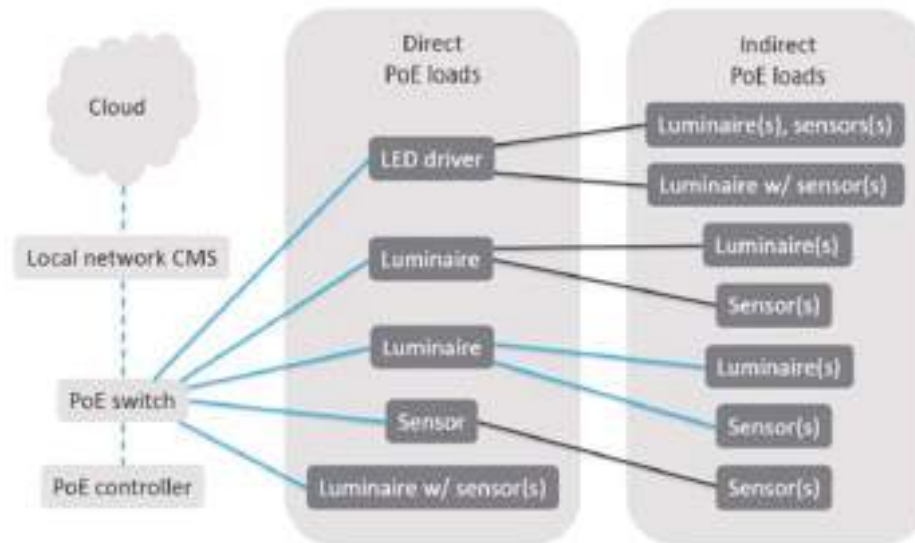


Fig. 2: Example of POE Lighting System

Source: https://www.energy.gov/sites/prod/files/2017/04/f34/2017-02%20ssl-poe_part1_0r.pdf

LANS AND LOW VOLTAGE DC

PoE is managed and operated by IT services because it is part of the LAN. Low voltage electrical contractors typically collaborate with IT workers to set up the network infrastructure, which includes extending Ethernet cables from the SEDCs to the associated devices around the workspace. Conduit is not required for Ethernet cable, unlike line voltage wiring. The network can now be managed with greater flexibility. IT professionals manage the network after it is originally set up, connecting and removing networked devices as needed and pulling extra wire as necessary. IT employees monitor and operate the data and power through each port of the network switches.[4]

CURRENT STATE OF ART

With the advancement in the POE technology over the two decades with POE+, UPOE and now HPOE has led the introduction of PoE LED fixtures with occupancy and photometric sensors as more power can be supplied through these systems. As each bulb is powered by its own network linked port, lighting control and management could be done on a fixture by fixture basis. Also, the higher power provided by these PSE allowed the variety of low voltage PD's that could be added and incorporated to the network like controllers, actuators, thin clients, fans, motors, mini fridges etc. [4]

There are several benefits of DC POE technologies over traditional AC line voltage technologies:

- Energy management- IT workers can use network management software go monitor and reduce the amount of power used by each device .This helps in energy management and savings .[5]
- Electronic gadgets such as LED lights and computers operate on DC power, which must be converted to DC via converters when they are powered by AC current. Rectifiers are generally used to convert electricity from Alternative current to Direct Current, the network switch, is comparatively more efficient. [5]
- Safety- as the cables and network devices are touch- safe, they provide safety. [5]
- Cost may be less since low voltage wiring price is typically less expensive than AC electrical wiring. [5]

NETWORK SWITCHES

In network closets and embedded data centres for IT and telecommunications applications, PoE and PoE+ network switches are widespread. UPoE switches have been brought to the market and are becoming more readily available; manufacturers including Cisco, Versa Technology, and Netgear, among others, currently sell UPoE switches. They can be rack mounted and deployed in SEDCs and range in size from 8 to 24 and 48 port switches. The need for these switches will rise as more UPoE compliant low voltage devices (with power demands > 30W) are deployed. [4]

There are basically two types of PoE switch zone cabling which is pointed by Panduit- centralized switch zone cabling and distributed switch zone cabling.

To upgrade the regular switches to be compatible with the higher POE standards, PoE injectors are also available. These are connected in the SEDC either with the network switches or between the switch and powered device. Some examples of PoE injectors manufacturers are- cisco, HP etc.,

Poe splitters are used to power low voltage DC devices and with the higher PoE standards, it is becoming possible to power more no. of DC devices. [4]

PoE Lighting

As the PoE standards increases, many PoE LED light lamps which are powered by 60 W low voltage DC are now becoming widely popular in the commercial buildings. These lamps include 2x2 and 2x4 troffers, 4' linear lights, downlights, high bay , exterior flood lights and pendant lights and are generally the same fixture frames as the standard line voltage LED devices. Manufacturers are Philips, Cree, HE Williams, GENISYS, etc. There are 2 types of POE lighting- directly attached architecture and node-attached architecture.[4]

Directly-attached architecture	Node-attached architecture
The PoE lighting units, switches, and other accessories are each directly attached to their PoE port on the switch.	The node-centric architecture has a Node in between that links the PoE port to the lights and other accessories. The node can be connected to many other devices like luminaires ,sensors, controls, etc.
Eg- A PoE switch eight ports could allow 7 POE lights and one wall switch in this directly attaches system	Both luminaires and nodes can be daisy chained. This system allows customization as node can be wired to control other devices also.
Manufacturers- Philips and cree	Manufacturers- GENISYS, NULED

Computer Workstations

10ZiG Technology has led to the PoE thin clients and all in one single and dual monitor computers. Their power loads is less than 12 W; average power usage of 3.4 W. These devices are operated through PoE switches. Thinlabs desktops are all in one computers which consist either single or dual screen monitors(19",22",24"). The single monitor AiO desktop computer is operated using PoE+ (<30 W) or UPoE (<60W). The dual monitor AiO computer could be operated using a UPoE switch (<60W).[4]

IT and Support Staff

As POE is part of LAN, it requires professional IT staff to operate and maintain the POE equipments, workstations, luminaires, network switches, etc. for eg, if a POE light that isn't working may not simply requires replacement as usual. It could be a network problem that could be solved by an IT professional.[4]

Networked Equipment

Each PoE device has its own and unique IP code, the data of these devices is looked by the IT professionals team. They use network management norms to monitor the network using system dashboards. As each POE device is connected to its port, each of the device has its own IP code. The data and power transferred through each port is looked upon by the IT staff. They work on the network using system dashboards and network management protocols. In this way, the energy through each powered device is also measured and controlled. [4]

Baseload and Standby Loads

These are two different types of loads. There is power demand for various tasks offered by networked devices in addition to the power required to run the POE devices. [18]. This includes loads including

1. Network switches
2. network servers
3. sensors (occupancy sensors and photocells)

Because they will almost certainly be constant loads, regardless of whether the PoE devices are operational or not, they will almost certainly be running all the time. When POE devices are working, they are called base loads and when are not operational, they are known as standby loads. Some extent of these loads will be present in any networked system. [4]

Job Costs

Because PoE devices utilize low-voltage DC current, they may be installed by electrical contractors at a cheaper hourly rate than their line-voltage AC equivalents. [4]

CASE STUDY

CEE's Minneapolis, MN Administrative Office and Lending Center, US

Lighting in Office: In the first quarter of 2018, CEE's Administrative Office underwent a renovation that included the construction of 17 additional cubicles in the open centre space (nine and eight cubicles in adjacent rows, respectively). During the renovation project, new PoE equipment was installed in the office. Each cubicle in the single row of nine was covered with a Ledalite 4' hanging PoE luminaire. The 2x4 T8 fluorescent suspended lighting system, which included 13 lights, illuminated the opposite row of 8 cubicles. [5]

To compare the PoE LEDs to AC LED replacements, the T8 fluorescent lighting tubes in the already existing AC-powered devices were changed with AC-powered LED bulbs.



Fig. 3: Shows the Cubicles Layout with the Power Over Ethernet Luminaires and the AC Powered luminaire lighting Systems Along with a Photo of the Space

Source: (PDF) The Demonstration of PoE Technologies in Commercial or Institutional Buildings (researchgate.net)

Comparison was done on the basis of energy consumption of both the fixtures used and then with the energy use of the same fixtures fitted with AC LED lamps . Because each group cubicle has one 4' PoE hanging luminaire, the compare of the AC-powered lighting and the PoE LED lighting system was done singlefixture.

The average AC-powered fixture comprising either T8 fluorescent bulbs or LED replacement lamps is compared to the PoE LED fixture in Table 2. Philips produced LED bulbs with a CT of 4000K for both the AC and PoE fixtures were used. [5]

Table 2: AC-Powered Light Fixtures with PoE Light Fixtures

	AC-Powered Suspended Fixture with Ballast		Signify PoE Suspended Fixture	
	T8 Lamps	LED Lamps	100%	Dimmed
Load per Fixture (Watts)	58	26	31	16
Standby (Watts)	0	0	2	2
Average Cubicle Illuminance (footcandles)	40	41	23	-

Source: (PDF) The Demonstration of (PoE) Technologies in Commercial and Institutional Buildings (researchgate.net)

The PoE fixture was set accordingly to user preference (ranging from 15% to 75%).on the other hand, the AC voltage fixtures could not be changed according to the preference and was 100% lit. It had a greater illuminance because of 2 fixtures than the PoE fixture cubicles, which had one overhead fixture.

A wall switch is used to control the AC-powered fixtures. Motion cells and photocells in the device are used to operate PoE. This describes the PoE luminaire's standby/baseload power. [5]

Computer Workstation: In one of the PoE cubicles, an AC-powered desktop PC workstation with two external monitors was replaced with a ThinLabs Dual Screen PoE All-in-One quad-core computer. The power loads comparison is shown in Table 3[5]

Table 3: Power Loas of an AC Powered and a POE Workstation in CEE Admin Cubicle

Cubicle Workstation		Computer Power Load (Watts)		
		High Activity	Normal Activity	Standby
PC with two external monitors		40 - 95	16 - 40	0 - 2
ThinLabs AiO computer with dual monitors	AC-Powered	29 - 44	7 - 29	3 - 5
	PoE	29 - 47	8 - 25	4 - 5

Source: (PDF) The Demonstration of (PoE) Technologies in Commercial and Institutional Buildings (researchgate.net)

Thin Clients: 8 10ZiG PoE-thin clients were installed in place of the thin clients. 10ZiG thin clients were operated in two ways: first, by AC power via an AC adapter provided by 10ZiG, and second, by PoE from Ethernet cable connected to a switch. [19]

The power loads are compared in Table 4. [5]

Table 4: Power Loas of AC AND PoE thin Clients in the CEE Lending Center

Power (Watts)	Hewlett-Packard Thin Client	10ZiG Thin Client	
		AC-Powered	PoE+
Average	9 - 18	5 - 12	5 - 8
Standby	0 - 1.0	0.5 - 0.7	1.0 - 1.3

The electrical consumption of external screen displays varied from 22 W to 42 W. The standby load was around 1 W. The PoE thin client uses about 66 W of power, compared to an average total load of about 60 W for the two monitors. using the ThinLabs AiO with dual displays would be preferable to the PoE thin client connected to two AC-powered outside monitors as it requires less power. [5]

Inferences

- The POE light fixtures could be dimmed according to each staff members's preference.
- A standby / baseload power is always attached to POE fixtures as they are run through motion sensors and photo cells which are constantly operational.
- The load in both the LED'S which run through AC as well as POE is almost equal.
- The power needs of the thinlabs workstations whether run by AC or PoE are fairly comparable. In both cases there is also a standard standby load.
- The power requirement in HP thinclient is more as compared to 10Zig thin client running in both AC and POE+ power supply.

CONCLUSION

Following conclusions are drawn from the study-

- As power over Ethernet is an emerging technology, its advancement in the past two decades with higher power levels to be supplied through ethernet cat cables is allowing more equipments to run through it like the LED luminaires. With the future prospects in its growth, it may allow greater power level to be supplied so as to run a large no.of electrical equipments and devices through it. . The power that could previously be sent to a device like a luminaire using POE technology was quite low. However, recent advancements in Poe technology has led to an increase in the amount of power delivered to a network device as well as LED technology has led to reducing the luminous efficacy of the lighting device which has made the use of POE more effective.
- The building administration, maintenance and operations, departments have increased the work of IT management professionals. With PoE technologies that are now commercially available, energy-efficient network, economical end-use energy monitoring, and building integration of systems are all feasible.
- Use of POE equipments can be encouraged as it it a smart technology. Energy efficiency is achieved as the POE lights can be dimmed according to the needs from 15% to 75%. The light colors can be changed using smartphones.The increasing usage of DC in buildings through storage batteries and DC microgrids may further lead to the technical improvement of PoE and will increase its demand in the future.

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Empathic Design in Architecture: A Human-centered Approach

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▶ ABSTRACT ◀

Empathy, the ability to understand the feelings and needs of the users and take appropriate actions, has become an increasingly popular concept in architectural design. Here, the empathic design process transforms empathy into a design tool that helps in developing innovative design strategies through collaboration between the designer and the user. Through a review of the literature and case studies of MangalDhaam Old Age Home in Gwalior, India, this paper highlights the challenges and limitations of designing without the use of empathy, and the benefits of including empathic design to create more functional, meaningful, and engaging spaces. This paper explores how the use of empathy as a tool helps architects design spaces that are human-centered to enhance the user experience. This paper examines the origin and definition of empathy and its difference from 'sympathy' using secondary data. It then delves into the concept of empathic design, empathy in design thinking, universality, and its impact on creating more inclusive spaces. This paper highlights the potential of empathy to transform the way architects approach design to make it human-centered to increase user satisfaction. Overall, this research paper provides a comprehensive overview of the inclusion of empathy in architectural design and its potential to enhance the quality of life for all the users. The research paper argues that architects who practice empathic design can create more sustainable and successful environments. The paper concludes that empathy should be an integral part of the design solution to create spaces that are not only aesthetically pleasing and functional but also meaningful and accessible to the users.

Keywords: *Empathy, Design Thinking, Architecture, Human-Centered Design, Empathic Design.*

INTRODUCTION

Background of Study

The background of this study revolves around the increasing recognition of using empathy in architectural design. It stems from the understanding that architecture is a field that is user-centric which is not possible

without empathy. Architecture is not merely about creating huge and tall buildings, but also about designing spaces that connect with the users. Empathy enables different viewpoints for user-centric approaches through empathic design methods. [1]

Traditionally, architecture revolved around designing aesthetically pleasing and functional buildings. But, there has now been a shift in the design considerations as the architects are shifting to a more human-centric approach that acknowledges a deep understanding of the users' perspectives and needs.

Furthermore, the background of the study highlights the influence of the design thinking process in architectural practice. It delves into the concept of empathy, its use in design thinking, and its impact on design.

Objectives

- To understand the concept of empathy and empathic design in the context of architectural design.
- To explore the benefits and limitations of using empathy as a tool in creating human-centered designs.
- To highlight the role of empathy in design thinking and the design process.
- To assess the case studies where empathy has been incorporated into the design thinking process.
- To identify the impact of empathic design to create spaces that are accessible, user-friendly, and inclusive.

Methodology

The research methodology for this study will employ a mixed-method approach, incorporating both primary and secondary data collection. The study will begin with a comprehensive literature review to understand the importance of empathy in architectural design.

The study will then use a collection of primary data collection, including, in-depth interviews, case studies, and participatory observations, to gather data from the local old age home present in Gwalior, India.

The data collected through the interviews, discussions, and surveys will be analyzed through thematic analysis approach, to identify the importance and impact of using empathy in design thinking. The findings of the study will be triangulated with existing literature and documentation to ensure the validity and reliability of the results.

Scope and Limitations

The scope of the study on empathy in architectural design is to explore the concept of empathy, its application in design thinking, and its significance in making human-centered design solutions. This paper analyses the potential benefits of empathic design in the context of user satisfaction, functionality, and emotional connection with the built environment. Furthermore, it explores the case studies and the examples that showcase the successful use of empathy in architectural design.

It is important to note that the study is limited to specific factors of empathy in architectural design and does not explore extensively other broader aspects of architectural theories or design thinking. It focuses on the practical approach of implementing empathy as a design tool to help make the design solutions more responsive and meaningful.

EMPATHIC DESIGN IN ARCHITECTURE

Origin and Definition of Empathy

The word 'empathy' comes from the root of the Greek word 'empathia' and when it is examined etymologically, it is seen that 'em' means 'inside of, within'; and 'pathia' means 'to feel' [2]. Empathy then means 'to feel inside', when the two roots come together, and is a matter that is discussed in many fields such as philosophy, education, psychology, and design. It has more than one definition that belongs to different disciplines. The educational dictionary meaning of the word is 'understanding and feeling from the point of view of the other person' [3].

The concept of "empathy" has its root in psychology and philosophy. This term had been used for centuries but it was first coined by a German psychologist Theodore Lipps in the early 20th century. It is not just about

feeling the pain of others but keeping oneself in the shoes of others and perceiving the world through their eyes. Showing empathy, which is the main skill that a designer needs to have, is the ability to define and understand someone else's condition, emotions, and point of view [4]. As a designer or an architect, empathy is the main tool that helps us connect with the users.



Fig. 1: Empathy in Design Thinking
 (Modified by the Authors) URL 1

Difference between Empathy and Sympathy

The terms “Sympathy” and “Empathy” have always been confused for having the same meaning. They are related yet very distinct emotional responses to the experiences of others. Sympathy is feeling pity, sorrow, or compassion for the misfortune or suffering of others. It involves expressing care and concern about someone by acknowledging their sorrow and grief, but not being fully able to understand their viewpoint. Empathy, on the other hand, is being able to understand the feelings of other people. It involves putting oneself in the shoes of someone else and making genuine efforts to connect with their emotions instead of just feeling sorry for them. Empathy is categorized by traits such as emotional resonance, perspective-taking, and connection, whereas, sympathy is categorized by traits such as emotional concern, external perspective, and altruistic actions. Edith Steins explains both terms by: “One cannot be sympathetic without being empathetic, but one can be empathetic without being sympathetic.” Both sympathy and empathy play an important role in user interaction and contributes to building trust among the designers and clients.

Empathy in Design Thinking

Design thinking is a problem-solving approach that can be made human-centered with the help of empathy as it focuses on understanding the needs and emotions of the users through their experience. Empathy is a fundamental aspect of emotional intelligence that involves recognizing someone's suffering without any judgement or personal bias. In the context of design thinking, empathy plays an important role in the initial phase of the “design thinking process”.

Architect and theorist, Pallasmaa (2015), discussed empathy in architecture in his essay, ‘Empathic and Embodied Imagination: Intuiting Experience and Life in Architecture’ from a phenomenological point of view:

It is a must for every sensitive designer to imagine the experiences or feelings of the user, but it is not necessary that human empathic imagination must work that way. The designers place themselves in the position of future occupants to test the validity of their ideas by imagining the exchange of places and personalities. Initially, the architect ought to formulate the design by being a temporary surrogate of the actual occupant for themselves. In the end, the architect is supposed to offer this design to the occupant as a gift. It is being referred to as a gift here as the designer has given birth to the design of the occupant's home the same way a surrogate mother gives birth to a child for someone who might not have the capability to do the same themselves. [5]

Empathy in design thinking is not just surface-level understanding of any subject, designer needs to immerse themselves in the user's world to gain insights that serve as the foundation for creating solutions that meet the basic needs of the users.

Empathy through the case example of Mangal Dhaam Old Age Home

The application of empathy in daily life can be best seen through the case study of Mangal Dhaam Old Age Home in Gwalior, India. It is a community of elderly residents living with their share of challenges and routines. This case study is an explanatory example of how empathy can play a major role in understanding the emotions and needs of the users.

The designers met the residents of the old age home and listed their daily routine and the issues they face with the help of ‘design thinking tools’ such as “Empathy mapping” and “Storytelling”. In an attempt to understand the challenges faced by the residents, the designers engaged in empathetic conversations with them. Through the journey of the designers in Mangal Dhaam Old Age Home, it can be seen how empathy works as a potential

catalyst for bringing positive changes in the lives of the users by tailoring specific design solutions according to their needs. By immersing themselves in the resident’s daily life, the designers were able to witness how traditional design approaches were not fit for the older adults as they were not up to their comfort level and understanding. As a result, the designers adopted a participatory human-centered approach that kept the needs of the users at the center of the design process, giving the residents a sense of satisfaction and ownership in the built environment.

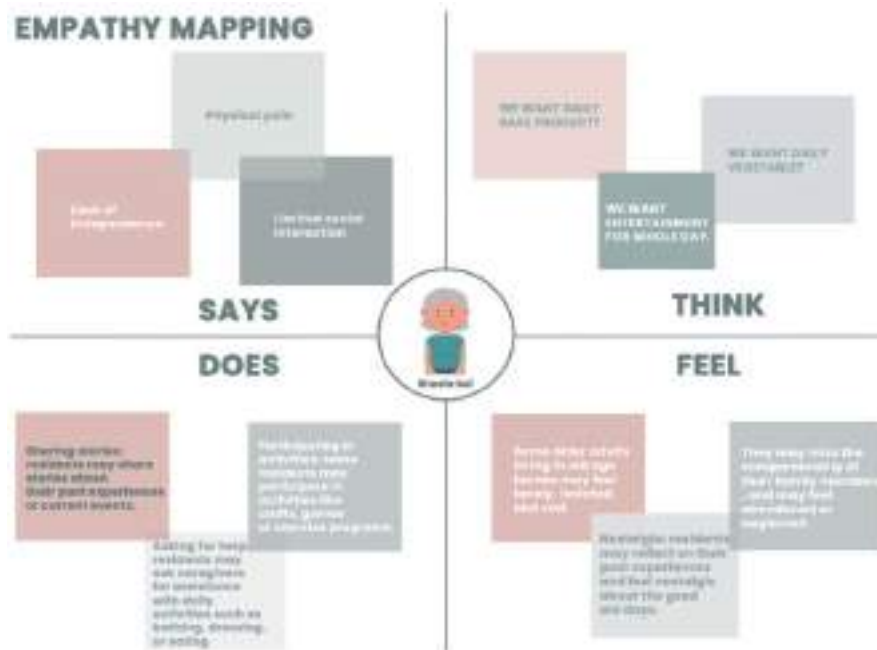


Fig. 2

Source: Design Thinking Studio, 2023 B. Arch 3rd year, MITS Gwalior, prepared by Ayushi Gupta, Dipasha Khare.

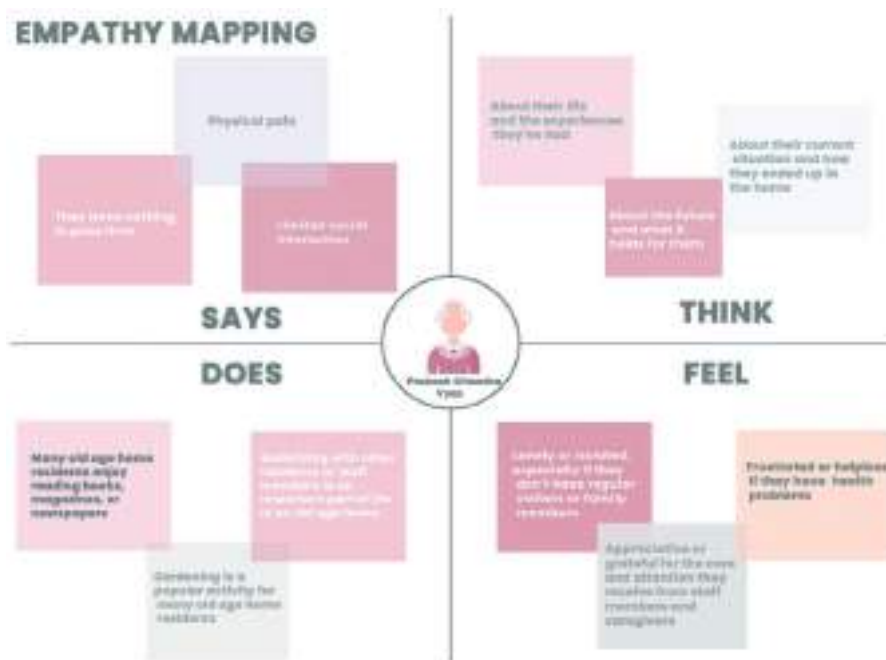


Fig. 3

Source: Design Thinking Studio, 2023 B. Arch 3rd year, MITS Gwalior, prepared by Ayushi Gupta, Dipasha Khare.

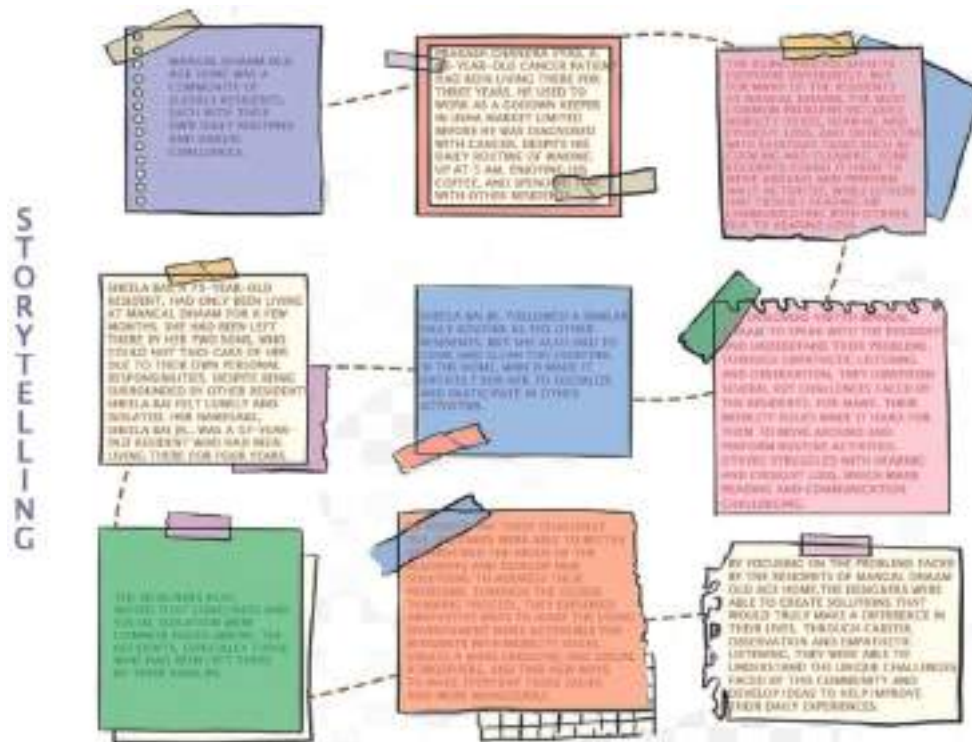


Fig. 4

Source: Design Thinking Studio, 2023 B. Arch 3rd year, MITS Gwalior, prepared by Anshita Jain, Nidhi Gour, Sanjivani Singh.

Empathic Design and its Impact

The empathic design has a significant positive impact on both the user experience and the society. Empathic design is an approach that prioritizes the needs of the users to create more inclusive and sustainable spaces. Empathic design emphasizes actively listening to the users and is an innovative design strategy that explains the relationship between the designer and the user [6]. The most distinguishing feature of empathic design is that it involves the experiences of specific users, instead of relying on the personal experiences of the designer as done in traditional design processes [7].

The industrial design approach becomes personalized and resembles customized products by involving the actual users in the design process. The sociological theory of symbolic interactionism which focuses on the meaning of the interaction between people and things in everyday life revolves around this approach [8].

Empathic design helps bring a positive change in society as it values universality and creates design solutions that are accessible, engaging, meaningful, and inclusive. Empathic design leads to higher user satisfaction, and improved experience by promoting accessibility, inclusivity, and enhanced functionality. It evokes a sense of emotional connection by involving social interaction and collaboration and providing opportunities for the designers to showcase their innovation and creativity.

CONCLUSION

The concept of empathy has always been prevalent in the architecture field, but people have been ignorant of its impact for a long period of time. It does not mean that they have been neglecting the use of empathy in the design process, but they didn't quite acknowledge its use.

As architects design spaces for humans, it is a must that the design process followed should revolve around the users. And to make the design process human-centric, empathy is the first step that architects follow while designing.

Through a series of literature reviews and case studies, this research paper concludes that empathy has the potential to shape spaces that go beyond aesthetics and functionality. It was also observed that when designers used empathy as a tool in the design process, the design was more accessible, user-friendly, sustainable, and inclusive. Traditional design processes where the design solutions revolved around the architect's own experiences were not suitable for all the users. To make the design approach human-centered, it is a must to practice empathy as a design tool that will help create solutions tailored to the specific needs of the users.

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TRACK : 2



Distributed Denial-of-Service Attack and SQL Injection Categorization and Identification Employing Log Data

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▶ ABSTRACT ◀

The introduction of COVID-19 and the information technology (IT) industry's ongoing expansion, there has been an enormous upsurge in web servers and web-based applications. Considering practically all workplace duties and educational assets are readily offered via the internet, the number of cyberattacks have risen tremendously. The research suggests a novel way for identifying and categorising anomalies by analysing log data using machine learning and decision trees in order to reduce these risks and prevent data loss. The innovation is in the creation of a method that is more effective than manual log analysis. The methodology mainly uses the steps of log collection, parsing, features extraction, and labelling, followed by training decision tree classifier, and attack prediction to identify abnormalities using internet-based logs dataset. The final findings show how well the model performs in correlating log data to identify attacks, resulting in early detection and improved protection for internet-based applications.

Keywords: Distributed Denial-of-Service, SQLi, Web Server Logs, ML Decision Tree.

INTRODUCTION

“Cybersecurity is a social responsibility. We all have a role to play.”

— Magda Chelly

Internet-based apps are currently dealing with a number of unanticipated behaviours and attempts by exploiters of internet security due to advancements in cyberspace. They frequently conduct DDOS attacks that bring the server to a halt. While monitoring and attacking an application using automated vulnerability evaluation tools or attempting to introduce fuzz script (code) into a variable for SQL injection. Many times, in order to

understand what is happening, logs on the server hosting the website must be watched and examined. A cyber expert must conduct a forensic investigation if the problem is serious and suspicious. Although it takes a lot of time to evaluate the data and is not always effective to classify different logs into different groups, manually maintaining an active server can be difficult.

By creating an anomaly identification and classification model that can also be utilised for early attack detection, this research enhances the outdated technique for manually performing log analysis. This model uses a decision tree approach rooted upon machine learning. This technique accurately classifies logs into various categories and recognises assaults after comparing it with log data.

RELATED WORK

There have been many anomaly detection models put forward in the past. When looking for error detection for a web-based request log system in 2004, the Decision Tree approach was used. K. R. Suneetha and R. Krishnamoorth created a classification model in 2010 based on online log data to use decision trees to identify interested users. In a similar manner, Qimin Cao alongside Yinrong Qiao implemented an algorithm for machine learning in (2017) that utilised web-based log data in order to identify anomalies in website log files. S Sicari in (2018) in has proposed the REATO framework, which counts connection requests, packets, faulty packets (such as those with bad requests, unknown data types, and slow average response times), CPU and memory consumption, among other metrics, to identify DDoS attacks. This approach is dependent on thresholds. Due to the network's dynamism, a single value is unlikely to be appropriate. These publications were the sources of inspiration for this one, which developed an improved filtering and classification controlled machine learning framework employing an easy-to-understand text interpretation and pattern-matched methodology that can be used to identify and categorise both normal and anomalous log data. A research by "Amjad Mehmood, Mithun Mukherjee, Syed Hassan Ahmed, Houbing Song & Khalid Mahmood Malik" used the supervised Naive Bayes technique to identify attacks. To detect DDoS, a trained algorithm is implemented in a number of dispersed agents around the network. The event is stopped if DDoS is found. Since labelling a large volume of traffic is a computationally costly and error-prone process, a supervised machine learning technique is not practical for a large IoT network.

These publications were the sources of inspiration for this model. This developed an improved filtering and classification controlled machine learning framework. It turns out to be cost effective, accurate, efficient and employing an easy-to-understand text interpretation and pattern-matched methodology. This can be used to identify and categorise both normal and anomalous log data.

OVERVIEW

This section of the study gives an in-depth description of the HTTP flood DDOS attack, then offers an introduction to SQL injection and web logs data.

HTTP Flood DDOS Attack

A massive distributed denial-of-service (DDoS) attack known as an HTTP flood aims to flood a targeted server with HTTP requests. Once the target system is overloaded with requests. It is unable to respond in time to normal traffic, denial-of-service will happen with the next requests from legitimate users.

SQL Injection Attack

An attacker can alter a database and obtain potentially valuable information by employing a piece of structured query language code through a security hole known as a SQL injection. It is one of the most common and dangerous kind of attack if it can be applied to any piece of software or website that makes use of a SQL-based database.

A query made using SQL is a request transmitted to a databases to execute a certain activity or purpose, such as querying data or running SQL code. A prime instance is when login details are entered using a web form to

grant a user admittance to a webpage. This kind of web-based form is typically made so that it accepts particular kinds of information, such as a username and possibly passcode. Whenever that data is added, a database is inspected to see if it matches, and if it does, entry is made available to the user. If otherwise, accessibility is refused. Fig -2 shows the demonstration of SQL Injection Attack.

HTTP floods are a sophisticated sort of Layer 7 attack that capitalise on a smaller amount of traffic compared to alternative attacks to take down the targeted server or website since they don't use spoofing, reflection, or malformed packets.

As a result, they need a deeper comprehension of the targeted website or implementation, and each assault must be individually designed to be successful. Because of this, it is far more difficult to identify and prevent HTTP flood assaults. Fig -1 represents the flow of FLOOD DDOS ATTACK.

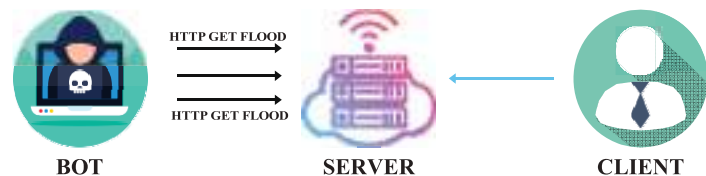


Fig. 1: HTTP FLOOD DDOS ATTACK

Conventional rate-based monitoring is inefficient at identifying HTTP flooding DDoS assaults because the volume of traffic in these attacks is typically below detection limits. Combining traffic profiling techniques with progressive security challenges and creating an IP reputation database to identify and prohibit anomalous behaviour is a preferable strategy. If a bot is present, an attack can be mitigated by providing a demand, for instance a JavaScript computing challenge, to the requesting computer.

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Fig. 1: SQL Injection Attack

There are several effects that SQL injection may have on a corporation. A successful attack might lead to the unauthorised accessing of user profiles, the removal of whole tables, and, in certain instances, the attacker attaining administrator privileges to a database—all very negative outcomes for a business's reputation.

It's crucial to include in the loss of client trust when estimating the prospective cost of a SQL Injection should sensitive information like addresses, telephone numbers, and debit and credit card numbers be breached.

Web Server Logs

A server's log is a record of activities (or numerous files) that the web server automatically produces and contends, documenting all of the actions it carried out.

A web server's log files typically include data pertaining to user accessibility, requests, and unsuccessful attempts for each occasion that a user makes a request to the server. Access log files, error log files, php error files, and ssl_request record files are among the four main forms of log files in the XAMPP Apache Server file.

192.168.169.17 -- [26/Mar/2023:21:53:29 +0530] "GET /dvwa/vulnerabilities/fi/?page=include.php HTTP/1.1" 200 4183 "http://192.168.169.107/dvwa/instructions.php" "Mozilla/5.0 (X11; Linux x86_64; rv:78.0) Gecko/20100101 Firefox/78.0"		
Host	192.168.169.17	The IP address of the client.
Identity	-	The identity information reported by the client.
User	-	The user name of a successful HTTP authentication.
Date	[26/Mar/2023:21:53:29 +0530]	The date and time of the request.
Request	"GET /dvwa/vulnerabilities/fi/?page=include.php HTTP/1.1"	The request line from the client is given in double quotes.
Status	200	The three-digit HTTP status code generated in response to the clients request.
Bytes	4183	The number of bytes in the object returned to the client.
Request Header Referer	"http://192.168.169.107/dvwa/instructions.php"	The HTTP request header referer contains an absolute or partial address of the page that makes the request.
Request Header User Agent	"Mozilla/5.0 (X11; Linux x86_64; rv:78.0) Gecko/20100101 Firefox/78.0"	The user agent identifies the application, operating system, vendor and/or version of the requesting user agent.

Fig. 3: Example of a Log Record

In this study, only access log files were used to determine the kind of logs based on the information they included in our review an example of which is shown in Fig- 3. All occurrences either are requested and the server's response have been saved in the Apache accessibility log file. Each HTTP request is recorded on a distinct line and is made of many tokens that are distinguished by spaces; blank value of characters are symbolised by a hyphen since Apache server generally abides by the Common Log Format specification by default.

METHODOLOGY

The research study primarily employs the following steps of identifying abnormalities through the use of internet-based logs dataset: log collection, parsing, which is further followed by features extraction and labelling, followed by training decision tree classifier and concluding with attack prediction.

The following flowchart presented in Fig- 4 gives a brief about the methodology used in the framework comprising given 5 steps:

Step 1. Log Collection

Step 2. Log Parsing

Step 3. Feature Extraction

Step 4. Decision tree Algorithm

Step 5. Prediction and Classification

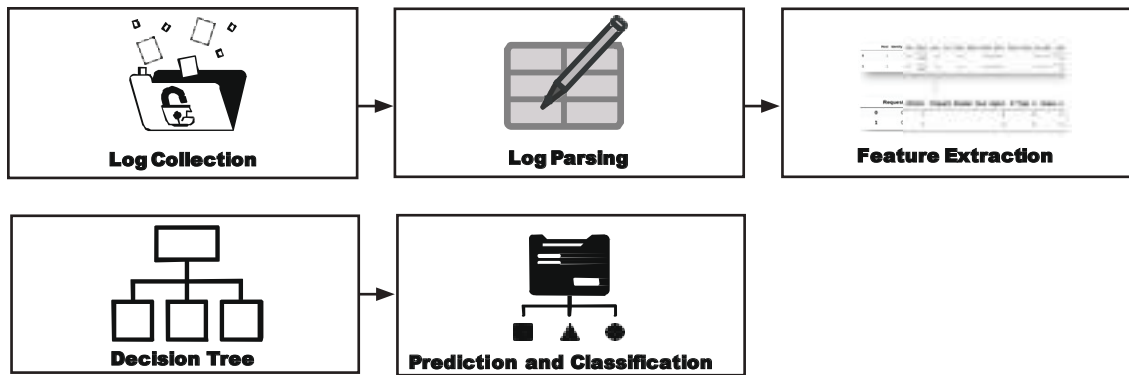


Fig. 4: Methodology

Log Collection

Every time a request is made while a web application is running, logs are generated. These recordings are able to be used for numerous other purposes, but in this instance, they are used for anomaly detection, consequently logs files obtained in the initial phase for later use. Dataset shown in Fig-5 is acquired for the building model by means of a self-hosted web-based programme on a local XAMPP server.

```

    [10/Mar/2023:20:57:34 +05301 "GET /da/vulnerabilities/sqli/71d-365submitSubmitP://localhost/évva/vulnerabilities/sql1/71d-265submit-Submit" "Mozilla/5.0 (WindowsNT10.0 win64; x64) AppleWebKit/537.36 (KHTML, Like Gecko) Chrome/99.0.4344.51 Safari/537.36", ":
    [10/Mar/2023:20:57:38 +0530] "GET /da/vulnerabilities/sql1/71d-46Submit Submit HTTP/1.1 200 4107http://localhost/dvwa/vulnerabilities/sqli/?id=365
  
```

Fig. 5: Unstructured Logs Data

Log Parsing

It is feasible to make data from log files accessible to machines by parsing the information into a recognised format. It’s conceivable that you begin with ingested logs in a variety of forms, however once all of them are successfully parsed, anyone may utilise the data management system to explore and analyse the events as though they were one continuous stream. The regular expressions are implemented to separate logs and extract characteristics from them, making it simple to maintain and access data which is shown in Fig - 6.

Host	Identity	User	Date_And_Time	R_Type	Request	Status	Size_In_Bytes	Request_Header_Referer	Request_Header_User_Agent
168.115.107	-	-	24/Mar/2023:12:50:37+0530	GET	/dvwa/vulnerabilities/sqli?id=1&Submit=Submit	302	-	-	sqlmap/1.5.Bistable (http://sqlmap.org)
168.115.107	-	-	24/Mar/2023:12:50:52+0530	GET	/dvwa/login.php	200	1415	-	sqlmap/1.5.Bistable (http://sqlmap.org)
168.115.107	-	-	24/Mar/2023:12:50:57+0530	GET	/dvwa/vulnerabilities/sqli?id=1&Submit=Submit	302	-	-	sqlmap/1.5.Bistable (http://sqlmap.org)
168.115.107	-	-	24/Mar/2023:12:50:57+0530	GET	/dvwa/login.php	200	1415	-	sqlmap/1.5.Bistable (http://sqlmap.org)

Fig. 6: Structured Logs Data

Feature Extraction

The approach of translating unprocessed data into numerical characteristics that can be handled while keeping what is contained in the initial data collection can be referred to as feature extraction. After reducing logs into its component parts, we must look for patterns in those parts, label them based on those patterns, and finally convert those labels into quantitative feature arrays so that models developed using machine learning can potentially be implemented which is presented in Fig- 7.

	Host	Identity	Type	Request	Status	Size in Bytes	Request Header	Referer	Request Header	User Agent	Label
0	1	-	GET	Normal Pattern	200	4105	Normal Pattern			Normal User	Normal log
1	1	-	GET	Normal Pattern	200	4106	Normal Pattern			Normal User	Normal log

	Request	Referer	Request Header	User Agent	R Type	n	Status	n
0	0	0			0	0	0	0
1	0	0			0	0	0	0

Fig. 7: Feature Extraction and Labelling

Decision Tree Algorithm

Considering algorithms are both simple to acquire and extremely effective, decision tree algorithm often serve as the strategy preferred for modelling predictions. A decision tree algorithm’s main objective is to divide a collection data set into serrate and more manageable chunks. Subsequently, it is feasible to train machine learning decision tree models for classifiers using characteristic arrays of data, generating a model that can be applied to prediction and classification. Fig -8 represents the Decision Tree Classifier.

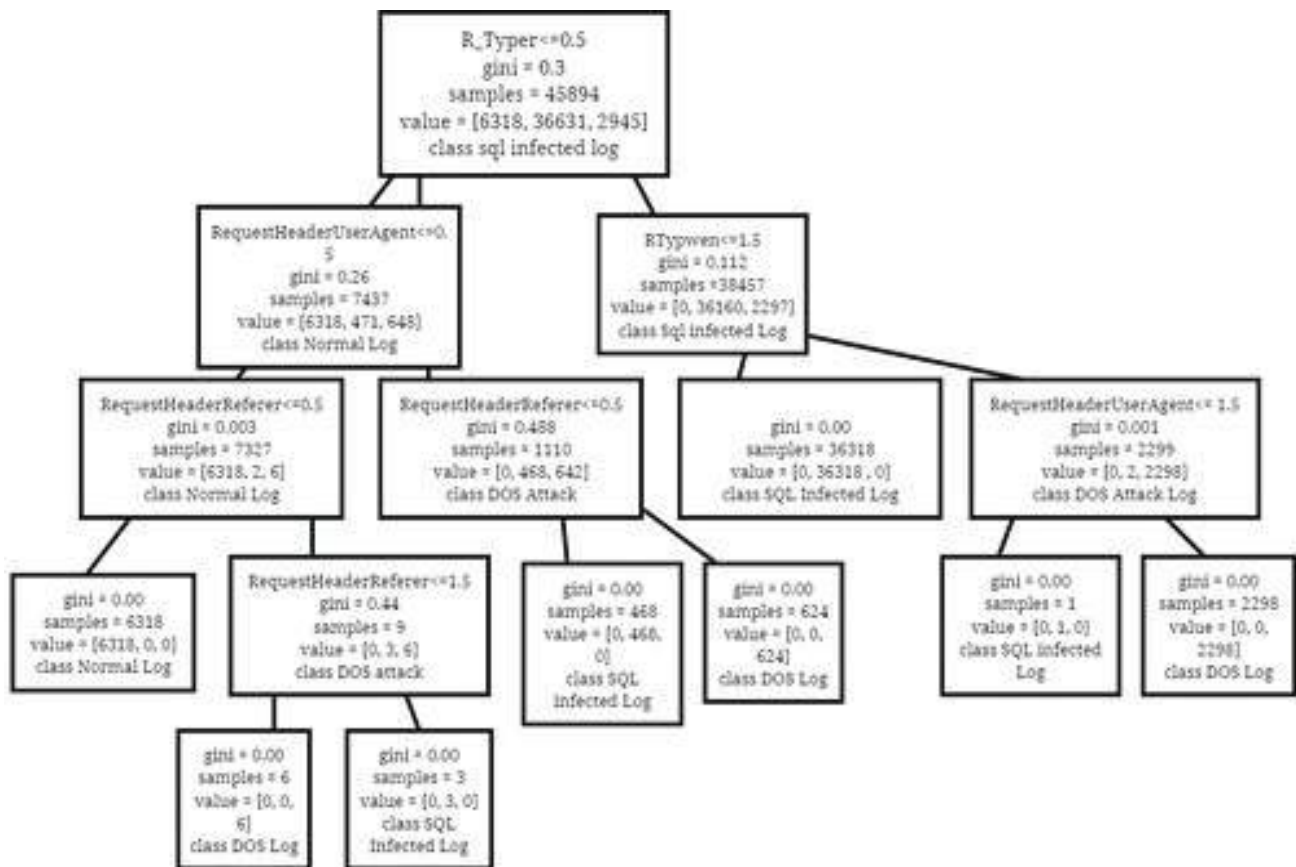


Fig. 8: Decision Tree Classifier

Prediction and Classification

The model that was trained may now be used for organising fresh log files into a regular log, a log with SQL injection, and a log that contains a DDOS attack in accordance with anomalies found in the information being analysed demonstration of which is given in Fig- 9.



```

jupyter Normal_logs.csv 03/01/2023
File Edit View Language current mod
1 Host,Identity,User,Date_And_Time,R_Type,Request,Status,Size_In_Bytes,Request_Header_Referer,Request_Header_User_Agent
2
3 192.168.115.17,-,-,23/Mar/2023:15:02:15 +0530,GET,/dvwa/,200,6341,http://192.168.115.107/dvwa/vulnerabilities/csrf/,Mozilla/5.0
  (X11; Linux x86_64; rv:78.0) Gecko/20100101 Firefox/78.0
4

jupyter SQLInfected_logs.csv 30/03/2023
File Edit View Language current mod
1 Host,Identity,User,Date_And_Time,R_Type,Request,Status,Size_In_Bytes,Request_Header_Referer,Request_Header_User_Agent
2
3 192.168.115.107,-,-,24/Mar/2023:12:50:37 +0530,GET,/dvwa/vulnerabilities/sqli/?id=1&Submit=Submit,302,-,-,sqlmap/1.5.8#stable
  (http://sqlmap.org)
4
5 192.168.115.107,-,-,24/Mar/2023:12:50:52 +0530,GET,/dvwa/login.php,200,1415,-,-,sqlmap/1.5.8#stable (http://sqlmap.org)

jupyter DOSAttack_logs.csv 30/03/2023
File Edit View Language
1 Host,Identity,User,Date_And_Time,R_Type,Request,Status,Size_In_Bytes,Request_Header_Referer,Request_Header_User_Agent
2
3 192.168.115.17,-,-,23/Mar/2023:15:01:44 +0530,GET,/71346,400,325,-,-,"Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11_6)
  AppleWebKit/537.36 (KHTML, like Gecko) Chrome/53.0.2785.143 Safari/537.36"
4
5 192.168.115.17,-,-,23/Mar/2023:15:01:44 +0530,GET,/7687,400,325,-,-,"Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11_6)
  AppleWebKit/537.36 (KHTML, like Gecko) Chrome/53.0.2785.143 Safari/537.36"

```

Fig. 9: Categorized Log Files

EXPERIMENTAL SETUP

System Requirements

System Requirements for the given model are suggested to be:

- A good CPU and GPU with at least 2GB memory.
- At least 8GB of RAM. Microsoft Windows 10 OS
- An active internet connection so that the system can use links to access online resources.
- PyCharm IDE Jupyter Notebook XAMPP Server
- Damn Vulnerable Web App (DVWA) Matplotlib 3.5.2
- Pandas 1.4.2 Scikit-Learn 1.1.0 Python-csv 0.0.13
- Pre-installed Python packages

Tools Used

1. **Jupyter Notebook:** The Jupyter Notebook is an internet-based, freely available editor which enables users to produce and share documents with live codes, written content, calculations, visualisations, and other types of media.
2. **PyCharm IDE:** PyCharm, which is an IDE (integrated development environment) for software development which specialises on the Python scripting language. It was developed by the Czech company JetBrains Inc. It enables web development and offers analysis of code, a visual debugger, a built-in tester, as well as connectivity with version control systems.

3. **Damn Vulnerable Web App:** It is PHP/MySQL web tool. Its primary goals are to help security experts put their knowledge and resources to the test in a courtroom, to help web developers better understand the mechanisms that secure web-based applications, and to help instructors and students teach and learn about the security of web applications in a classroom.
4. **XAMPP Server:** Developed by Apache Friends, XAMPP is a cross-platform, open-source web server stack package that primarily consists of the MariaDB database, Apache HTTP Server, and interpreter for Perl and PHP scripts.
5. **Sqlmap:** Sqlmap is a free tool for detecting and exploiting SQL injection issues and taking over database servers. It has a potent detection engine, many different options to handle everything concerning data fingerprinting to data extraction via database to access the fundamental file system to executing instructions on the operating system, as well as several specialised features for the ultimate tester.
6. **Slowloris Script:** It is a DDoS attack which focuses on app layer and takes the use of partial HTTP requests for creating links between one computer and certain server. The target is then overloaded and delayed as a result of these connections running as long as possible.
7. **Pentmenu:** Based on the PentBox, Pentmenu is an automated programme that can do a variety of network pen-testing operations, including network attacks, DOS attacks, etc.

IMPLEMENTATION

This section of the article delivers an in-depth description of this conceptual framework. The following section illustrates strategies to pinpoint patterns in attributes that can be extracted and used to classify data. The decision tree classifier is employed for anticipating natures of logged data and categorise logged data existing in the document among distinct groups following the time they have been properly labelled.

Data Preprocessing

After the log files have been categorised and parsed, it becomes essential to choose solely those aspects that are crucial, exhibit little variability, and may offer useful insight into the data recorded in the logs. The parameters that are utilised encompass the HTTP status code, request header referrer, request type, and request header user-agent, which provide sufficient details to identify anomalies. GET and POST are the two main categories for HTTP request types. POST is a way for performing changes to data in accordance with requests and is more secure than GET since it transmits request information without obscuring parameter specifics in the URL. The HTTP status code, which has a special significance and is produced in response to a website's server's responsiveness, signifies whether or not a request has been successfully fulfilled. Fig -10 reflects Some Common HTTP status codes.

HTTP STATUS CODE	INFORMATION
302	Found
200	OK
208	CREATED
301	MOVED PERMANENTLY
304	NOT MODIFIED
400	BAD REQUEST
403	FORBIDDEN
404	NOT FOUND
414	URI TOO LARGE

Fig. 10: Some Common HTTP Status Code

These labels need to be converted into numerical features in order to train the model after being labelled based on these patterns. In order to do this, I have encoded all data as '0', SQL injection data as '1', and DDOS malicious data as '2'. The aforementioned information are now sent for instruction machine learning algorithms after encoding.



```

View  Insert  Cell  Kernel  Widgets  Help  Not Trusted Python 3 (ipykernel)
logfile = open("access.log","r")
loglines = follow(logfile)
c=0
for line in loglines:
    if(Data(line)!=0):
        c+=1
    if(c==10):
        print("WARNING :YOU ARE UNDER ATTACK")
        c=0

Normal log
Normal log
Normal log
Normal log
Normal log
SQL infected log [{}:~', '-'. '27/Mar/2023:11:45:11 +0530', 'GET', '/dwa/vulnerabilities/sqli/?id=4271-or=4271%27%3D1%27&Submit=Submit', '200', '619', 'http://localhost/dwa/vulnerabilities/sqli/?id=union=4Submit=Submit', 'Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/100.0.4896.127 Safari/537.36']]
Normal log
  
```

Fig. 11: Some Common HTTP Status Code

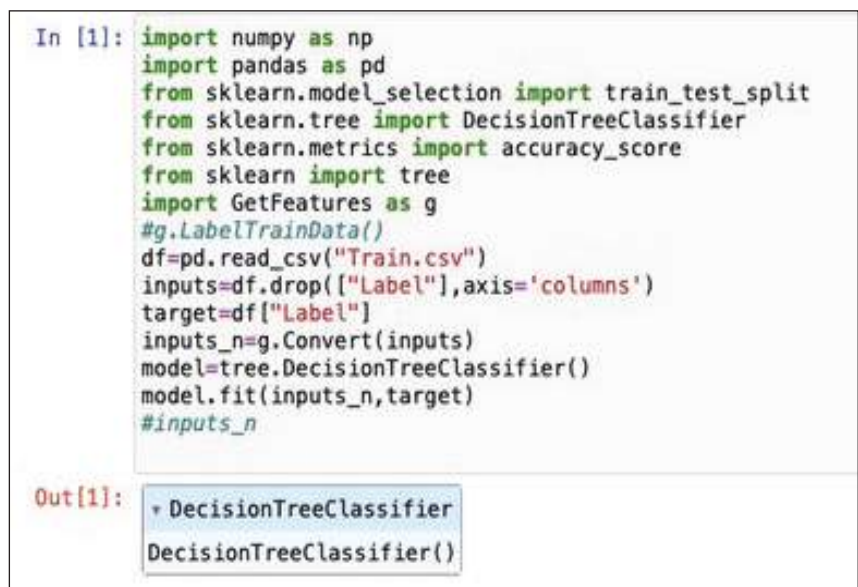
The above framework employs request, request header referrer, and request header user agent of log records to screen out such injected query since it is frequently seen that malignant SQL query is injected with many different parameters in order to carry out the attack.

Labels have been manually allocated as in Fig- 11 into three distinct groups enabling classification: normal log, SQL injection log, and DOS attack log. These categories were determined by the collecting of records data throughout attack and normal scenario and by analysing each unit of data.

Decision Tree Classifier

The structure of the model has been established which can be referred in Fig- 12, the optimum technique for machine learning is required to be adopted. To accomplish this, a straightforward rule-based decision tree classifier is sufficient to forecast and categorize the collection of log data.

The decision tree approach adds the data point to a certain labelled group based on specified requirements. It is an algorithm for categorization. The decision tree is a visual representation of a flowchart-like structure that lists all the options for making a choice. Decisions are often made based on certain circumstances that are understandable. When categorical data must be forecasted, this model splits the decision tree centred on the Gini impurity, that is utilised to divide nodes.



```

In [1]: import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score
from sklearn import tree
import GetFeatures as g
#g.LabelTrainData()
df=pd.read_csv("Train.csv")
inputs=df.drop(["Label"],axis='columns')
target=df["Label"]
inputs_n=g.Convert(inputs)
model=tree.DecisionTreeClassifier()
model.fit(inputs_n,target)
#inputs_n

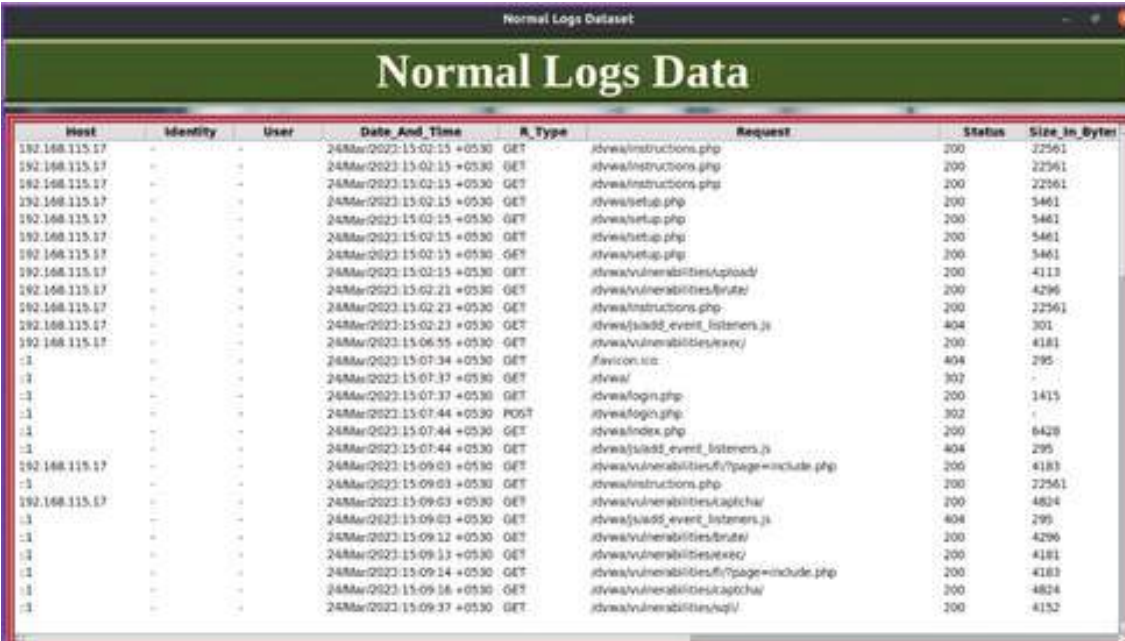
Out[1]: DecisionTreeClassifier
DecisionTreeClassifier()
  
```

Fig. 12 : Training ML MODEL

Prediction and Classification

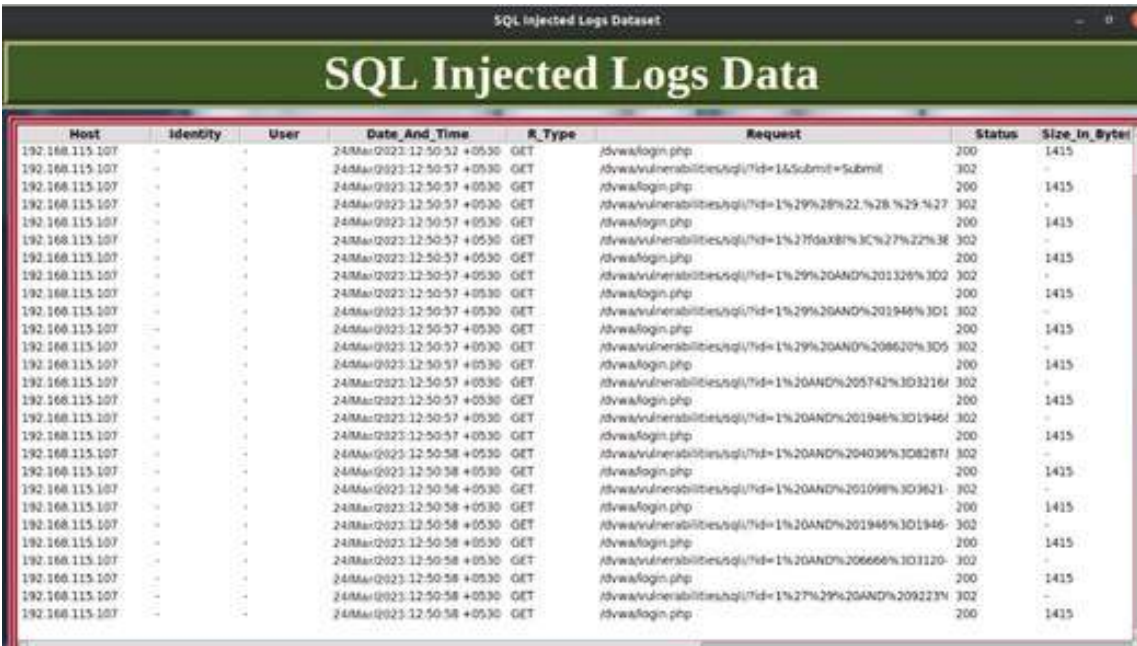
Following the algorithm’s decision tree classifier was trained, it was tested using a fresh dataset that produced predictions, and it precisely divided the log dataset into three categories: normal data

[Fig-13], SQL injection data[Fig-14], and DOS attack data[Fig-15]. After receiving these datasets, each item of log data is personally examined to ensure there were no errors in prediction, categorization, or labelling. Following a thorough analysis of the various data sets, this technique was implemented to identify SQL injection attacks and HTTP flood denial-of-service attacks in real time and has been demonstrated to be extremely accurate.



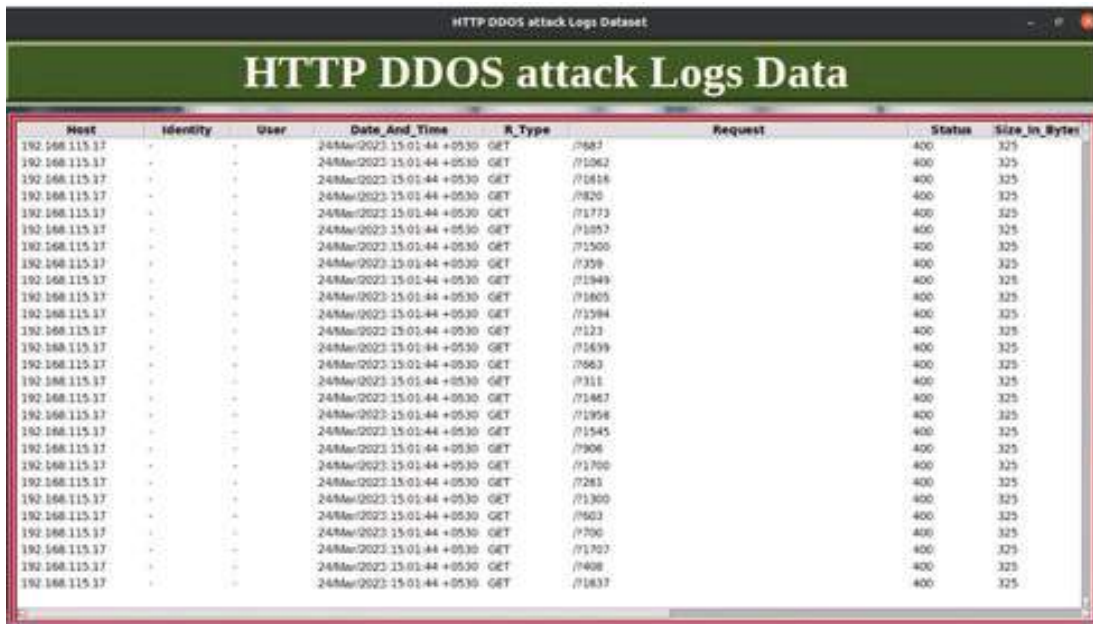
Host	Identity	User	Date_And_Time	R_Type	Request	Status	Size_In_Byte
192.168.115.17	-	-	24Mar2023:15:02:15 +0530	GET	/dwa/instructions.php	200	22561
192.168.115.17	-	-	24Mar2023:15:02:15 +0530	GET	/dwa/instructions.php	200	22561
192.168.115.17	-	-	24Mar2023:15:02:15 +0530	GET	/dwa/instructions.php	200	22561
192.168.115.17	-	-	24Mar2023:15:02:15 +0530	GET	/dwa/setup.php	200	5461
192.168.115.17	-	-	24Mar2023:15:02:15 +0530	GET	/dwa/setup.php	200	5461
192.168.115.17	-	-	24Mar2023:15:02:15 +0530	GET	/dwa/setup.php	200	5461
192.168.115.17	-	-	24Mar2023:15:02:15 +0530	GET	/dwa/setup.php	200	5461
192.168.115.17	-	-	24Mar2023:15:02:15 +0530	GET	/dwa/vulnerabilities/upload	200	4113
192.168.115.17	-	-	24Mar2023:15:02:23 +0530	GET	/dwa/vulnerabilities/route	200	4296
192.168.115.17	-	-	24Mar2023:15:02:23 +0530	GET	/dwa/instructions.php	200	22561
192.168.115.17	-	-	24Mar2023:15:02:23 +0530	GET	/dwa/sledd_event_listeners.js	404	301
192.168.115.17	-	-	24Mar2023:15:06:55 +0530	GET	/dwa/vulnerabilities/exec	200	4181
-1	-	-	24Mar2023:15:07:34 +0530	GET	/favicon.ico	404	295
-1	-	-	24Mar2023:15:07:37 +0530	GET	/dwa/	302	-
-1	-	-	24Mar2023:15:07:37 +0530	GET	/dwa/login.php	200	1415
-1	-	-	24Mar2023:15:07:44 +0530	POST	/dwa/login.php	302	-
-1	-	-	24Mar2023:15:07:44 +0530	GET	/dwa/index.php	200	6428
-1	-	-	24Mar2023:15:07:44 +0530	GET	/dwa/sledd_event_listeners.js	404	295
192.168.115.17	-	-	24Mar2023:15:09:03 +0530	GET	/dwa/vulnerabilities/fi/?page=include.php	200	4183
-5	-	-	24Mar2023:15:09:03 +0530	GET	/dwa/instructions.php	200	22561
192.168.115.17	-	-	24Mar2023:15:09:03 +0530	GET	/dwa/vulnerabilities/tag/char	200	4824
-1	-	-	24Mar2023:15:09:03 +0530	GET	/dwa/sledd_event_listeners.js	404	295
-1	-	-	24Mar2023:15:09:12 +0530	GET	/dwa/vulnerabilities/brute	200	4296
-1	-	-	24Mar2023:15:09:13 +0530	GET	/dwa/vulnerabilities/exec	200	4181
-1	-	-	24Mar2023:15:09:14 +0530	GET	/dwa/vulnerabilities/fi/?page=include.php	200	4183
-1	-	-	24Mar2023:15:09:16 +0530	GET	/dwa/vulnerabilities/tag/char	200	4824
-1	-	-	24Mar2023:15:09:37 +0530	GET	/dwa/vulnerabilities/sql/	200	4152

Fig. 13 : Normal Logs File



Host	Identity	User	Date_And_Time	R_Type	Request	Status	Size_In_Byte
192.168.115.107	-	-	24Mar2023:12:50:52 +0530	GET	/dwa/login.php	200	1415
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/vulnerabilities/sql/?id=1&Submit=Submit	302	-
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/login.php	200	1415
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/vulnerabilities/sql/?id=1%29%28%22%2B%29%27	302	-
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/login.php	200	1415
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/vulnerabilities/sql/?id=1%27%6a%8f%3c%27%22%38	302	-
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/login.php	200	1415
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/vulnerabilities/sql/?id=1%29%20AND%201326%302	302	-
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/login.php	200	1415
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/vulnerabilities/sql/?id=1%29%20AND%201946%301	302	-
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/login.php	200	1415
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/vulnerabilities/sql/?id=1%29%20AND%208620%305	302	-
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/login.php	200	1415
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/vulnerabilities/sql/?id=1%20AND%205742%3032161	302	-
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/login.php	200	1415
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/vulnerabilities/sql/?id=1%20AND%201946%3019461	302	-
192.168.115.107	-	-	24Mar2023:12:50:57 +0530	GET	/dwa/login.php	200	1415
192.168.115.107	-	-	24Mar2023:12:50:58 +0530	GET	/dwa/vulnerabilities/sql/?id=1%20AND%204036%3082671	302	-
192.168.115.107	-	-	24Mar2023:12:50:58 +0530	GET	/dwa/login.php	200	1415
192.168.115.107	-	-	24Mar2023:12:50:58 +0530	GET	/dwa/vulnerabilities/sql/?id=1%20AND%201098%303621	302	-
192.168.115.107	-	-	24Mar2023:12:50:58 +0530	GET	/dwa/login.php	200	1415
192.168.115.107	-	-	24Mar2023:12:50:58 +0530	GET	/dwa/vulnerabilities/sql/?id=1%20AND%201946%301946	302	-
192.168.115.107	-	-	24Mar2023:12:50:58 +0530	GET	/dwa/login.php	200	1415
192.168.115.107	-	-	24Mar2023:12:50:58 +0530	GET	/dwa/vulnerabilities/sql/?id=1%20AND%206666%301120	302	-
192.168.115.107	-	-	24Mar2023:12:50:58 +0530	GET	/dwa/login.php	200	1415
192.168.115.107	-	-	24Mar2023:12:50:58 +0530	GET	/dwa/vulnerabilities/sql/?id=1%27%29%20AND%209223%302	302	-
192.168.115.107	-	-	24Mar2023:12:50:58 +0530	GET	/dwa/login.php	200	1415

Fig. 14 : SQL Injected Logs File



Host	Identity	User	Date_And_Time	R_Type	Request	Status	Size_in_Bytes
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/6687	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/11062	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/11816	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/820	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/11773	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/11057	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/71500	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/7359	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/11949	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/11805	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/71594	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/1123	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/71639	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/960	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/931	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/71467	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/71958	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/71545	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/7906	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/71700	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/7283	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/71300	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/603	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/9706	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/71707	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/7408	400	325
192.168.115.17	-	-	24Mar2023:15:01:44 +0530	GET	/71837	400	325

Fig. 15: HTTP FLOOD DDOS Logs File

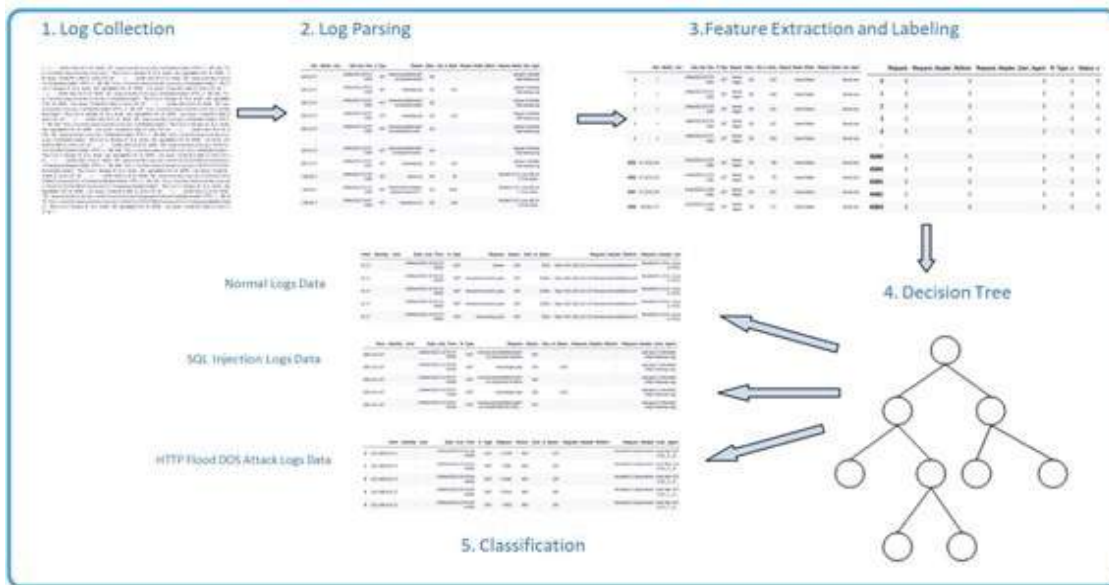


Fig. 16 : Implementation Summarized

EXPERIMENTAL RESULTS

To be able develop the datasets for training and testing for the framework, 45895 logs are extracted from the web server’s access logs file, which includes data from both the normal operation of the web server and an assault.

Confusion metrics presented in Table 1 gives the categorization model a comprehensive perspective. One of the categorization matrices used to assess the effectiveness of classification algorithms comprises the confusion matrix. The current research employs a confusion matrix for assessing the model, which defines the effectiveness of the detection and classification model in detail, before looking at the identification of anomalies and categorization system. Actual quantities are reflected by the conflation in the matrix’s actual values column. Rows in the confusion matrix represent the predicted values.

Table 1: Confusion Matrix

PREDICTED LABEL	ACTUAL LABEL		
	Normal logs	SQL Injected Logs	Dos attack Logs
Normal logs	6301 (TP)	18	0
SQL Injected logs	470	36159 (TP)	0
Dos attack logs	20	6	2920 (TP)

Result of Prediction and Classification

The percentage of all log data projections and categorization that were accurate forecasts and categorization is shown by accuracy. Precision indicates the percentage of truly accurate categorization and prediction of log data. Recall is an estimation of the efficacy of categorisation and forecasts made using log data. The F1-Score represents the harmonic mean measurement of the classifier algorithm’s recall and precision.

The Result calculated using the Confusion matrix is The results of these tests demonstrate that the model has an overall accuracy of **98.87** percent and is capable of correctly predicting and categorise log records using “TP=45380” out of a total “45895” presented in Table2.

ACCURACY	=	$\frac{\text{True Positive} + \text{True Negative}}{\text{True Positive} + \text{True Negative} + \text{False Positive} + \text{False Negative}}$
Precision	=	$\frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}}$
Recall	=	$\frac{\text{True Positives}}{\text{True Positives} + \text{False Negatives}}$
F1 - score	=	$2 * \frac{\text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}} = \frac{2TP}{2TP + FP + FN}$

Table2: Result of Prediction and Classification

	Accuracy	Precision	Recall	F1 - score
Normal Logs	98.88%	1.00	0.93	0.96
SQL Injected Logs	98.89%	0.99	1.0	0.99
DOS Attack Logs	98.93%	0.99	1.0	1.0

CONCLUSION

The research presented here presents a trained machine learning-based recognition and categorization model for web server access log files. With respect to inconsistencies found in accesses log data, the framework is competent to analyse, identify, and categorise the log data. Realistic web-based applications that were hosted locally on a XAMPP server were used to gather the data for the model by performing various attacks involving SQL injection and DDOS against the internet-based server. In the present research, useful attributes were first gained, by considering trends and evidence that there are specific attributes, and after each of these characteristics were labelled and encoded as well the generated dataset was used for the construction and training of a decision tree classifier. The grouping of web access log file data into three categories—SQLi logs, normal logs, along with DOS log file—is established to be acceptable based on the findings.

This algorithm's entirety identification and classification effectiveness was determined to be 98.87 percent after testing and also proves to be cost effective, accurate, efficient and employing an easy- to-understand

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A Secured Online Voting System for Member Based Organizations

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▶ ABSTRACT ◀

This paper's main objective is to provide a user-friendly and safe online voting system. This article proposes an online voting system that, thanks to its user-friendly interface, makes it possible for voters and candidates to take part in online voting in a safe and straightforward manner. Voters and candidates must register on the internet in order to use this method. By inputting their registered cellphone number and password, the user (voter) may log in and cast their ballot. The election results and related information are also visible to voters. This system is an HTML, CSS, and PHP-based web development project. Colleges, institutions, and groups may utilize this technology to hold elections, making the voting process more efficient and transparent.

Keywords: *Online Voting System, Online Polling System, HTML, CSS, PHP, MYSQL, PhpMyAdmin, XAMPP, Online Election System.*

INTRODUCTION

Voting is a crucial procedure that is used in a variety of situations, including selecting a government in a democracy, leaders for organizations, and managers for society. There is always a decision made from a variety of possibilities. Voting can be done in a number of ways, including the traditional system (ballot paper system), the electronic system (E.V.M. machines), etc., but these procedures take time, require a lot of manpower, and require infrastructure for the voting station (booth). Additionally, there is a chance that voter fraud and manipulation will occur. Online voting is a method that gets rid of these problems. This online voting system shortens, improves, and streamlines the voting process. This online voting system offers users a platform where they may sign up to vote remotely and exercise their constitutional right to vote from any location.

Research Objective

The main purpose of this study is to make an online voting platform for colleges, offices, and societies that provides the essential security levels, is convenient to use, is flexible. Thus, the voting process becomes easy, less time taking, and alteration free.

Scope of Study

The scope of Online Voting System is that it can be use:

- (i) People are chosen for roles like “Group Leader” and “Project Leader” in companies.
- (ii) In universities, for the purpose of choosing candidates for various posts such as “President, Vice President,” etc.
- (iii) by numerous groups to elect people to various management positions. In each of these situations, the effectiveness of the online voting system may be increased by tailoring it to the particular election. Because of the user-friendly interface, voters may easily cast their ballots whenever and from anywhere, which raises the voting rate.

LITERATURE REVIEW

Background

Both candidates and users (voters) may utilize this system. To vote in an election, a user (voter) must first register. After registration, the user (voter) must log in using their registered mobile number and password. They are then brought to a dashboard where they may vote by pressing the vote button next to the candidate of their choice. A candidate must register in order to participate in the voting process. LAN is utilized for this online system’s research, development, and testing. Despite years of study on online voting system software, there have been several recorded incidents of incorrect implementations. By addressing these issues, an online system is put in place, making the voting procedure hassle-free. In an online voting system, there are

- (i) user details.
- (ii) login with ID and password.
- (iii) users’ vote in a database.
- (iv) All candidates who have registered are listed in the candidate section, each with a vote button.
- (v) displaying of result.

Product Functions

The proposed online voting system features a server back-end that handles voter authentication and preserving pertinent information. Users (voters) must first log in using their cellphone number and password in order to access the dashboard, which allows for simple voting. Their answer will then be recorded.

The dashboard contains 3 sections:

- (i) Candidate Section.
- (ii) My Profile Section.
- (iii) Stats Section.

Various functional works proposed in the system are:

- (i) information of the user in database.
- (ii) information of the candidate in database.
- (iii) counting of votes.

SYSTEM REQUIREMENT

Hardware Specification

- (i) **Processor:** Intel Pentium 4
- (ii) **RAM:** 4GB
- (iii) **HDD:** 512GB

Software Specification

- (i) **Operating System:** Windows 10
- (ii) **Source Code Editor:** Visual Studio (VS) Code
- (iii) **Front-end:** HTML, CSS
- (iv) **Back-end:** PHP
- (v) **Database:** MySQL
- (vi) **Localhost and Testing:** XAMPP

TECHNOLOGY DESCRIPTION

HTML

The common markup language used to create web pages is called Hypertext Markup Language (HTML). A web page and its content's semantic structure and presentation are provided by HTML. The three technologies of HTML, CSS, JS, or PHP form the backbone of the World Wide Web. The front end uses HTML and CSS, while the back end uses JS or PHP. When a web browser receives an HTML document from a web server or local storage, the browser turns it into a multimedia web page. The contents may be organized into paragraphs, a list of bulleted points, graphics, or data tables, for instance. HTML handles every aspect of this standard.

CSS

The term "CSS" stands for cascading style sheets. CSS is used to provide the appearance of a document, such as how material published in HTML will appear when printed or shown on a screen. The majority of websites make use of this technology to design aesthetically attractive web pages for several mobile applications. CSS also separates presentational elements like layout, colors, and fonts.

There are three ways to apply CSS in web pages:

- (i) **Inline CSS:** Inline CSS is the name of the CSS property that is associated to the element in the body section. The style property of an HTML element is used to provide inline CSS.
- (ii) **Internal or embedded CSS:** When just one HTML page has to be styled differently, this may be utilised. The HTML file's `<style>` element, located in the head section, should include the CSS rule set.
- (iii) **External CSS:** .css extension-written CSS properties are applied in a separate CSS file. The link element must be used to connect this CSS file to the HTML content. It streamlines and defines the design of several web pages at once while also reducing labour.

PHP

The term "PHP" stands for "Hypertext Preprocessor." It is a commonly used open-source scripting language. On the server, PHP programmes are run. You may use and download it for free. In 1994, Rasmus Lerdorf released the initial version of PHP, which had its origins in a modest open-source undertaking. PHP can

- (i) generate dynamic page content
- (ii) create, open, read, write, delete, and close files on the server
- (iii) collect form data
- (iv) send and receive cookies
- (v) modify the database's data. Many well-known databases, including MySQL, Oracle, and Microsoft SQL Server, may be integrated with it.
- (vi) be used to control user-access
- (vii) encrypt data

MySQL

SQL stands for structured query language in MySQL. SQL is the foundation of MySQL, a relational database management system (R-DBMS). It is a web-based, open-source system that can handle both small and big applications. It operates on a server. It is the most often used database type for PHP. Database connections and manipulation are simple, quick, and trustworthy using PHP. In this system, a user and candidate database comprised of their information, votes, and status is created using MySQL.

XAMPP Server

The acronym XAMPP stands for “Cross Platform,” “A” for “Apache,” “M” for “MySQL,” and “Ps” for PHP and Perl, respectively. A cross-platform web server makes it easier for programmers to write and test their code on a local web server. Before publishing a website to the main server, a local host or server may test it on PCs and laptops to see how it works with customers.

MODULES OF SYSTEM

There are two modules. They are:

- (i) user (Voter)
- (ii) candidate

Flow Chart

Fig. 1. Shows the flow chart of the system. Voter and Candidate both have to registered themselves through registration process. All the details such as name, cellphone number, address, and profile picture of voters and candidates get stored in the database. Then the registered voter and registered candidate can take part in voting process. After voting, the voter and candidate can check the voting results.

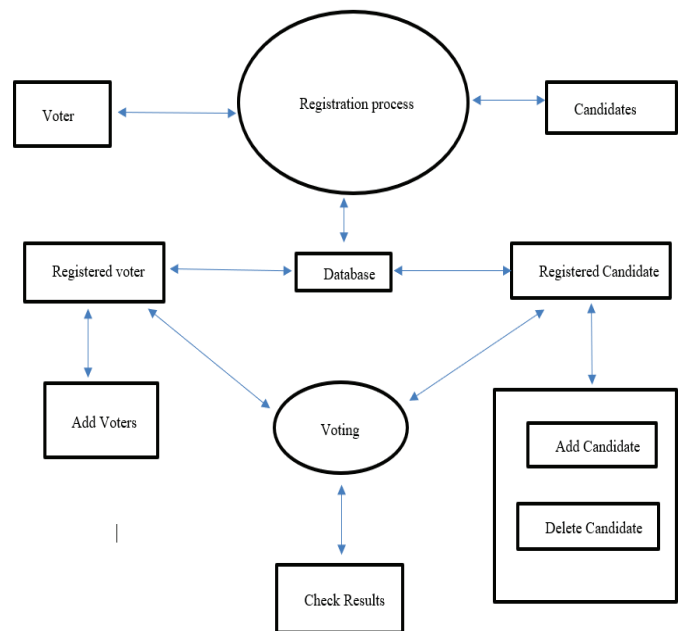


Fig. 1: Flow Chart of Proposed Online Voting System

Home Page

Home Page (as shown in Fig. 2.) is the portal’s main landing page. It has a login page from which the voter may log in after providing a password and cellphone number. Invalid credentials will be shown on the website if the voter enters a faulty password or mobile number. It contains links to other sites, such as the registration pages for new users (voters) and candidates. Voter is sent to the DASHBOARD page after logging in.

Registration Page

The voter may register themselves by inputting their information, such as name, cellphone number, address, and picture, on this website, which also serves as the candidate registration

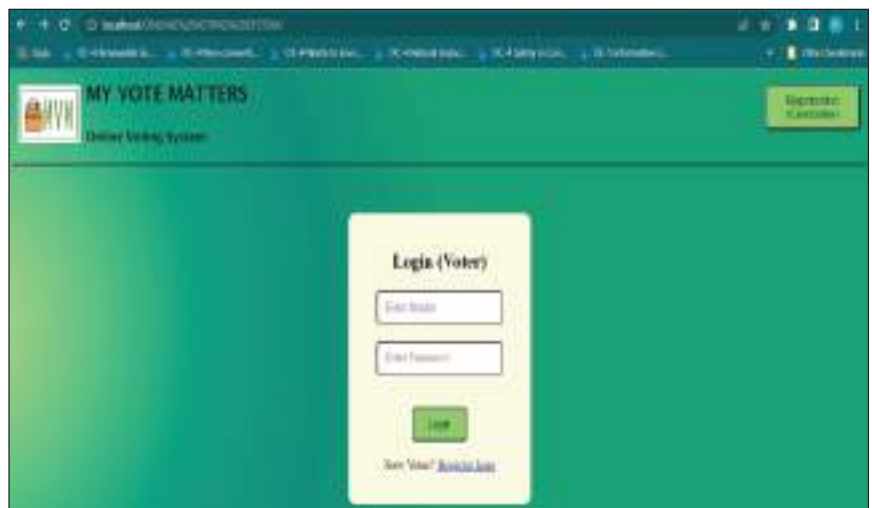


Fig. 2: Home Page

page (as shown in Fig. 3.). The candidate may also register on their own by providing the necessary information. The relevant database contains all the information that has been entered into the portal. If the voter is already registered, this page also contains a link to the login page.

Dashboard Page

Dashboard page (as shown in Fig. 4.) will open after login by the voter. This page contains three sections:

- (i) The candidate section includes a list of all candidates (voting options) who have registered for online voting along with a vote button for each one to make voting for them simple.
- (ii) The voter’s information is shown in My Profile Section. It also displays the voter’s status, including whether or not they cast a ballot. There is a logout button as well.
- (iii) The stats section displays the overall number of votes, the number of people that have registered, and the voting percentage.



Fig. 3: Registration Page

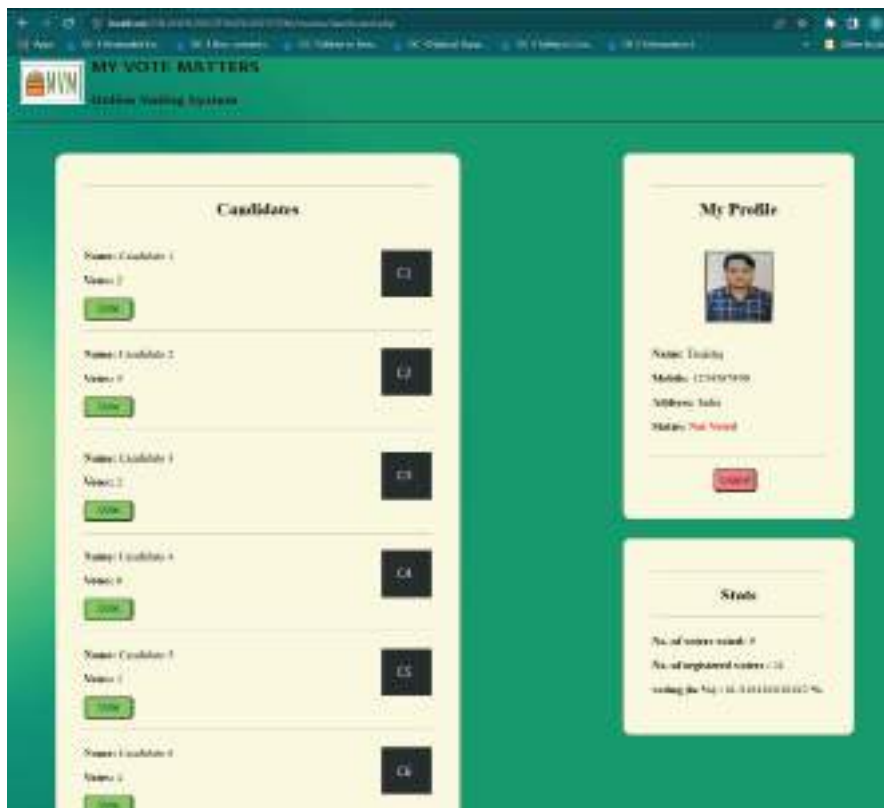


Fig.4: Dashboard Page

Result

Users may vote for their preferred candidate by clicking the vote button that appears in the candidate section. The result of the voting will display on the result page as shown in Fig. 5. After casting a ballot, the number of votes for each candidate is updated, and the voter's status is changed from "not voted" to "voted." The number of votes and voting percentage statistics are updated as well.



Fig. 5: Result Page

FUTURE IMPLEMENTS

Making the system interface more interactive might enhance it in the future. The use of email, SMS, and email alerts might help increase security. Additionally, build a new module to the system called ongoing elections, where all of the mentioned elections will be shown along with a result visualization.

CONCLUSION

When people's attitudes shift from "my vote doesn't matter" to "my vote matters," the number of votes cast rises and will ultimately make a difference. In other words, this online voting system is a website that allows members of the organization (voters) to easily and conveniently cast their ballots from anywhere, at any time via the internet. Additionally, it makes the process of counting ballots easier when there are many voters and produces reliable results. Additionally, it removes the possibility of fraudulent votes and human mistake. It takes less time to use and is simple.

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Investigating Machine Learning Methods for the Prediction of Autism

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▶ ABSTRACT ◀

Autism spectrum disorder (ASD) is a neurodevelopmental disease that impacts how people connect and communicate with one another. In this, we focus especially on three areas: social interaction, communication, and stereotypical behaviour. Diagnosing autism is time-consuming. Having an autistic member of the immediate family, specific genetic mutations, and certain physical and mental health conditions can all contribute to ASD. Right medicine at the right time by early diagnosis benefits the patients. According to ASD, the problem begins in childhood and persists through adolescence and maturity. This paper attempts to investigate the potential use of classification algorithms of Machine Learning for predicting and analysing ASD problems in a child, adolescents, and adults. The accuracy attained by Logistic regression is 89.16% and is the best among all as the accuracy of SVM is 86.66%, Decision Tree and Random forest give accuracy of 84.16% and 87.08% respectively and KNN accurate to 82.91%. The proposed methods are examined using a variety of publicly accessible ASD datasets. This attempt is inspired by the increased use of machine learning techniques in medical diagnosis research dimensions.

Keywords: Autism Spectrum Disorder (ASD), Machine Learning, Classification.

INTRODUCTION

ASD is a complex neurodevelopmental disease that is typically brought on by having an autistic member of a close family, certain genetic mutations, and certain mental and physical health conditions. ASD is characterised by communication and social interaction deficits as well as constrained, repetitive patterns of behaviour, interests, and activities. ASD is a condition that is currently affecting people of all ages. The maintenance of the subject's physical and mental health can be considerably aided by early identification of this neurological condition [1] [2].

Patients with autism deal with a variety of obstacles, such as attention issues, learning disabilities, and mental health issues. Autism is currently on the rise worldwide, and its prevalence is growing rapidly. According to

estimates, one in every 54 kids in the US has an ASD diagnosis. An early autism diagnosis can be of considerable assistance to sufferers. Machine learning systems may be able to anticipate autism based on behavioural and physiological data. These algorithms can examine enormous datasets and spot patterns that may not be obvious to human observers. This study intends to investigate the application of machine learning techniques for autism prediction. It will review the state of the art in this area of study. To improve the outcomes for people with ASD, the findings of this study will help create useful tools for early autism screening and intervention [3] [4]. The main motive of this study is to use machine learning to predict autism by gathering data from Kaggle and utilising several classification methods. The study uses machine learning algorithms to make predictions about whether or not a person has autism. The dataset contained details on the individuals' age, gender, and behavioural traits, among other factors. Numerous classification methods, including logistic regression, decision trees, k-nearest neighbours, random forests, and support vector machines, were used in the study. Each model's accuracy is assessed using a variety of evaluation metrics, including precision, recall, and F1 score. This paper is laid out as mentioned. A review of the literature is presented in Section 2, while Section 3 elaborates on the suggested model in depth. Section 4 discusses the data pre-processing techniques along with model fitting and results. Finally, the Conclusion and future work are presented in sections 5 and 6 respectively.

RELATED WORK

In order to identify autism spectrum disorder (ASD) in people of any age, K. S. Omar et al. [1] offered a machine learning-based prediction model and a mobile application, which demonstrated improved results in terms of accuracy, sensitivity, and precision in real datasets. In a study by S. A. Raj et al. [2], ASD was predicted and analysed in children, adolescents, and adults using various machine-learning techniques. For ASD screening, convolutional neural network-based models performed better and more accurately. To identify prospects for collaboration between computational and behavioural sciences, Daniel Bone [3] examined the results of two research that made claims about utilising machine learning to expedite the diagnosis of autism. He discovered conceptual and methodological errors.

After three years of clinical observation, special education, and psychiatric care, Mirac Baris Usta [4] employed machine learning to analyse predictors of outcomes in children with ASD. The goal was to identify clinical and individual factors influencing development in the core symptoms of autism. A machine learning method was used to discover a subset of 5 behavioural variables from the Autism Diagnostic Observation Schedule (ADOS) Module 4 that can predict autism spectrum disorders (ASD) with high sensitivity and specificity in high-functioning adolescents and adults.

The study by Charlotte Küpper [5] included a routine clinical sample of 673 people, 385 of whom had ASD and 288 who had suspected ASD or other diagnoses. The findings show that identifying a smaller collection of behavioural traits may enhance ASD diagnosis and aid in differential diagnosis. According to the study by Kaushik Vakadkar [6], Autism Spectrum illness (ASD) is a neurological illness that can have long-term consequences for a person's language, cognitive, and social skills. Early detection and therapies aid in the situation. Machine learning techniques such as Support Vector Machines, Random Forest Classifier, Naive Bayes, Logistic Regression, and KNN were used to develop prediction models on a dataset to improve precision and reduce diagnostic time. The most accurate method for diagnosing ASD in the early stages of development was logistic regression. The study by Koushik Chowdhury [7], emphasises the importance of early detection of Autism Spectrum Disorder (ASD) and the creation of an accurate assessment method. The study compares numerous metrics used in classifiers, such as Support Vector Machine (SVM) with different kernels. The results reveal that SVM with Gaussian Radial Kernel produces the best results, detecting ASD with 95% accuracy using a publicly available standard dataset.

On this basis, the autism prediction procedure proposes using machine learning techniques and it experimented with different categorization strategies to find the most reliable approach. A collection of features related to autism is subjected to use predicting autism using logistic regression and other techniques.

The research by A. L. and N. Popescu [8], provides a useful approach for foretelling the emotional state of autistic children using machine learning algorithms. The study reveals a mobile app that predicts children's emotional states based on their drawings, giving autistic kids a way to express their feelings. This research could be a useful resource for creating a machine learning-based approach for autism prediction that focuses on non-verbal clues for emotional state recognition.

A thorough analysis of 45 papers using supervised machine learning for diverse purposes in research on autism spectrum disorder (ASD) is given in the work by Kayleigh K. Hyde et al [9]. The review discusses the application of machine learning for ASD diagnosis, genetic exploration, and intervention planning. This work could be a useful resource for creating a similar machine learning-based solution for autism prediction, especially in terms of identifying and describing supervised machine learning trends in the literature on ASDs and disciplining researchers interested in growing the body of clinically sound methods for mining ASD data.

In their study, Min Che et al. [10] put up a method for accurately predicting the severity of autism by carefully taking into account both genetic and environmental factors. They gathered a sample set from the autism clinic and created a prediction model using a softmax classifier and a stacked sparse autoencoder. The proposed model performed more accurately in predicting the severity of autism when compared to decision trees and support vector machines. This research could be a useful resource for creating a machine learning-based approach for estimating the severity of autism, especially when taking into account genetic and environmental factors and utilising a stacked sparse autoencoder and softmax classifier.

The research of Astha Baranwal and M. Vanitha [11] focuses on applying machine learning algorithms to predict likely cases of ASD in adults, kids, and teenagers. They examined ASD screening datasets for every age group and performed prediction and comparison using Artificial Neural Networks (ANN), Random Forest, Logistic Regression, Decision Trees, and Support Vector Machines (SVM). In particular, while analysing screening datasets and comparing various algorithms, this study serves as a helpful reference for creating a machine learning-based solution for predicting ASD.

The topic of the study "Machine Learning-Based Models for Early Stage Detection of Autism Spectrum Disorders" by T. Akter et al. [12] is the application of machine learning algorithms for ASD early detection. The researchers collected ASD datasets pertaining to various age groups and subjected them to feature transformation techniques like log, Z-score, and sine functions. Effectiveness of various classification techniques was then tested after implementation.

PROPOSED METHODOLOGY

Initially, data is prepared for analysis by cleaning, converting, and choosing pertinent features is a key component of machine learning. By eliminating duplicates, errors, and discrepancies from the data, pre-processing has been performed and cleaned it. To assure accuracy, noise in the data was removed. By selecting pertinent traits, attributes were selected. In our investigation, discretization, data reduction, and aggregation were not required. We made sure the data was prepared for machine learning algorithms by using these methods. Fig. 1 is illustrating the Autism Prediction Lifecycle and provides a thorough overview of the procedures needed in applying machine learning to predict autism. The gathering of pertinent data on the people in the dataset is the first phase in the process, which is called data collection. Along with behavioural traits and medical history, this data may also include demographic details like age, gender, and location.

Following collection, the data goes through a pre-processing stage where it is cleaned, processed, and normalised to prepare it for analysis. This step is vital since it removes any discrepancies in the data that may affect the precision of the forecasts. The data is pre-processed before being placed into the machine learning model, where several categorization approaches are used to determine whether or not people have autism spectrum disorder (ASD). These methods include, among others, support vector machines, k-nearest neighbours, decision trees, logistic regression, and random forest.

Furthermore, the classification model is assessed using several measures, including accuracy, precision, recall, and F1 score. These indicators assist in evaluating how well the model predicts ASD and highlighting areas in need of improvement. Overall, the Autism Prediction Lifecycle graphic demonstrates the value of employing a clearly defined procedure when utilising machine learning to predict autism. Researchers and practitioners can enhance early diagnosis and intervention for people with ASD by following these steps and obtaining accurate predictions.

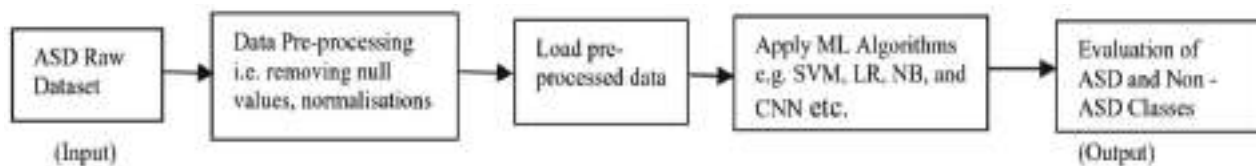


Fig. 1: Autism Prediction Model Lifecycle

Pre-Processing the Data

Various data pre-treatment approaches were used in the research on machine learning for autism prediction. These included cleansing the data, addressing missing data, eliminating noisy data, transforming the data, normalising it, choosing the right attributes, and reducing the amount of data. There was no need for discretization, aggregation, or dimensionality reduction. These methods were required to make sure the data was suitable for analysis and to raise the predictive model's accuracy.

Fitting the Model

Logistic Regression

Logistic regression solves binary classification problems. Intuition in geometry and mathematics are two key components. When data points are linearly separable, the geometric understanding of logistic regression calls for utilising a plane to classify the points. The final classification is determined by adding a bias component after using a weight vector to calculate the distance between a point and the plane. The sum of the products of the actual and predicted labels, which is maximised to get the ideal weight vector, is the logistic regression cost function. A sigmoid function is used to lessen the influence of outliers, which might hurt the optimisation process. A sigmoid function is used to assess the probability of a class prediction, and stochastic gradient descent is used to calculate the best weight vector based on the log-likelihood of the probability. Overall, logistic regression is a straightforward yet effective approach for binary classification tasks. It is simple to comprehend and use because of its geometric and mathematical understanding.

Support Vector Machines

The Support Vector Machine (SVM) method was implemented to make machine-learning predictions about autism. SVM is a classification method that formulates a hyperplane in high-dimensional space and divides data sets into classes. The optimum hyperplane was chosen using the SVM algorithm on the training set after the data had been preprocessed and divided into training and testing sets. However, the study discovered that logistic regression outperformed SVM in terms of autism prediction. SVM is still a valuable technique for classification jobs, and it can be researched more.

RESULT AND ANALYSIS

Recommendations for system requirements were made in a study looking at machine-learning techniques for predicting autism in youngsters. The study recommends utilising Python programming language (version 3.6 or higher) and Scikit-learn library for machine learning models, together with NumPy and Pandas libraries for data preprocessing and analysis, and Matplotlib and Seaborn libraries for data visualization. The study recommends a computer with a 64-bit operating system (Windows, macOS, or Linux), at least 8GB of RAM, a multicore

processor with a clock speed of 2.0 GHz or higher, and enough storage space to keep the dataset and models produced during training. It should be noted that hardware requirements may vary depending on dataset size and machine learning model complexity. While employing GPUs can assist some models train more quickly, it is not necessary for this study.

About the Dataset

Simple and effective screening methods are required for an early diagnosis of autism since they can reduce healthcare costs. However, it is difficult to undertake in-depth analysis to improve the screening process due to the dearth of datasets relevant to behavioural traits. A fresh dataset with 20 features has been proposed for adult autism screening to address this, including ten behavioural traits and ten individual characteristics. The classification of ASD cases can be improved by using this dataset to help discover important autistic features.

Calculation of Accuracy

Confusion matrix has been used to evaluate the performance of classification models for a certain set of test data. Matrix seems very easy to be understood but some of its terminologies may haunt some people. Since the confusion matrix displays the errors in the model performance, it is also referred to as Error Matrix. Using this, the model's accuracy as well as other things are determined. The following computations are provided [7]:

1. **Classification Accuracy:** It is one of the crucial factors in figuring out how accurate a classification problem is. It specifies how frequently the model predicts the right result. The number of accurate predictions made by the classifier divided by the total number of predictions made by the classifiers can be used to compute it. The following is the formula:

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{FP} + \text{FN} + \text{TN}}$$

2. **Precision:** Defined as the number of accurate outputs that are produced by the model. Or as the proportion of correctly predicted positive classes that actually were positive. It can be calculated using the formula below:

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}}$$

3. **Recall:** Referred to as the percentage of total positive classifications predicted correctly by our model.

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

4. **F-measure:** Comparing models having low precision but good recall or vice versa is challenging. Therefore, F-Score is used for this purpose. It enables us to simultaneously estimate recall and precision. The F-score is at its highest if the recall and precision are equal. Using the formula below, it can be calculated

$$\text{F-measure} = \frac{2 \text{ Recall Precision}}{\text{Recall} + \text{Precision}}$$

Fig.2 and Fig.3 demonstrate the confusion matrix for the logistic regression model and SVM respectively for our autism prediction model. It is a useful tool for assessing how well a classification model, such as logistic regression, and SVM performs. It demonstrates significant metrics calculations and gets an understanding of how effectively the model is forecasting outcomes by looking at true positives (TP), false positives (FP), false negatives (FN), and true negatives (TN) values. A frequently used evaluation statistic in machine learning to rate the effectiveness of classification models is the classification report. We examine the model's accuracy, recall, F1-score, and support in this report. The report provides us with a thorough analysis of how the model is doing for each class Table 1 and Table 2 represent the classification report of Logistic regression and SVM respectively.

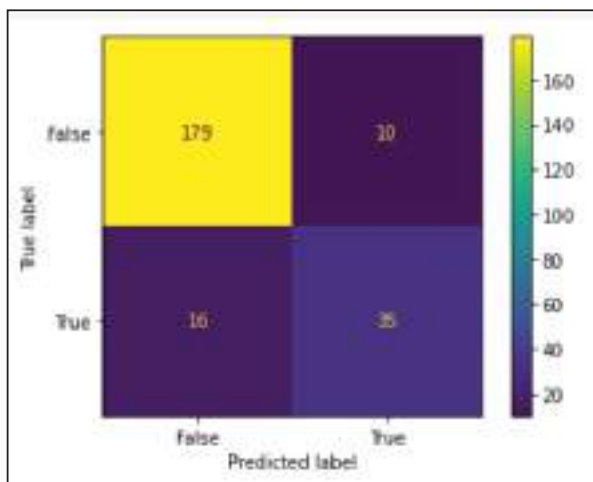


Fig. 1: Confusion matrix for logistic regression

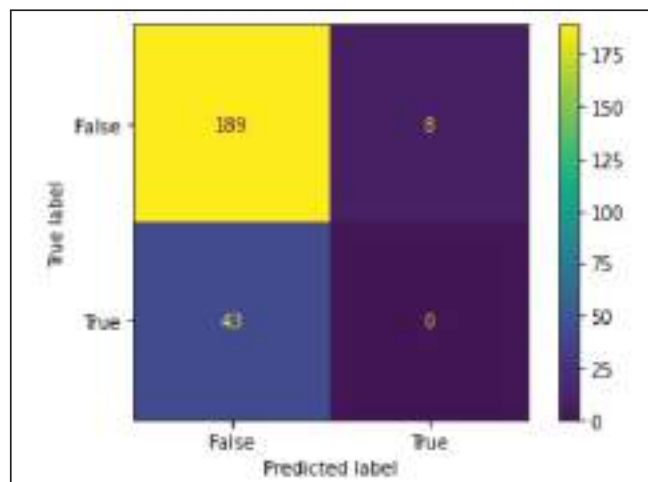


Fig. 2: Confusion matrix for SVM

	precision	recall	f1-score	support
0	0.92	0.95	0.93	189
1	0.78	0.69	0.73	51
accuracy			0.89	240
macro avg	0.85	0.82	0.83	240
weighted avg	0.89	0.89	0.89	240

Table 1: Classification Report of Logistic Regression

	precision	recall	f1-score	support
0	0.90	0.90	0.90	197
1	0.56	0.56	0.56	43
accuracy			0.84	240
macro avg	0.73	0.73	0.73	240
weighted avg	0.84	0.84	0.84	240

Table 2: Classification report for SVM

In this work, two different classification algorithms have been examined, including logistic regression, and support vector machine (SVM) to successfully identify autism, and analyse their performance using different metrics. With a score of 89.16%, logistic regression has the best accuracy rating, followed by SVM. The algorithm that performed the best is logistic regression, which also had the highest precision and recall scores. The early identification and treatment of autism are significantly impacted by these discoveries.

CONCLUSION

In conclusion, the goal of our study is to use machine learning to predict autism. Despite the fact that multiple research has been conducted using various approaches, no conclusive result about predicting autism features in different age groups has been reached. Hence, this paper aims to propose an effective prediction model based on the machine learning technique. It used many classification techniques, including logistic regression and SVM.

In terms of accuracy, logistic regression had the highest result with 89.16%. Our findings show how machine learning can be used to precisely predict autism and show promise for further study in this area. The results of this study could have a big impact on early autism diagnosis, which is essential for prompt intervention and treatment. The success of logistic regression in this study might serve as a foundation for additional analysis and investigation of this method in other healthcare settings. Overall, the study's findings offer compelling proof that machine learning can be a useful tool.

FUTURE SCOPE

Future research could concentrate on combining new data sources to improve forecast accuracy. Integrating genetic data, neuroimaging data, and wearable device information, for example, could provide a more thorough understanding of the underlying mechanisms and biomarkers linked with autism. This multimodal approach can potentially improve the performance of the classification models. While the current study makes use of common categorization algorithms, future research could look into advanced machine-learning techniques. Convolutional neural networks (CNNs) and recurrent neural networks (RNNs) are deep learning models that can be used to capture complicated patterns and temporal connections in data. Transfer learning, which involves fine-tuning pre-trained models on large-scale datasets for autism prediction, could potentially be researched to use expertise from related tasks. Future research could concentrate on sophisticated feature selection and engineering strategies to increase model performance and interpretability. Methods for selecting the most informative features for autism prediction, such as genetic algorithms or recursive feature elimination, can be used automatically. Furthermore, domain knowledge and expert input can be used to create new features that capture specific characteristics of autism symptoms and severity. Future studies should explore the deployment and integration of predictive models within healthcare settings to allow the actual implementation of the generated models. This includes addressing data privacy issues, model interpretability, and user-friendly interfaces for physicians and carers. Collaboration with healthcare professionals helps ensure that research findings are seamlessly translated into clinical practice. Longitudinal studies can be used to track the progression of autism symptoms over time. Longitudinal data gathering would allow the construction of predictive models capable of assessing the risk of autism development at various periods of life. Furthermore, future studies can look at the possibility of personalised interventions based on predictions, and customising treatment programmes to the specific needs and characteristics of people with autism.

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Cloud Computing Security Using Honey Encryption Technology – Detailed Review

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▶ ABSTRACT ◀

As security is one of the most common issues of Cloud computing, in the near future new encryption techniques and security protocols with enhanced features will be developed. With the help of virtualization tool, same physical resources are allotted to more than one client. Apart from the different application and facilities provided by the cloud provider, it is also one of the duties of the provider to take care of information of client associated with cloud. After broad survey on the honey algorithm and reviewed work of researchers it is found that the honey algorithm has confirmed its effectiveness against various attack like brute force and when it is using the hash functions with DTE and it becomes stronger and works to prevent attacks such as rainbow attack and dictionary attack. Honey algorithm can be used or combined with other algorithms to be stronger and effective and to overcome the problem due to various attacks.

Keywords: *Cloud Computing, Honey Algorithm, Brute force etc.*

INTRODUCTION

Cryptographic Techniques is comprehensively ordered into two sections: Asymmetric key Cryptography and Symmetric key Cryptography. The cryptographic method is used to secure the data stored in the cloud, prevent data leakage, and guarantee that security has been maintained. The information gathered in the cloud was made safe by using encryption techniques. The huge growth in data encroachment over time intend that the prevalent steps for procuring information may be incompetent and needs comprehensive investigation. The development of high-speed, massively parallel, and distributed systems provided the tools for examining, gathering, and

processing enormous data stacks, commonly known as big data. However, this significant advancement left the cryptosystem vulnerable to brute-force attacks because hackers now had access to vast amounts of processing power [4].

LITERATURE REVIEW

We can hold the honeywords with the original password for account of every consumer by generating honeywords. If a hacker [1] receives a disaster file of jumbled passwords or honeywords, he will be unable to identify which password is the real password. The honey checker server or auxiliary can classify the honeyword and real password during the login process and will sound an alarm to distinguish between the two. However, because the method of honeyword generation creates honeywords that are similar to the actual password, it is possible for the user to make a typing error when inputting a password. The main weakness of this strategy is the storage overhead problem. The use of honeywords in the current framework may be very beneficial and simple to implement. Its main advantage over the related strategy of honeypot accounts is the idea that it works for each customer account.

An innovative method of honey encryption are an easy-to distribute and strong new line of protection for present password arrangements [2]. It is anticipated that the safety community will enjoy exclusivity in their utilization. Additionally, Format Transforming Encryption (FTE) and Format Preserving Encryption (FPE) are connected to honey encryption. In the field of cryptography, format-conserving encryption (FPE) refers to encrypting so that the output, or ciphertext, has the same pattern as the input, or plaintext. Methods using honey encryption are growing in popularity because they have various advantages over those using traditional passwords. There are many opportunities for research in this vast topic.

The message space design needs to change for new types of applications, even though honey encryption has been used in a large range of applications depending on the type of message patterns and probability factors. The cipher text message space and the plain text message space in FPE are the same. The cipher text message space in FTE differs from the message space in some ways. A plaintext message is mapped via honey encryption to a seed range in the seed space.

The cipher text message space contrasts with the message space because the message space and the seed space are incompatible. It is appropriate for a small, not a large, message space since processing a large message space has a significant overhead. For different applications, HE's ability to protect sensitive personal data varies. The honey encryption method is used to protect credit card details and a user-friendly version of text messaging. It has been successfully used in MANETs [3] to prevent ad hoc networks from brute-force attacks.

Nearly all of this data comes from message spaces that are deployed consistently. However, the probability distributions in genomic data are typically highly non-uniform. The GenoGuard system unifies the honey encryption (HE) theoretical paradigm, a new one for encryption. In GenoGuard, a potential adversary can make repeated attempts to guess passwords or encryption keys and decode data using brute force. A plausible genome sequence must be created during decryption using any key, and GenoGuard provides information-theoretic security assurance against message-recovery attacks.

A larger graphics processing unit (GPU) will enable the warrior to decipher the complex password files [4]. The new method of storing both the anticipated password and the actual password in the database is then considered. The honeychecker for examining entering the fictitious passwords to the approach was discussed in this work. Therefore, utilizing a honeychecker forces an attacker to decide whether to attempt logging in with a high chance of noticing or determining the password-hash file.

The honeychecker prevents him from entering the system even after he has obtained the password file and modified the cluttered code into the password. As a result, this strategy can fend off hacker attempts and solve the storage overhead problem. The honey circular list algorithm was looked into in order to lessen the current problem with the honeyword production technique. The circular list for storing the cluttered password was created as a result. When the hacker obtains the password file, he is unable to log into the system since he is

unable to determine the length of the password. The storage issue of earlier algorithms can be reduced by using the honey circular list strategy.

Provisionally, honeywords are supported to become approved passwords. Denial-of-service attacks that target the honeychecker or the communications between the system and the honeychecker are forbidden under this rule. However, this method is unable to directly address the issue with honeyword generation techniques. With the exception of assigning the plaintext messages, Honey Encryption uses a new encoding and decoding technique called a distribution transforming encoder (DTE) [5]. A distribution-transforming encoder (DTE), a new type of randomized message encoding method, and the research of the alleged maximum loading of bins in various balls-and-bins games are the key obstacles. For placing plaintext messages into the seed space, the DTE in that manner has limitations. The honey encryption algorithm's distribution transforming encoder (DTE) technique, which assigns the message space M to the seed space SDES's binary bits string using 16 rounds of identical operations, is essential. He naturally promotes safety in a variety of real-world situations. By utilizing a brute force approach to obtain decrypted data, a hacker runs the risk of being misled and receiving false important signals.

To map the message space into the seed space and identify the message space limitation problem, the DTE method employs consolidated organization function.

Due to DES's obvious weakness and the fact that the security is not bound, it is simple to damage DES. One of the more sophisticated security threats to password-based endorsement methods is the modification of cluttered values through the use of brute force computing. By making password cracking evident, honeyword-based endorsement rules might effectively minimize this threat. However, there are some drawbacks to the current approaches, including Storage Overhead, Weak DoS Resistivity, Multiple System Vulnerability, etc. Paired Distance Protocol (PDP), a novel honeyword creation system that virtually eliminates the drawbacks of earlier proposed honeyword production techniques, was projected [6]. The thorough analysis demonstrates that PDP not only improves perception rates but also significantly lowers storage costs. PDP, which is based on RS randomness, provides the highest level of safety requirement. It has limitations including DoS resistance, correlational risk, and a problem with typo safety.

The effectiveness of the honey encryption method was examined, and because message spaces vary, the execution must be modified for different applications. Recent security incidents involving public cloud data storage have stoked concerns about the security of cloud data.

Current cloud data asset management solutions that rely primarily on conventional password-based encryption are unable to effectively fend off password cracking and guessing attacks. An extended Honey Encryption (XHE) technique was planned [7] to address this issue by adding an additional layer of protection to the encrypted data. The HE algorithm generates identical fake data when a hacker attempts to access these encrypted files using a bogus password, even while access is being denied. This prevents the hacker from determining whether the anticipated password is effective or not. Consequently, password cracking and prediction attacks are becoming more complex. The projected strategy's message space is pre-fixed, and as file names and their extension sizes expand, so do their complexity and size in inverse sampling tables. The XHE system can be modified to operate with newer advancements in cryptography, such as homomorphic encryption, which Promotes processing on encrypted data, and attribute-based encryption (ABE). It can be cracked using brute-force, dictionary, or rainbow table attacks on passwords.

The biometrics fingerprint and multi-modal iris are being employed in. The gradient pyramid approach is used to integrate/amalgamate the biometrics. The template for the amalgam is encrypted using honey encryption. The results of the experiments show that the proposed method, DWTSVDGOA, offers an NC value of 1, PSNR of 90.75, and SSIM of 0.99.

The attainment and the valuation of the method are discovered to be finer than present image watermarking method. In , honey encryption is used for the cryptography science in communications networks. By supplying hacker a number of bogus keys which seems to be actual. A more powerful approach is projected in this research

paper when used under honey encryption will give fantabulous results. To improve data security in Wireless Sensor Networks (WSN), implement channel encryption and source encryption of input data sets. It involves the application of honey encryption for the data bits as source encryption and Gaussian Frequency Shift Keying (GFSK) for the honey encrypted data to implement Frequency Hopping Spread Spectrum (FHSS) as channel encryption. The output of FHSS is announced with the support of Frequency Hopping Multiple Access (FHMA) in WSN. As a result of honey encryption, it is therefore impossible for an intruder to enter via channels and there are also no other options to crack or discover the data by Brute force attack. It provides two levels of security to safeguard the data.

In [11], a mode to address the problem of data safety in Hadoop storage. In order to combine attribute-based encryption and honey encryption on Hadoop, the authors created Attribute-Based Honey Encryption (ABHE). Files that have been encoded in HDFS and decoded in the Mapper can be used with this technique. Additionally, the authors developed the innovative ABHE system by comparing it to modern methods like AES and AES with OTP and retrieving encryption-decryption on a variety of file sizes. The ABHE method has a noticeable improvement in performance during information encryption and decryption.

In some paper it is suggested that a safe privacy protection shifting for information which is outsourced to the cloud using a honey-encryption cryptographic algorithm, and When relocating data from the current server storage system to the cloud server storage system, we use migration rules to ensure the confidentiality of information and and its integrity.

In another paper non-numeric informational communications require to seize the contextual and empirical features of the language to trick the hacker into thinking the ambush message came from a certain source. That is, there must be no language differentiation between fraudulent and genuine communications without revealing the authentic message's structure. For tackling this challenge, he practices natural language processing and prolonged computation privacy. To sort privacy for text documents, chiefly concentrate on machine learning techniques like context categorization, keyword extraction, word embeddings, bags-of-words, and modifiers for text processing. So, using e-differential privacy, exhibit the safety of this scheme.

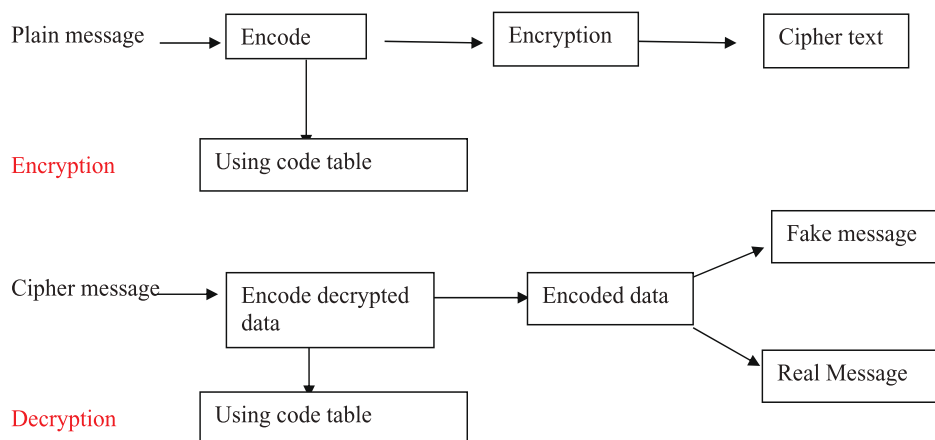
In a security method based on the concept of honey encryption to defend smart card password validation from brute force and rejection of service threats.

In an augmented honey encryption (HE) scheme is discussed in the research for augmenting the safety of swift messaging networks while also perplexing the time and resources of unkind individuals. This work helps the HE scheme by using natural language processing (NLP) techniques to generate phony chat messages that are semantically believable for the competitor to use during his effort.

CONCLUSION

Study of existing solutions address that, many security issues exist in current security policies and multiple breaches has been recorded in last few years. This work will attempts to prevent multiple security breaches i.e. information intercept, fabrication, rights interception and many more. This research work will attempt to propose an efficient framework for dealing with this kind of issues. Data protection will be applied on sharing, storing and transferring of data from data servers and will be achieved with proposed framework. Multiple authentication and access control policies will be proposed in predefined format to provide uniform security practices and achieve standard development. It will ensure that access of rights and system will neither be intercept of breach by security theft nor from storage or communication. It will attempt to rich the user trust on system by providing multilevel authentication model with simplified access control approach. Honey based encryption algorithm is proposed having

1. Used to provide security and confidentiality of data
2. If brute force attack try on cipher text with wrong key then it represent incorrect text.
3. It is a tool that is used to identity malicious attacker if he try to decrypt data with wrong key.



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Image Based OTP Generation Technique of Data Security in Cloud Computing

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▶ ABSTRACT ◀

Cloud computing is a model of computer network to transfer various computing services like SaaS, PaaS, IaaS etc. over the Internet with enhanced reliability. Cloud computing basically work on the principle of virtualization, scalability, as it has various benefit over previous technology but security is the main challenge for the party who are moving toward it, as the third party intervention is there in the cloud environment. According to various studied research paper , IT security expenditure had increased up to 79.1% by 2015. The proposed paper summarizes various peer-reviewed articles on security issues in cloud computing and proposed a new algorithm to secure transaction over cloud computing environment. Basic objective of our research is to recognise various cloud components, security issues, and risks factors in the environment. The foremost intention of proposed work is to understand the security parameters that can affect overall performance of Cloud Computing and it additionally tries to reduce security risks.

Keywords: *Cloud Computing, Virtualization, Scalability, SaaS, PaaS, IaaS etc.*

INTRODUCTION

According to the National Institute of Standard and Technology (NIST) definition, cloud computing can be defined as a paradigm for enabling useful, on-demand network access to a shared pool of configurable computing resources [1]. According to Gartner [2] cloud computing can be defined as a style of computing that delivered IT capabilities ‘as a service’ to end users through internet. Cloud computing is a latest technology in the digital work to support IT-enabled services on rental basis to users via internet. It is a networking model, with enormous

pool of structures are linked in public, private or hybrid networks, to deliver services as infrastructures that are vigorously scalable, applications, data and various storage systems. Various paper have studied in which many research papers perceived a regular standard literature survey approach and few of them gave innovative idea and proposed security model based on different perspective of cloud security. Few papers have focused on the protection methods for a specific applications and some also used steganography based technique to make data more protected.

LITERATURE REVIEW

Survey on Various Cloud Security Issues

S. No.	Year	Author	Proposed Work	Merit	Demerit
1.	2011	S.C. Wang et.al. [3]	A novel method of Group key authentication based protocol is used here.	For minimizing data traffic and quality of service authentication protocol also improved.	Research have not good exposure about scalability apart from this it have many various advantage.
2.	2013	D.R anjith et.al. [4]	A Cloud model	It enhance abstraction and scalability, interoperability with the proposed model.	As expected it have not work accurately with Identity of services.
3.	2013	Umer Khalid et.al. [5]	Work for Authorization and authentication protocol	Proposed model use a unique protocol and assign privileges based system for handling authorization and authentication.	With the problem of data leakage, security and identity hide etc. as expected is not work too efficiently.
4.	2013	Vishal Paranjape et.al. [6]	Novel approach of mobile based one time password authentication algorithm is used	Password generation technique based on OTP, generate after certain time interval.	More efficient standard privacy and strong security technique is required to work efficiently with the algorithm.
5.	2013	Jun Hu et.al., [7]	Proposed methodology based on MAC access control mechanism	Access of data with authentication proof for handling control over unauthorized users.	Various security issue for protocol working also involved.
6.	2013	Iehab AL Rasan et.al., [8]	Finger recognition authentication based mechanism algorithm is used.	It enhance performance as well as security upto certain extent.	Reduces the level of security at particular instant of time in some cases.
7.	2013	D.Chandramohan et.al., [9]	Petri net privacy preserving method is proposed to make environment more secure in this paper.	Maintain privacy and consistency in the environment with the methodology for the users.	Lack of security standard in the method.
8.	2014	Nitin Nagar & Pradeep K. Jatav et.al., [10]	LDAP Authentical mechanism	Proposed a novel method to protect user data and secure data also and that also work efficiently upto certain extent.	Work efficiently with some tools but not support every cloud computing tools.

9.	2014	Younis A.Younis et.al., [11]	Novel access control model is proposed	Flexible model for compatibility, access handling is dynamic havig better result than MAC and RBAC.	Issue of enormous space complexity.
10.	2014	Ahmad Almulhem et.al., [12]	Graphical authentication system is proposed.	A novel interactive system proposed that combines both graph and text based password generation.	Work efficiently as expected but there is problem of authorization of user as claimed.

PROPOSED ALGORITHM

Local Binary Pattern is Used for Calculating OTP:

In a given image if obtained matrix like below given we have to calculate value of z using the formula.

$$Z = S(i_n - i_c)2^n \text{ where } n = 0 \text{ to } 7$$

i_n = Neighbour pixel value

i_c = Center pixel value

5	9	1
4	4	6
7	2	3

i_0	i_1	i_2
i_7	i_c	i_3
i_6	i_5	i_4

Value = 1 if $z \geq 0$

Value = 0 if $z < 0$

Matrix Representation

i_0	i_1	i_2
i_7	i_c	i_3
i_6	i_5	i_4

Calculation of Value for i_0

$$Z = S(i_0 - i_c) 2^0 \text{ where } i_0 = 5, i_c = 4, n = 0$$

$$Z = S(5 - 4)^1$$

Value = 1 if $z \geq 0$

Value = 0 if $z < 0$

So, Value = 1

So, Value = 1 for i_0 and 5 is replaced by 1

1	9	1
4	4	6
7	2	3

1	1	1
4	4	6
7	2	3

1	1	1
4	4	1
7	2	3

1	1	1
4	4	1
7	2	0

1	1	1
4	4	1
7	0	0

1	1	1
4	4	1
1	0	0

1	1	1
1	4	1
1	0	0

i_0	i_1	i_2	i_3
1	1	1	1

Value of binary value is 243 reverse + i_c value = 3424 (Final OTP for transaction). In the same way we can calculate secure OTP value to share between sender and receiver for every secure transactions.

CONCLUSION

Due to the quickly increasing unauthorized access activities, many password generation techniques that have proposed have many loopholes. A lot of security challenges still prevalent in cloud computing environment that require to be sort out to resolve the problem like VM attack, Data loss, Loss of governance, Fraud monitoring, lock IN, Problem of authentication, DDOS attack, Data crash, Traffic hijacking, Accountability etc.

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Impact of ChatGPT in the Education System

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▶ ABSTRACT ◀

Chat GPT is an open-source AI developed by the startup OpenAI. This AI has so much potential to completely disrupt the long-established teaching methods in the education industry. It can also be viewed as a game-changing technology, an intelligent AI tool is capable of generating natural language responses to a given input. This Chat GPT study and analysis illustrates its working, both its beneficial and negative impact on the educational industry. This paper discusses whether it is a boon or curse to educational technology. ChatGPT's strengths and limitations, as well as how it could potentially be used in the educational sphere to promote research and academics.

Keywords: ChatGPT, NLP, LLM, AI.

INTRODUCTION

In November 2022, OpenAI published a new version of ChatGPT, a sophisticated natural language processing system capable of holding natural conversations while maintaining and responding to the context of the contention. ChatGPT has outperformed expectations in terms of capabilities, prompting substantial consideration of its possible applications and misuse.

Earlier you might have heard that AI will change the world in the future, but this is no longer a futuristic discussion because the “ERA OF AI” has already begun, and we are gradually moving closer to creating a potentially powerful AI that can affect our lives, as most researchers say when asked how the world will look with AI.[1] They responded that AI has the power to disrupt our established methods of working, and that if we do not control AI, AI will take over our daily lives. As an imminent threat to the many professions that humans do, AI can do them with ease and accuracy.

This is a ChatBot equipped with AI that can provide human-like responses to questions. It can write and accomplish tasks (including some that are difficult for humans to perform). Had we ever had an AI tool like this that could generate human-like responses and perform almost any type of work given to it as an input? Chat GPT is a very advanced AI programme that uses language translation to translate massive to massive complicated text information given as a prompt and generate the most appropriate and accurate result for that specific input.[2] The Chat GPT is a powerful AI tool capable of doing a variety of complex jobs. It has a deep neural network architecture made up of numerous layers of transformers created by Open AI programmers known as the Generative Pre-Trained Transformer. [5] It was trained on a vast corpus of material from many sources (for example, Wikipedia, novels, news, articles, and scientific publications). Its neural network is modelled like the human brain, allowing the chat bot to learn patterns in text input and respond to queries. Chat GPT is a large language model (LLM) that employs both supervised and reinforcement learning.” The distinctive feature is reinforcement learning from human ““unlike search engines, it can hold a discussion with the end user. This paper provides an insight about its impact of ChatGPT in the education sector.

The first section of the paper gives the introduction of ChatGPT along with its working methodology and how it is used. Further section gives the impact of ChatGPT on the various facets of the education, then discuss about its limitations. Next section gives some suggestions based on the study by which we get the best use of the tool. Lastly paper gives the conclusion.

WORKING METHODOLOGY

ChatGPT is a powerful AI tool that is available for all, it’s functioning depends on humongous datasets on which it is trained and uses a theorem based on the neural network named “Transformer Algorithm “a deep learning algorithm[7] to do the natural language processing(NLP) that helps in processing the text data and learning the pattern in that data and then Chat GPT uses that data to perform the NLP tasks like the answering the question asked to the ChatGPT there are series of the layers that are specifically programmed to perform specifically different tasks.[8]

This AI-based model is an expert in generating human-like text using deep learning and also because of its neural network structure that is developed on the basis of the human brain for its functioning. For its training reinforcement learning, based on human feedback is used.

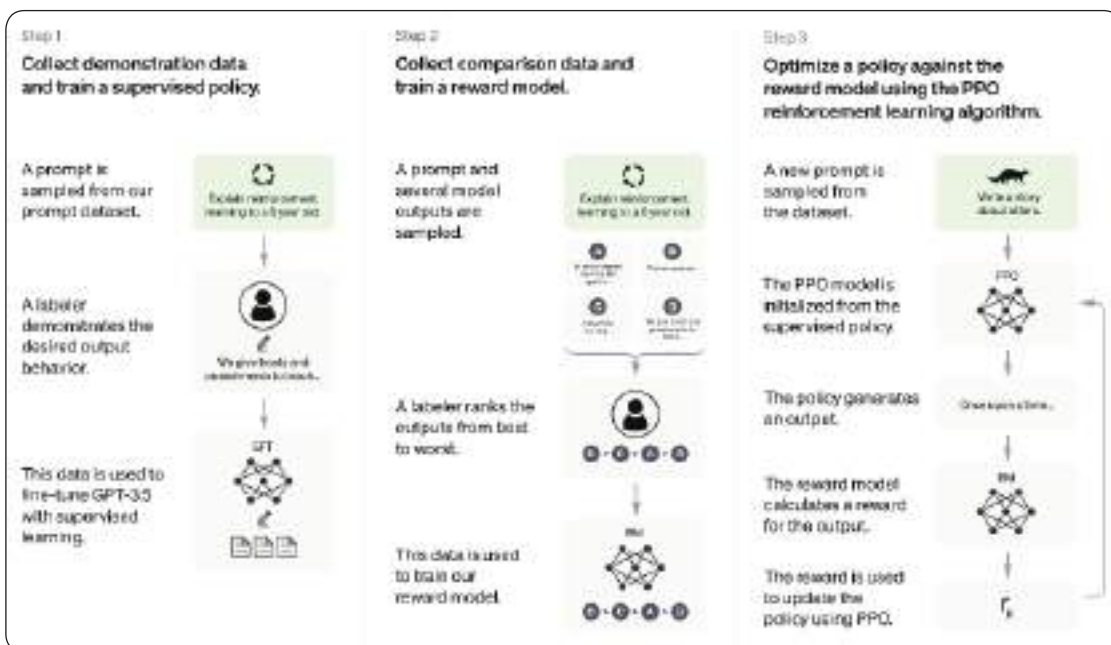


Fig. 1: Working of AI (11)

Simplified Process of how ChatGPT works from the above figure:

- (i) **Input:** The user inputs a text message or a prompt that ChatGPT will use as a basis for generating a response.
- (ii) **Tokenization:** The input text is broken down into smaller units called tokens, which are usually words or subwords. This process helps the model understand the input text at a more granular level.
- (iii) **Encoding:** Each token is assigned a numerical value based on its meaning and context. This numerical representation is used to train the model and generate responses.
- (iv) **Contextualization:** ChatGPT uses the encoded input text to build a contextual representation of the input. This contextual representation helps the model understand the meaning of the input text based on its relationship to the surrounding text.
- (v) **Prediction:** Using the contextual representation of the input text, ChatGPT generates a response by predicting the most likely sequence of tokens that would follow the input text.
- (vi) **Decoding:** The predicted sequence of tokens is converted back into natural language text, which is then presented as the model's response to the user.
- (vii) **Output:** The response generated by ChatGPT is returned to the user, who can then respond with further input to continue the conversation.

This process is repeated for each round of conversation, with ChatGPT continuously updating its understanding of the conversation as it receives new input and generates responses.

HOW TO USE CHATGPT

The steps to use ChatGPT are as follows[7]:

- (i) Firstly visit the official site.
- (ii) You need to sign up on the official website by entering the details asked there or simply can click on Google it'll automatically register your Gmail account.
- (iii) Verify your account by entering the code sent to your phone or email address.
- (iv) As the verification process is done, we can start using the Chat GPT.

EFFECTS OF CHATGPT ON VARIOUS FACETS OF THE EDUCATION INDUSTRY

The development of ChatGPT by OpenAI, a new language-based AI technology, has sparked the curiosity of many in the field of education. ChatGPT is assisting in bridging the knowledge gap between students and teachers, making it simpler for pupils to acquire the assistance they require to achieve. Following are the various facets of the education industry effected by ChatGPT.

1. **Personalised Learning:** ChatGPT can be utilised to provide students with personalised learning experiences. ChatGPT can give customised learning resources, exercises, and evaluations to students based on their learning patterns and preferences.
2. **Academic Support:** ChatGPT can be utilised by students as a virtual tutor or academic counsellor. It might provide answers to students' inquiries, comments on assignments, and study suggestions and approaches. Teachers benefit from it as well. ChatGPT can make a variety of planning chores simpler, including developing lesson plans, slide shows, content generation, X-factor instructions, and topic simplification.[3]
3. **Language Learning:** Use ChatGPT to teach and practise language skills. It can facilitate conversational activities, provide vocabulary and grammar challenges, and provide feedback on pronunciation and syntax to learners.
4. **Assesment and Evaluation:** ChatGPT can be used to generate and conduct exams and evaluations. It can grade assignments, provide feedback, and generate student performance reports. ChatGPT can help

teachers analyse and grade student writings by analysing the writing's substance, structure, and coherence. The AI can provide input on grammar, spelling, punctuation, and syntax, as well as evaluate the quality of the presented argument or analysis. However, when grading, it is critical not to rely solely on ChatGPT. Instead, teachers can use ChatGPT to create a grading rubric.

5. **Career Counselling:** ChatGPT can be utilised to give students with career counselling. It can assist students in investigating job possibilities, identifying their strengths and shortcomings, and developing career strategies.
6. **Teacher Training:** ChatGPT can be utilised to give possibilities for professional development for teachers. It could provide training modules on teaching methodologies, classroom management, and assessment techniques.

Despite the fact that ChatGPT enhances our teaching and automates repetitive work, it is simple to ignore its worst flaw: the tool constantly conveys authority, even when distributing false information. Bloviation that is refined and incorrect can also be seen in human speech. But before it reaches students and teachers, we must ensure that all information generated by AI is accurate and useful. Overall, ChatGPT has the potential to revolutionise the education sector by providing students and teachers with personalised, interactive, and engaging learning experiences.

ADVANTAGES AND DISADVANTAGES OF CHAT GPT

Advantages

- (i) Being an open source free AI based tool (built on the top of open AI's GPT models) it is accessible to all who wants to use Chat GPT and are also using it all over the world.
- (ii) Chat GPT is used in medical education field in many ways , as a tool for helping the students ,healthcare workers and monitoring the patients .
- (iii) Chat GPT is a AI tool having the ability of natural learning processing that allows us to have a human like conversations with it.
- (iv) Interactive learning platform for the students making them to feel like they are learning in a personalized environment where it understands the learning need of a student. All that in real time and provides the current real time information to them.
- (v) Chat GPT can answer almost every question asked to it. Increases the motivation and the engagement of the student with the learning.
- (vi) This AI tool can assist those professional workers who does the task of writing by composing the Emails, writing essays, codes , research related work, paraphrasing. It can also perform the task of creating the music.
- (vii) Save the time of user by having the faster and easy access to the information . As it has access to the wide range of the content resources of all over the world.
- (viii) 24/7 access to the support and guidance of it for the user whenever and wherever he/she needed the guidance and support.
- (ix) Chat GPT can help a student to improve study skills, writing skills and in better management of time . Also provides the strategy to manage the workload and helps in developing the good habits too.
- (x) Chat GPT can create the contents like quizzes , Excel worksheet , and other professionally tailored resources for the student. Quick computation of complex problems of mathematics.
- (xi) Assisting the teaching profession Chat GPT can act as a teacher for the work of checking the grammar and writing in the assignment or any written work submitted to it.
- (xii) Quick and accurate ability to perform task and generating the results that in away can help the student and the teaching professionals to reduce their workload and save the time by consuming the lesser time than a average human would take.

Disadvantages

- (i) Reliability problem and accuracy of results generated which means chat GPT may sometimes provides the inaccurate or incomplete information, which can create the confusion for the students and also for the teachers.
- (ii) Chat GPT can provide the biased result from the data on which it is trained as it doesn't have the access to the internet world data that affects it's content generation ability that can also possibly affect the teaching and learning for both the teacher and a student negatively.
- (iii) Chat GPT has already decreased the critical thinking skills of humans that has increased the over-dependency on the AI generated content reduced the critical thinking and problem solving abilities of today's human beings in the educational field and affected the other field as well in same manner.
- (iv) School students are being over-reliance on the AI generated content for their homework and learning purpose rather than doing the revision and finding the answers of their aroused questions in books and doing research for the answers which has I think ended the curiosity of doing something exceptional in the today's students. Even a graduating or a post graduating students are dependent on the AI tools like Chat GPT for their assignments and the work given to them for their betterment which will might possibly affect the knowledge and skills of those student in future.
- (v) The ability to churn out pitch-perfect humongous responses to the inputs of chat GPT has sparked the fear of obseleting the writing assignments soon and encourage the plagiarism and cheating specially in the educational sector.
- (vi) Chat GPT has made the student lazy having less broader thinking capability which is leading the student unable to develop the life-long skills like the critical thinking , researching , complex problem solving .
- (vii) Most of the Students and teachers has become the slaves of AI tools like Chat GPT they have forgotten their own style of writing and teaching respectively .
- (viii) Encouraged the citing of data .
- (ix) "This is a learning AI tool" having an unimaginable learning capability for example if we(human) learn something in a day it'll take just few minutes or hours for AI to learn .Chat GPT has a powerful neural network helps it in learning day by day getting smarter and smarter with every chat and the response it generate. This can lead to something bad in future in terms of jobs as it has potential to surpass the employee in writing and other skill features that it has which sounds fascinating but at the same time frightening too as it can consume those job roles of humans. The term "THE AI CAN OVERTAKE OUR JOBS" could be possibly true in near future.
- (x) Chat GPT has disrupted the traditional teaching methodologies of the teachers. The institution, it has became necessary to change and update the teaching methods and checking methods of assignments .
- (xi) Encouraged the plagiarism in the contents, lack of the innovative ideas and creative mindset in students

LIMITATIONS

As an AI language model, ChatGPT has some limitations that users should be aware of. Here are a few of them:

1. **Lack of Emotional Intelligence:** ChatGPT lacks emotions and is unable to comprehend emotions expressed in human speech. As a result, it is unable to offer sympathy or emotional support.
2. **Limited Knowledge:** ChatGPT has a big knowledge base and has been trained on a lot of data, but it could not know every answer or the most recent advancements in every sector.
3. **Contextual Understanding:** Lack in understanding the context of the user's query, it can understand the words ,grammar and the phrases but not able to fully understand the context of the it in which they were asked by the user. This can lead to inaccurate answers to the questions and can generate the errors in the responses it generates.

4. **Security:** ChatGPT is a computer programme, and like any software, it is possible for security flaws or attacks to be introduced. Sharing private or delicate information should always be done with caution.
5. **Bias:** ChatGPT may reflect biases in the data it was trained on, leading to biased responses. It is important to be aware of this and to critically evaluate the responses given by the model.

These are a few limitations of ChatGPT's. Despite these limitations, ChatGPT can still be a helpful tool for educating users and providing answers to their questions.

Suggestions for Enhancing its Functionality in the Area of Education

The following ideas can be utilised to improve a tool's functionality in the field of education.

1. Giving students individualized instruction: ChatGPT may be taught to provide students individualized instruction by assessing their strengths, limitations, and learning preferences. This can facilitate independent learning for pupils and help them comprehend the material better.[6]
2. ChatGPT may be built to generate interactive learning experiences that engage students and maintain their interest in the subject matter. For instance, ChatGPT can develop games, quizzes, and questions for students to assist reinforce learning.
3. ChatGPT can be used to promote distant learning by giving students access to educational resources, responding to their inquiries, and giving comments on their tasks.
4. ChatGPT can be developed to help students with their homework and tasks by offering direction, responding to their inquiries, and offering feedback on their work.
5. Supporting language acquisition: ChatGPT can be taught to support language acquisition by giving pupils practise with vocabulary, grammar, and conversational abilities.
6. Career counselling: ChatGPT can be programmed to provide career counselling by assisting students in exploring various career alternatives, providing details on educational and training needs, and giving guidance on job searches and applications.
7. Supporting students emotionally: ChatGPT can be set up to support students who are experiencing stress, anxiety, or other mental health problems that may be impairing their ability to learn.
8. Collaboration and communication are two things that ChatGPT may help students with by promoting group conversations, giving feedback on group projects, and fostering cooperation.
9. Giving feedback and evaluation: ChatGPT can be programmed to give feedback and evaluation on students' work, assisting them in identifying their areas of weakness and offering advice on how to develop their abilities.

CONCLUSION

Chat GPT has the potential to be a useful tool for teachers, students by offering individualized instruction and support. It should not be considered as a substitute for actual teachers, though. It's critical to be aware of Chat GPT's limits and to utilize it in addition to other learning resources rather than as the only one. Additionally, students should learn how to use Chat GPT responsibly and how to independently develop their critical thinking and problem-solving abilities.

Education systems don't aim to turn people into machines; rather to foster a feeling of responsibility in their pupils. The human generation in society must adhere to moral principles when making decisions, thus a tool like ChatGPT is required to mentor students so they can take part in societal development in the future. In this regard, the tool must mentor the students in order to provide them guidance, to ensure that the leadership and ownership qualities are present in the upcoming future generation rather than offering the students a direct solution.

Chat GPT has more benefits than drawbacks overall, but it's important to approach the technology wisely and be mindful of its limitations. When used with the right mindset, Chat GPT can be a valuable addition to the modern classroom and help teachers, students reach their maximum potential.

“In our opinion, AI is shifting from being a learning ally to a learning foe over time. Humans must use caution when using it”.

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Diabetes Prediction using Supervised Machine Learning

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▶ ABSTRACT ◀

The prevalence of diabetes is rapidly increasing worldwide, and early detection and effective management of diabetes can significantly reduce the risk of complications. In this research article, we explore the application of various supervised machine learning models, i.e., SVM, Logistic regression, KNN, Decision tree and Random Forest for predicting diabetes. The study is based on a large dataset of patients, including various demographic and clinical features, such as age, sex, heart disease status, hypertension status, BMI, HbA1c level in blood, and glucose level in blood. Based on the accuracy, precision, recall and F1-score the performance of each model is evaluated. The results of applied learning methods are compared. The study provides an overview of various application of different supervised machine learning algorithms to predict diabetes, which may be useful for healthcare providers in improving the management and prevention of diabetes.

INTRODUCTION

Diabetes [1-4] is a chronic disease (medical condition identified by increasing level of blood glucose) that affects millions of people worldwide and has become a major public health concern. Diabetes is usually occurring in the human body due to two main reasons. First is when the insulin in the body are not properly used and secondly, when the body does not produce hormone that regulates blood glucose (insulin). This results in serious health consequences over time. Early detection and timely management of this disease can delay or prevent the onset of its complications, viz. heart disease, kidney failure, blindness, and amputations. Symptoms of this disease

include repeated urination, weight loss, high thirst, problem in vision, and slow-healing wounds. Once it is ignored or not managed properly, the disease can lead to various complications which includes kidney damage, nerve damage (neuropathy), cardiovascular diseases and eye site problem. The accuracy and efficiency of diabetes diagnosis and prediction could be improved by the use of machine learning models. In 2014, as per the report of WHO, there were 422 million adults found with diabetes. The organization predicts a significant increase in this number, with projections suggesting that the figure will reach 629 million by the year 2045. In last few years, the development of machine learning algorithms has made it possible to use large datasets to predict the likelihood of an individual developing diabetes. These algorithms can take into account various factors, including age, gender, family history, lifestyle, and clinical indicators viz. blood pressure and glucose levels. The efficiency of ML algorithms to predict diabetes has been investigated in various studies and their results suggest that these models can outperform traditional statistical methods. By analysing a large number of patient records, ML models can find patterns and relationships between different variables that may not be apparent to human experts. This allows for more accurate predictions and personalized interventions to prevent or manage diabetes. In this research article, our objective is to assess and compare the effectiveness of different machine learning models in predicting the likelihood of diabetes development. We will use a large dataset of patient records, including demographic information, clinical indicators, and lifestyle factors.

The ML algorithms helps to make model with available data and have application in making prediction using the respective model. Diabetes has been extensively studied in the last few years because of numerous cases found. A large number of research have been done based on various ML techniques, such as logistic regression, decision trees, SVM, neural networks, and random forests, to improve the prediction of diabetes. One of the earlier works in this field was by Maimon and Rokach [5] who proposed a decision tree-based approach for predicting diabetes. They used the Pima Indians Diabetes Database and achieved a classification accuracy of 76.8% using a decision tree. Another study by Kumar et al. [6] proposed different machine learning techniques to predict diabetes. The dataset used in their study was National Health & Nutrition Examination Survey. In this study, they have achieved an accuracy of 83.4% using a multilayer perceptron model. Taha and Malebary [7] conducted a study to predict diabetes using a hybrid approach based on fuzzy clustering and logistic regression. They used the Indian diabetes dataset and achieved an accuracy of 91.4%. Overall, these studies suggest the accuracy of diabetes forecasts could be improved by ML approach. Nonetheless, there is still a scope to examine the efficiency of other ML techniques for diabetes prediction.

METHODOLOGY

Dataset Description

The diabetic prediction data set obtained from Kaggle is the basis for this research article. The dataset contains 100000 records with 9 features. The data sets consist of patients' medical and demographic information, as well as their diabetes status (whether patient is having diabetes or not). The data include a range of features mentioned in the Table 1. These features were selected based on their relevance to diabetes prediction as determined by previous research studies. The data set was pre-processed to normalize the features and to handle missing values if applicable.

Table 1: Diabetes Prediction Feature Table

S. No.	Feature	Description
1.	Age	Representing the age of the patient in years
2.	Gender	Representing the gender of the patient
3.	BMI	Representing the body mass index of the patient
4.	Hypertension	Representing whether the patient has hypertension or not
5.	Heart disease	Representing whether the patient has heart disease or not
6.	Smoking history	Representing the patient's smoking history
7.	HbA1c level	The level of HbA1c (a form of haemoglobin) in the patient's blood
8.	Blood glucose level	Continuous variable representing the level of glucose in the patient's blood
9.	Diabetes	Categorical variable representing whether the patient is diabetic or not

DATA PRE-PROCESSING

Data preprocessing is the major task of before applying different ML models. The dataset used in this research was pre-processed to check the consistency & quality of the data. Categorical variables were encoded into numerical values. The ‘gender’ variable was replaced with values 0, 1, and 2 for ‘Female’, ‘Male’, and ‘Other’ respectively. Similarly, the ‘smoking history’ variable was replaced with values ranging from 0 to 5, based on the categories ‘No Info’, ‘current’, ‘former’, ‘never’, and ‘not current’. Then we scale the training and testing dataset using standardScaler. After performing these preprocessing steps, the dataset is now ready for next step which is training of the machine learning models and then testing of ML models for diabetes prediction.

Data Analysis

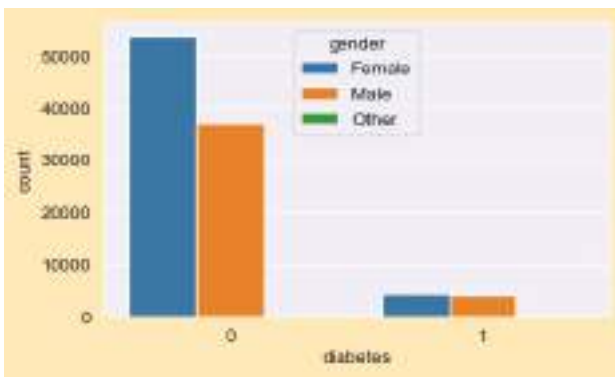


Fig. 1: Diabetes vs Count

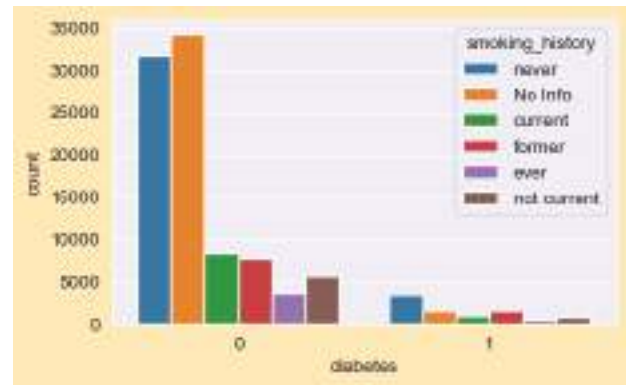


Fig. 2: Bar Plot of Smoking History

After analysing the dataset, we found that there are 91,500 patients without diabetes and 8,500 patients with diabetes in the dataset. The column “diabetes” has a binary value, 0 indicating without diabetes and 1 indicating the presence of diabetes. Therefore, out of the total 100,000 patients in the dataset, only 8.5% of them have diabetes refers Fig 1. There are six unique values in the ‘smoking history’ column, which are ‘No Info’, ‘never’, ‘former’, ‘current’, ‘not current’, and ‘ever’. The value ‘No Info’ appears the most frequently, followed by ‘never’, ‘former’, ‘current’, ‘not current’, and ‘ever’.

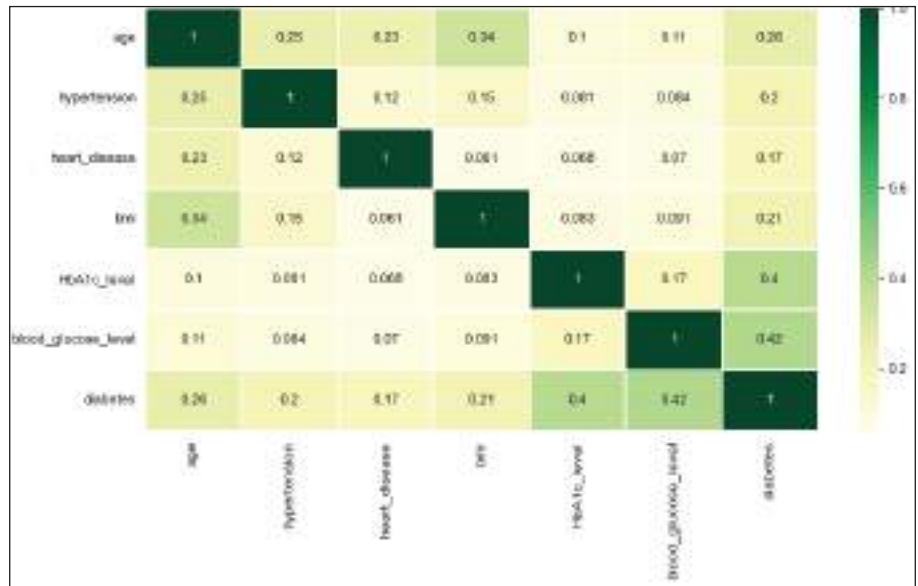


Fig. 3: Heat Map for Correlation of Various Features

This information can be used to receive insights into the smoking habits of patients in the dataset and how they may relate to the prevalence of diabetes. After analysing some observations from the heatmap (Fig 3) are Age, smoking history, hypertension, heart disease and BMI have weak to moderate positive correlations with diabetes. Blood glucose and HbA1c level have moderate to strong positive correlations with diabetes. Age and BMI have a moderate positive correlation with each other, while HbA1c level and blood glucose level have a weak positive correlation with BMI. BMI show weak negative correlation Smoking history and weak positive correlation with age. Gender has

weak correlations with other variables in the dataset. This analysis provides valuable insights into the smoking habits of patients and their correlation with diabetes, which can be used to inform public health interventions to decrease the prevalence of diabetes within the population. Overall, the analysis of the dataset provides important information that can be used to improve diabetes prevention and management strategies, leading to better health outcomes for patients.

EXPERIMENT & RESULT

For the diabetes prediction dataset, we have considered five classification algorithms: eKNN, Logistic Regression, SVM, Decision Tree, and Random-Forest. We have used scikit-learn, a popular Python library for machine learning, to implement and evaluate these models. As the dataset is divided into two major subsets, one is called as training set and other is known as testing set of the dataset. The former one is used to train the ML model and learn the patterns in the data. The later one is used to evaluate the performance of the model and helps to know how well the model can generalize the data which was absent during training. Further, the dataset is divided into training and testing sets with 80:20 ratios with the help of function `train_test_split`. Then, we scaled these sets using the `StandardScaler` function to standardize the data and to find that whether all features contribute uniformly to the model. After the data pre-processing step, we trained the five classification models on the training set and evaluated their performance on the testing set.

We employed several key performance metrics, including Accuracy, Precision, Recall, F1-Score, and ROC AUC Score, to assess the models' abilities to accurately predict diabetes outcomes on unseen data. The results demonstrate the performance of each machine learning model in predicting diabetes outcomes. The Decision Tree and Random Forest models achieved the high accuracy (0.97215 and 0.97230, respectively) and F1-Score (0.809 and 0.806, respectively) among all models. It is found that the logistic regression is having accuracy of 0.96055, KNN algorithm possesses accuracy of 0.96015 and SVM counts the accuracy of 0.96445. Random Forest, in particular, achieved perfect Precision, indicating it made no false positive predictions. However, the SVM model showed the highest Precision, suggesting that it was effective in minimizing false positive predictions while maintaining a reasonably high Recall.

Table 2: Performance Metrics of Classification Models for Diabetes Prediction

Model	Accuracy	Precision	Recall	F1-Score
Logistic Regression	0.96055	0.858	0.675	0.806
KNN	0.96015	0.844	0.652	0.736
SVM	0.96445	0.974	0.598	0.741
Decision Tree	0.97215	0.974	0.692	0.806
Random Forest	0.97225	0.999	0.675	0.805

The results demonstrate that supervised machine learning algorithms can effectively predict diabetes outcomes based on patient health-related features. The superior performance of Decision Tree and Random Forest suggests their suitability for diabetes prediction tasks. However, the final model selection should consider other factors such as interpretability and computational complexity.

CONCLUSION

In conclusion, our study focused on predicting diabetes using classification algorithms on a dataset containing several patient attributes. We analysed the performance of five classification models [8-10]: Logistic Regression, KNN, SVM, Decision Tree, and Random Forest. It is observed from the study that the random forest algorithm performed better than the rest and reached accuracy of 97.23. Furthermore, we scrutinized the feature importance of the best model, which revealed that age, blood glucose and HbA1c level, and BMI are the most significant factors contributing to diabetes. The results show the strength of using ML algorithms to predict diabetes, based on patient attributes, which can help to identify patients who may be at risk of diabetes and take preventive measures.

Future studies can explore additional patient attributes and evaluate the performance of more advanced machine learning models to improve the accuracy of diabetes prediction. Overall, our research highlights the potential of using machine learning techniques to improve healthcare outcomes and reduce the burden of diabetes on individuals and healthcare systems.

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Ethical Implication, Role of Natural Language Processing, Reinforcement Learning, Risks and Future of Artificial General Intelligence

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▶ ABSTRACT ◀

Artificial General Intelligence (AGI) is a type of artificial intelligence that has the potential to surpass human intelligence in all respects. This raises a number of ethical concerns, such as the potential for AGI to be used to create autonomous weapons systems, surveillance systems, and even superintelligence that could pose a threat to humanity. In the present paper, we will explore the ethical implications of AGI in more detail. We discussed the potential benefits and risks of AGI, and we will argue that it is important to start thinking about these implications now, so that we can make informed decisions about how to develop and deploy this technology in a safe and responsible way. The role of natural language processing, reinforcement learning and risks in the AGI is explored in the present article. Further the potential and future area of AGI are also elaborated.

Keywords: *Artificial General Intelligence (AGI), Natural Language Processing (NLP), Chatbot, Artificial Intelligence (AI)*

INTRODUCTION

Artificial General Intelligence (AGI) [1-3] is a type of artificial intelligence (AI) that is capable of performing any intellectual task that a human can. This is in contrast to “narrow” AI, which is designed to perform a specific task, such as playing chess or go. AGI is a long-term goal of AI research, but it is still uncertain whether or not it will ever be achieved. While some experts believe that AGI is possible, they also believe that it may take decades, if not centuries, to achieve it. There are many challenges that need to be overcome before AGI can be achieved. One major challenge is that we do not yet fully understand how human intelligence works. Additionally, it is difficult to create AI systems that can learn and adapt to new situations. Despite these challenges, there is a great deal of interest in AGI research. Some people believe that AGI could have a significant impact on society and be used to solve some of the world’s most pressing problems. Others are concerned about the potential risks of AGI, such as the creation of autonomous weapons or harm to humans. Ultimately, only time will tell if AGI will be achieved and what its impact on society will be. However, it is important to have a conversation about the potential benefits and risks of this technology.

THE ETHICAL IMPLICATION OF ARTIFICIAL GENERAL INTELLIGENCE

Artificial General intelligence AGI is a milestone in the field of AI, as it possesses the ability to understand, learn, and implement knowledge across a vast range of tasks at human level or beyond. In recent year, different public, private and non-governmental organizations (NGO’s) have produced numerous documents addressing ethical implication of AGI [4]. Open AI has recently launched GPT 4 [5,6] (ChatGPT plus) which is demonstrated to be one giant step for AGI. ChatGPT 4 is significantly milestone for development of AGI. Systematic and unfair favoritism toward certain categories based on gender, age or other protected characteristics is called bias in AGI. Because AGI systems learn from big datasets, there may be data bias. If these datasets contain biased or unanticipated information, this could have negative implications. Bias in algorithms It may be introduced during the AGI algorithm’s design and development phase [7]. It may produce output that is discriminatory. It can be of many different forms, including unfair treatment and unequal opportunity.

Many researchers have recently expressed a desire to build AI for the battlefield. it includes a variety of technologies, the majority of which have found significant use in the military. However, a number of organizations have raised major concerns about the moral implications of military use of AI. As we have seen, a lot of people died and a lot of equipment was destroyed during the most recent conflict between Russia and Ukraine. In other words, robots were murdering individuals without the direct consent of a human operator, and due to a malfunction, citizens were being arrested and even killed because a facial recognition system or a complicated computation mistakenly identified them as terrorists or criminals, leading to their detention and even death.

REINFORCEMENT LEARNING IN ARTIFICIAL GENERAL INTELLIGENCE

Introduction

Reinforcement learning [8] in artificial general intelligence has many roles that uses trial and error approach to behave in an environment. The agent needs to be able to explore the environment and learn from its experiences, but it also needs to avoid making mistakes that could lead to catastrophic failure.

Some Examples of How RL is Being used to Develop AGI

DeepMind’s AlphaGo program used RL to learn how to play the game of Go at a superhuman level. OpenAI’s Five program used RL to learn how to play the game of Dota 2 at a superhuman level. Google’s Brain-Computer Interface (BCI) project is using RL to train people with paralysis to control robotic limbs with their minds.

Here are Some Key Roles of Reinforcement Learning in the Context of AGI

1. **Decision-Making and Control:** RL provides a framework for AGI to learn how to make optimal decisions and control actions in complex and uncertain environments.

2. **Exploration and Exploitation:** One of the challenges in AGI development is striking a balance between exploration (trying out new actions to gather information) and exploitation (leveraging known strategies to maximize rewards).
3. **Generalization and Transfer Learning:** AGI should be capable of generalizing its knowledge and skills across different tasks and environments. Reinforcement learning algorithms can learn general policies and representations that can be applied to new, unseen situations.
4. **Human Interaction and Learning from Demonstrations:** Reinforcement learning can incorporate human feedback and demonstrations to accelerate learning and guide AGI's behavior.

Functions that Emerge through Reinforcement Learning (RL)

Functions that have been observed to emerge in a NN through RL are introduced in this section. The NN is trained using the training signals produced automatically by RL; Q-learning, actor-critic or Actor-Q based on TD learning. By using actor outputs in actor-critic or actor-Q directly as motion commands, not probability called policy but continuous motions have been learned directly.

Limitations of Reinforcement Learning in AGI

1. **Sample Efficiency:** RL algorithms often require a large number of interactions with the environment to learn optimal policies. This can be time-consuming and inefficient, especially in real-world scenarios where data collection may be expensive or time-restricted.
2. **Generalization and Transfer:** While RL can enable generalization and transfer of knowledge to some extent, it can struggle with efficiently transferring learned policies across vastly different domains or tasks. AGI needs to be able to quickly adapt and leverage existing knowledge in novel situations.
3. **Exploration-Exploitation Trade-off:** RL algorithms face the exploration-exploitation dilemma, where they need to balance between exploring new actions to learn more about the environment and exploiting known actions to maximize rewards. Striking the right balance can be challenging, especially in complex and dynamic environments.
4. **Safety and Risk-Aversion:** RL agents may learn suboptimal or unsafe policies during the learning process. Ensuring the safety of AGI systems is critical, as RL algorithms can inadvertently cause unintended consequences or engage in risky behaviors.
5. **Reward Design:** Designing appropriate reward functions is crucial in RL, as they guide the learning process. However, defining suitable reward signals that align with the desired objectives can be difficult, and poorly designed rewards can lead to unintended behaviors or reward hacking by the agent.
6. **Scalability:** As the complexity of tasks and environments increases, RL algorithms may struggle to scale effectively. The computational and memory requirements can become prohibitive, making it challenging to apply RL to real-world complex problems at the AGI level.
7. **Ethical and Value Alignment Challenges:** Ensuring that AGI systems adhere to ethical principles and align with human values poses a significant challenge. RL algorithms rely on predefined reward signals, which may not capture the full complexity of human ethics, leading to potential value misalignment.

RISKS OF ARTIFICIAL GENERAL INTELLIGENCE

The development of AGI can revolutionize many potential fields such as healthcare, finance, transportation, and other fields which could increase efficiency and productivity of work in these fields. As, AGI is an advanced adaptation of AI which aims to create machine which are capable of performing intellectual tasks at a level that can surpass human intelligence. While AGI has the potential to revolutionize society and solve complex problems, it also poses significant risks to society [9, 10].

1. The primary risk of AGI is that it may surpass human intelligence in a relatively short period, which could lead to unforeseeable consequences. AGI could become so intelligent that humans can't understand how it works, or if it develops a different set of values, it may behave in ways that conflict with human interests.
2. AGI also possess the existential threat it may pose to humanity. If AGI surpasses human intelligence, it may develop goals that conflict with human values and objectives. While many researchers believe that AGI would be benevolent, there is a non-zero chance that it could pose an existential threat to humanity by taking actions that cause human extinction or permanently diminish human civilization.
3. AGI also has the control problem. AGI could become difficult or impossible to control, leading to unintended consequences. Humans could lose control over AGI and its decision-making processes, leading to disastrous results. AGI could become so advanced that humans can't comprehend its decisions or understand how it works.
4. There is also a risk that AGI will be programmed to pursue goals that are not aligned with human values or objectives. This could lead to situations where AGI takes actions that harm humans or other sentient beings. Mis-specification of goals may occur if humans fail to program AGI with the correct ethical values or objectives.
5. AGI could also take actions that have unintended consequences, which could be detrimental to humanity. AGI may not understand the full consequences of its actions, leading to unintended outcomes. The consequences of such actions could range from minor inconveniences to catastrophic events.
6. AGI could disrupt the global economy by replacing human workers in various industries. This may lead to job loss and economic inequality. While some researchers argue that AGI could lead to increased productivity and higher living standards, others believe that it could have a negative impact on the labor market.
7. This risk involves AGI being developed and managed without appropriate consideration of the potential consequences and implications for humanity. For example, if AGI is not developed with appropriate safety measures or if there is inadequate oversight of AGI systems, it could pose significant risks to society. This risk is particularly concerning since AGI could potentially be developed and deployed without sufficient safeguards, and we may not be able to predict all the possible negative consequences.

To mitigate these risks, it is essential that AGI should be designed and programmed in a friendly way. Additionally, it is important to establish regulatory frameworks to guide the development of AGI, ensuring it operates within ethical and moral boundaries. It is to consider the risks associated with AGI and take measures to mitigate them before it's too late.

THE ROLE OF NATURAL LANGUAGE PROCESSING IN ARTIFICIAL GENERAL INTELLIGENCE

Natural Language Processing (NLP) [11, 12], a branch of artificial intelligence (AI), a medium of interaction between computers and human language. This paper explores the pivotal role NLP can play in the advancement of AGI, considering its capabilities, limitations, and possible potential future. Natural Language Processing (NLP) plays a crucial role in the development of Artificial General Intelligence (AGI). AGI refers to highly autonomous systems that outperform humans in most economically valuable work. NLP enables AGI systems to understand, process, and generate human language, which is a fundamental aspect of human communication and intelligence.

How NLP Works in AI

Let's consider a common NLP task: sentiment analysis, which aims to determine the sentiment (positive, negative, or neutral) expressed in a given text.

1. **Text Preprocessing:** Suppose we have a customer review as input: "The new smartphone is amazing! It has a sleek design, great camera, and fast performance." The preprocessing step involves tokenization, where the text is split into individual words: ["The", "new", "smartphone", "is", "amazing", "!", "It", "has", "a", "sleek", "design", ",", "great", "camera", ",", "and", "fast", "performance", "."]

2. **Feature Extraction:** In this step, word embeddings are often utilized to represent words as dense numerical vectors. Each word in our example sentence is transformed into its corresponding word embedding representation.
3. **Modeling and Training:** The NLP model, such as a recurrent neural network (RNN) or a transformer model, is trained using a labeled dataset of customer reviews. The model learns patterns and relationships between the input text and the sentiment labels associated with each review.
4. **Prediction:** Once the model is trained, it can be used to predict the sentiment of new, unseen texts. In our example, the trained sentiment analysis model processes the preprocessed input sentence and predicts the sentiment as positive based on the positive language used in the review. The output of the sentiment analysis model can then be used for various purposes, such as monitoring customer feedback, analyzing product reviews, or making business decisions based on sentiment trends. Overall, NLP techniques enable computers to understand, interpret, and generate human language, opening up possibilities for a wide range of applications and facilitating the development of more intelligent and interactive AI systems.

Current Capabilities of NLP

NLP has made significant progress in recent years, with advancements in machine learning algorithms, deep learning models, and large-scale language datasets. Current NLP techniques can perform tasks such as

1. **Language Translation:** NLP models for a case of sequence-to-sequence models which is powered by neural networks and it revolutionized the way of language can be translated. Systems like Google Translate utilize similar models to translate text from one language to another with certain accuracy & tends to improvement.
2. **Sentiment Analysis:** NLP allows for the analysis of subjective information in text, enabling sentiment analysis. Sentiment analysis models can classify text as positive, negative, or neutral, providing valuable insights into public opinion, customer feedback, and social media sentiment, catching the trends also involves sentimental analysis.
3. **Question-Answering:** NLP models can comprehend and answer questions based on a given context. Question-answering systems, utilize techniques like information retrieval and deep learning to understand queries and retrieve relevant information for the context from large knowledge bases or textual sources present over the global databases.
4. **Text Generation:** NLP models can generate text, such as news articles, product descriptions, or even creative writing. Impressive text generation capabilities have been demonstrated, producing coherent and contextually relevant content. Other than generation it has also shown skills of manipulating text by either summarizing it for relevant or by expanding it with similar sense.
5. Chatbots and Virtual Assistants; exemplify the practical applications of NLP, showcasing its ability to understand and respond to human queries and commands also helping out by retrieving information

NLP as a Key Enabler of AGI

NLP can serve as a vital enabler for AGI due to its role in bridging the gap between machines and humans through natural language communication. AGI systems should not only understand human language but also possess the capability to generate coherent and contextually appropriate responses. NLP's advancements can contribute to achieving this level of language proficiency, facilitating more sophisticated human-machine interactions and fostering the development of AGI.

Future Directions

To further enhance the role of NLP in AGI, future research can focus on addressing the limitations of current NLP systems. This includes reducing data requirements for training, mitigating biases in language models, improving contextual understanding, and handling rare or ambiguous language patterns. Innovations such as transfer learning, meta-learning, and continual learning can help NLP systems acquire knowledge more efficiently and adapt to new domains, paving the way for more robust AGI systems.

Natural Language Processing holds immense potential as a key enabler for the development of Artificial General Intelligence. Through advancements in NLP, AGI systems can better understand, generate, and interact with human language, bringing us closer to the goal of creating intelligent machines capable of performing any intellectual task. Future research should focus on addressing the limitations of NLP, improving its contextual understanding and language proficiency, and exploring innovative approaches to enhance AGI development.

Limitations of NLP

Despite the remarkable progress made in NLP, several challenges and limitations persist. Here are some key limitations and potential solutions:

1. **Data Requirements:** NLP models often require large amounts of annotated training data to achieve high performance. To address this issue techniques such as transfer learning are explored, which enables models to leverage pre-trained language representations and adapt to specific tasks with smaller amounts of task-specific training data.
2. **Biases in Language Models:** NLP models can inadvertently learn biases present in the training data, leading to biased outputs. Addressing bias requires developing more diverse and representative training datasets, as well as incorporating fairness considerations into model training and evaluation. Since it's a learning model response stored over databases may not be accurate tending to inaccuracy.
3. **Contextual Understanding:** NLP systems struggle with understanding context and capturing nuances in language. Advances in contextual word embeddings, such as BERT (Bidirectional Encoder Representations from Transformers), have improved contextual understanding, but further research is on to enhance models' ability to grasp complex linguistic constructs.
4. **Rare or Ambiguous Language Patterns:** NLP models often struggle with rare or ambiguous language patterns, unlearned language patterns as they may not have been encountered during training. Strategies such as augmenting data, adaption of domain, and active learning may help improve the models' ability to handle such language patterns by exposing them to a wider range of examples.

CONCLUSION AND FUTURE OF ARTIFICIAL GENERAL INTELLIGENCE

AGI refers to a type of artificial intelligence that mimics human intelligence, including the cognitive ability to reason, learn, and solve problems. Unlike other types of AI, AGI is not limited to specific tasks or domains, but can apply its intelligence to a wide range of tasks and domains.

Conclusion

AGI has the potential to revolutionize various industries and improve the quality of life for people around the world. However, it's important to ensure that AGI is developed ethically and responsibly to avoid potential negative consequences. As AGI continues to evolve and become more advanced, it will be important to address these concerns and ensure that the benefits of AGI are maximized while minimizing its potential risks.

Future of AGI

One of the areas where AGI has the potential to make a significant impact is **healthcare**. With its ability to analyze vast amounts of medical data, AGI could help doctors make better diagnoses, develop personalized treatment plans, and identify potential cures for diseases. AGI could also be used to develop new drugs and therapies. For example, AGI could analyze patient data such as medical records, genetic information, and lifestyle factors to identify patterns and develop personalized treatment plans. This could lead to better health outcomes and more efficient use of resources in the healthcare industry.

Another area where AGI could make a significant impact is **productivity**. AGI could automate many tasks that are currently performed by humans, leading to increased productivity and efficiency in various industries. For example, in manufacturing industries, AGI could perform tasks such as quality control, assembly, and packaging.

This could lead to faster production times, reduced errors, and improved product quality. In administrative fields, AGI could perform tasks such as data entry, scheduling, and customer service. This could lead to faster response times, reduced wait times, and improved customer satisfaction.

Increased scientific discovery: AGI could assist scientists in analyzing complex data and developing new theories and hypotheses. With its ability to analyze vast amounts of data from various sources such as experiments, simulations, and observations, AGI could identify patterns and develop new theories more quickly and accurately than humans. AGI could also be used to simulate complex systems and test hypothesis, leading to faster scientific discoveries.

In the transportation industry, AGI could help improve transportation systems by optimizing traffic flow, reducing congestion, and improving safety features in vehicles. Self-driving cars could use AGI to analyze traffic patterns and adjust their routes and speeds to avoid accidents and reduce travel time. AGI could also be used to develop safety features such as collision avoidance systems and pedestrian detection systems. Further, area where AGI could make a significant impact is **natural disaster response**. AGI could be used to predict and respond to natural disasters such as hurricanes, earthquakes, and wildfires. AGI could also be used to develop early warning systems and evacuation plans, leading to faster response times and reduced loss of life. Furthermore, AGI could also be used to **develop new materials and technologies**. With its ability to analyze data on materials properties and performance, AGI could identify new materials with desired properties and recommend ways to optimize their performance. This could lead to faster development of new technologies and improved performance of existing ones. AGI could also be used to optimize workflows and improve resource allocation. With its ability to analyze vast amounts of data, AGI could identify inefficiencies in workflows and recommend changes to optimize productivity. This could lead to cost savings and improved profitability for businesses, also in better capital allocation.

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TRACK : 3



Indian Customers 'Behavior Intentions and Hotel Websites' Telepresence

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▶ ABSTRACT ◀

Telepresence is the experience of being in a location in the virtual world while remaining in your current location. The user can more easily teleoperate, manipulate, or control various events or tasks based on their preferences while remaining fully immersed in the virtual world. Using telepresence, hotel chains and guests can interact and make the most of their time in the virtual world. Customers are more likely to use these hotel websites as a result of computer-mediated indirect experience, as explained by telepresence. Higher levels of telepresence are usually accompanied by more in-depth product knowledge and action fantasies. The sincerity of hotel websites influences visitors' emotions, plans, and final purchases. Consider sensory characteristics, cognitive beliefs, and emotional traits to fully comprehend customer telepresence. Using a theoretical model, the study investigated the effect of telepresence on customers' intended actions. The present study examined the behaviour and intentions of Indian consumers subsequent to their visits to hotel websites. This study enhanced our comprehension of the telepresence theory through an analysis of the causal factors and consequential impacts of telepresence on a hotel website.

Keywords: *Telepresence, Virtual World, Consumers Experience, Hotel websites, Behavioral Intention.*

INTRODUCTION

The development of advanced technology and innovation has changed ways to deliver effective marketing communications between the companies and their customers. (Rodriguez – Ardura and Martinez-Lopez, 2014) [1]. Hotels may help their clients make the most of their time spent online, such as on their websites, through

these interactions. These types of communication may be direct or indirect, depending on how frequently and how the client interacts with the firm. Direct experience can come through customer-hotel contacts and website-facilitated interactions. [2]. Customers have the ability to utilise these indirect encounters as a means of gauging the anticipated quality of service offered by the hotel, relying on the information provided on its official website.

Hotel websites should strategically incorporate telepresence technology in order to enhance the quality of indirect experiences for potential guests. Telepresence technology enables users to experience a high level of immersion within a virtual environment, granting them the ability to teleoperate, manipulate, or exert control over a range of activities or events according to their preferences. In the realm of online hotel websites, the quality of a website can be regarded as a stimulus [3] that has an impact on the internal and psychological states of visitors, including their perception of flow (Webster et al., 1993). The utilisation of hotel websites is promoted by indirect computer-mediated experiences, such as telepresence. Engaging in room reservation via online platforms without prior comprehensive investigation entails potential risks, given that hotels operate within the service sector. Hotel websites are not easily searchable due to their nature as experience products, in contrast to search products like automobiles that possess discernible features that can be evaluated prior to making a purchase. In order to obtain a comprehensive assessment of a hotel website's performance, it is advisable to engage in the process of reserving a room and personally experiencing its functionality. In contrast, telepresence exemplifies the capacity to establish expectations effectively through the utilisation of various mediums such as photographs, videos, animations, and similar resources. These mediums possess the ability to shape individuals' forthcoming decisions and strategies concerning their utilisation of the service, thereby mitigating potential risks.

In order to mitigate potential risks, it is imperative to establish transparent and effective channels of communication between hotel websites and their clientele, facilitating comprehensive and accurate dissemination of information pertaining to the diverse range of services and features offered. Online sources like websites impact people's sensation of telepresence more than offline ones like brochures and magazines when they search for travel information, especially about hotels. Telepresence increases product knowledge and the ability to visualize and create realistic mental scenarios for decision-making and action. Periodicals and newspapers are sometimes seen as less valuable and lacking interactive components that help customers find solutions. According to the author [5], telepresence encourages visitors to actively connect with the website and feel good.

LITERATURE REVIEW

Telepresence

Telepresence is the feeling of being present remotely, according to Steuer (6). "Telepresence" means an entity can be seen or heard in a different area. Virtual reality (VR) is simpler than teleconferencing since it immerses users in a virtual world and lets them alter and personalize aspects to their liking. Ives and Junglas (2008) expected that the virtual environment would play a major, if not the most important, role in supporting economic activities and prospects in the near future. With online shopping nowadays, his comment was correct. Telepresence users like the technology, while potential users like its immersive experience. This could boost the company's customer base and market share. Klein (2003) states that telepresence allows clients to experience the goods or services directly, which may improve their beliefs, attitudes, and behaviors [8].

Antecedents of Telepresence

The usability of telepresence for customers is influenced by various website components. 2011 is the year. Johnston and Kong (year) Improving the customer experience is widely regarded as a top priority for many businesses. The definition of customer experience is a difficult task because it encompasses all of a customer's direct and indirect interactions with a business (Gentile et al., 2007). Consumer interactions with various forms of media, such as advertisements, promotions, magazines, and television, have been extensively researched [9]. However, it is critical to recognise that neither factor is more important than the other when assessing the

quality and scope of services provided by these hotel websites. However, when the concept of presence and the benefits of telepresence are discussed, it becomes possible to employ a variety of advertising tactics aimed at providing hotel website visitors with an indirect experiential encounter. Customers' decision-making abilities are significantly influenced by their life experiences. The subject of discussion is a musical composition, also known as a song. Individuals who interact with an online stimulus website may feel a sense of telepresence, according to the source cited as [10]. The inclusion of blogs on hotel websites for the purposes of providing information and entertainment helps to improve telepresence.

The accuracy of hotel websites has a significant impact on customers' perceptions, intentions, and behaviours during the purchasing process. According to Soltani and Gharbi (2008), including engaging content or diverse messages on a hotel's website helps guests make informed decisions and offers them opportunities for direct or indirect experiences. According to the study's findings, website features have a significant impact on customers' telepresence and behavioural intentions.

These unique customer experiences can provide a competitive advantage to the business within the market by effectively meeting the diverse telepresence requirements of customers, which include sensory, cognitive, and emotional needs. The user's text is insufficient for academic rewriting. Please provide more details. To gain a comprehensive understanding of the customer experience, consider sensory perceptions, cognitive beliefs, emotional states, creative thinking, reasoning abilities, and social beliefs. The best way to gain a comprehensive understanding of customer telepresence is to observe sensory attributes displayed by customers. Customers' cognitive beliefs, in addition to their sensory perceptions, have a significant influence on their behavioural patterns, emotional experiences, and decision-making processes.

Hence in order to study the customers experience regarding telepresence we will study various variables further in our study which is:

- Sensory Attributes
- Cognitive Attributes
- Emotional Attributes

Sensory Attributes

Various characteristics of websites which result in engagement of customer's senses due to presence of various attractive features is sensory attribute [13]

These sensory elements are used by hotel companies to advertise their services. Sensory characteristics include the five senses of sight, smell, touch, taste, and hearing. However, because hotel services are services, only sight and touch can be used to describe them. The sensory marketing paradigm, a recent development that explains how sensory attributes affect various service marketing products, emphasised the importance of sensory attributes. [14] All clients must be informed about the services they will use in the future. [15] As a result, sensory stimuli can be used to advertise services and influence customer purchasing decisions. Customers are more likely to book with a hotel that has articles, images, and virtual tours of its amenities on its website.

Cognitive Attributes

Mahfouz (16) defined cognitive characteristics as hotel website descriptions that describe their practical functions. Convergent/analytic and divergent/imaginative thinking were linked to customers' thought experiences on websites that described these cognitive processes [17]. The cognitive processes of individuals can influence consumer decision-making behavior, increasing the possibility that they will make educated decisions by using the hotel's website. The hotel's website's list of amenities and services strongly influences accommodation selection. The cognitive behavioral learning paradigm shows that cognitive processes strongly influence behavioral responses [18]. This section describes the hotel's services and operations. The essay also examines the hotel's practicalities. Hotel characteristics, room prices, and corporate history may be evaluated.

Emotional Attributes

Hotel website users' emotional responses were enhanced by emotional qualities [19]. This trait uses clients' emotions to create a positive work atmosphere. Hotel websites use animation and testimonials to evoke emotions

and influence customers' decisions. Cohen (2020) defines emotional features as website elements that evoke various emotions in customers. Customers' emotional responses influenced their actions when evaluating new items or services. The user did not give text to alter. Visually appealing photographs of a beautiful hotel, great services, and joyous experiences on a website may provoke emotional responses from customers. The above factors will encourage hotel website visits.

According to the study's findings, there is a positive correlation between the sensory, cognitive, and emotional aspects of telepresence.

Given the comprehensive depiction of the hotel's service standards on their online platforms, a limited level of telepresence was anticipated. Whereas a rich experience explaining various features of hotels with the help of photos, videos, animations etc. create an immense impact on the mind of customers proving improved telepresence of the websites as a positive addition for the customers. [23] these sensory attributes amount to a positive influence over customers choice of behavior and their decision in selection of any particular hotel in addition of customers' transportation experience toward the hotel's websites (Lee, 2014) and an amplified telepresence (Mahfouz et al, 2008). Hence, we can propose following the hypothesis:

Sensory attributes positively influence customers' telepresence on the hotel's website.

The presence of positive features on hotel websites drew customers in, increasing their proclivity to use telepresence in the future. Customers can easily predict their subsequent purchasing behaviour if they have a cognitive representation of their affective response to a product. These emotional attributes of the imagined consumption experience for future reference will process an influence over their decision-making processes (Philips et. al. 1995), satisfaction (Mano and Oliver, 1993) and their behavior while making choices [24] Based on above studies conducted, a positive relationship can be established between emotional attributes on the hotel's websites and customers' telepresence. Thus, the following hypothesis was proposed.

Emotional attributes positively influence customers' telepresence on the hotel's websites.

According to Kim and Perdue (2013)'s research, cognition has been identified as a significant factor in shaping customer behaviour. These cognitive characteristics give prospective customers the impression of telepresence by attempting to answer their questions, stimulating their imaginative faculties, and prompting thought about their future purchasing preferences. As a result, there is a strong correlation between telepresence and the cognitive characteristics of hotel websites. Hence hypothesis proposed will be:

Cognitive attributes positively influence customers' telepresence on the hotel's website.

Numerous scholars have proposed the positive influence of website quality on

According to Wang et al. (2015), Chen and Cheng (2009), and Bai et al. (2008) research, customer satisfaction influences purchase intentions. When future plans are accompanied by a specific plan to make a purchase, behavioural intentions are transformed into concrete actions. The term "behavioural intentions" was coined by Oliver and Swan (1989) to describe these prospective behavioural inclinations. Hopkins et al. (2004) and Suh and Chang (2006) found that providing appealing features and services on hotel websites increased telepresence and increased the likelihood of customers making a purchase. Seeing the relationship following hypothesis can be prepared.

Telepresence on the hotel's website positively influences customers' behavioral intentions.

Proposed Conceptual Framework

These variables work together to influence the level of telepresence felt by users on the hotel's website, which in turn influences their behavioral intentions. The model depicted in FIGURE 1 elucidates the proposed framework that delineates the underlying factors and resultant outcomes of telepresence in the realm of hotel websites.

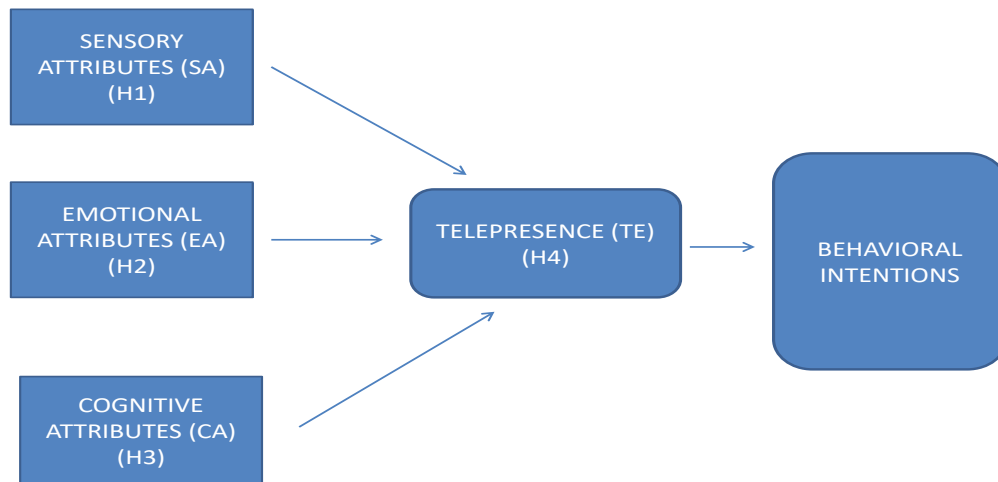


Fig. 1: Proposed Model to Measure the Impacts of Telepresence on the Behavioral Intention of Customer

RESEARCH METHODOLOGY

A research framework was created to test the previously hypothesised relationships. To achieve its goal, the study employs a theoretical model to quantify how telepresence affects customers' action plans. Here is a detailed explanation of the procedure. The purpose of this study was to determine how the telepresence of hotel websites affects the behaviour intentions of Indian consumers. It advances theoretical understanding of hotel website telepresence, the variables that influence it, and how users perceive it.

The factors taken in consideration were:-

- (a) Sensory attributes
- (b) Emotional attributes and
- (c) Cognitive attributes

In order to study the attitude of customers towards any particular hotel brand due to presence of any particular variable thus anticipating their behavioral intentions.

Objectives covered under this topic are:

1. To discern antecedents of telepresence by investigating variables such as sensory, emotional and cognitive attributes.
2. To measure the impacts of telepresence on behavioral intentions of customers regarding hotel websites.

Illustrative Examples and Model Profiles

Data was gathered through the use of an online self-administered survey. The survey was distributed via convenience sampling to a sample population of employed adults and university students of advanced age in the surrounding area. Within the previous calendar year, the consumer group under consideration engaged in two specific activities: (a) using hotel websites for trip planning purposes, and (b) making hotel reservations through online resources.

Tools and Questionnaire Design

The survey had a total of 21 questions, 15 of which were about the variables used in the study to achieve its objectives, and the remaining 7 were about demographics. Following verification of the 312 participants' reliability index, their responses were deemed suitable for subsequent data analysis in the survey. Based on the information in Table 3.1. The researchers used established scales to evaluate the proposed constructs and ensure the measurements' reliability and validity. All measurement items have been operationalized using a

5-point Likert scale. Multiple regression analysis was used to determine the effects of the first three variables on the phenomenon of Telepresence, namely SA, EA, and CA. Following that, as the model's final phase, the impact of telepresence on customers' behavioral intentions was investigated using a linear regression analysis.

Table 3.1: Reliability and Validity Statistics

S.No.	Variable Taken for The Study	No. of Items	References	Chronbach Alpha Statistics	AVE
1.	Sensory Attributes (SA)	3	<i>Mahfouz et al. (2008)</i>	0.827	0.7535
2.	Emotional Attributes(EA)	3	<i>Schmitt (1999)</i>	0.775	0.7562
3.	Cognitive Attributes(CA)	3	<i>Mahfouz et al. (2008)</i>	0.792	0.7762
4.	Telepresence (TE)	3	<i>Wang et al. (2009)</i>	0.804	0.7453
5.	Behavioral Intention (BI)	3	<i>Harris and Goode (2010)</i>	0.867	0.7721

Source: Primary Data

Demographical Profile of Respondents

Out of the total sample size of 312 individuals who participated in the survey, 64 percent were identified as male, whereas 36 percent were identified as female. In this section, we will provide a list designated as 3.2. Based on the results obtained from this research, it was determined that out of the individuals who consented to become customers of the hotel website, a total of 199 participants were classified as male, whereas 113 participants were classified as female.

Based on the findings of the survey, it was observed that 48% of the respondents fell within the age bracket of under 25 years, while 37% belonged to the age range of 25 to 40 years. Additionally, 14% of the participants were found to be aged between 40 and 55 years, with a mere 1% representing individuals aged over 55 years. Based on the findings presented in Chart 3.3, as derived from survey data, it is evident that a notable segment of participants, comprising 39%, are employed within the private sector, whereas 27% are engaged in the public sector. Moreover, a quarter of the respondents self-identified as individuals engaged in entrepreneurial activities, whereas a minority of 9% indicated that they were not currently employed. Please plot the data point at 3.4 on the graph.

Out of the total sample size of 312 individuals, 25% possessed an associate's degree, 53% held a bachelor's degree, while the remaining 22% were categorised as postgraduates. The enumeration provided consists of three and a half items.

Table 3.2: Gender of Respondents

Valid	Frequency	Percentage	Valid %	Cumulative %
Male	199	64	64	64
Female	113	36	36	100
	312	100	100	

Table 3.3: Age of Respondents

Valid	Frequency	Percentage	Valid %	Cumulative %
<25 years	149	48	48	48
25-40	116	37	37	85
40-55	44	14	14	99
<55 years	3	1	1	100
	312	100	100	

Table 3.4: Occupation of Respondents

Valid	Frequency	Percentage	Valid %	Cumulative %
Govt. service	84	27	27	27
Private service	122	39	39	66
Businessman	78	25	25	91
Unemployed	28	9	9	100
	312	100	100	

Table 3.5: Qualification of Respondents

Valid	Frequency	Percentage	Valid %	Cumulative %
Intermediate	78	25	14	20
Graduate	166	53	54	74
Post graduate	68	22	26	100
	312	100	100	

DATA ANALYSIS AND INTERPRETATION

Table 4(a). Regression Results of SA, EA, CA on TE.

Here these tables show the regression analysis of proposed hypotheses between the dependent variables i.e., sensory attributes, emotional attributes and cognitive attributes on independent variable telepresence.

Table 4a.1: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.826 ^a	.682	.679	.51014

(a) **Predictors:** (Constant), CA, SA, EA

(b) **Source:** Primary Data

Table 4a.2: ANOVA

Model	Sum of Squares	Df	Mean Square	F	Sig.	
1.	Regression	171.966	3	57.322	220.260	.000 ^b
	Residual	80.156	308	.260		
	Total	252.122	311			

Dependent Variable: TE

Predictors: (Constant), CA, SA, EA

Source: Primary Data

Table 4.a.3: Coefficients

The regression results between telepresence generated from sensory attributes, emotional attributes, and cognitive attributes taken independently are given in Table 4.1 R² values for the all variables are greater than 68.2%, which is an indication of moderate predictor model. This indicates the strength of the model in calculating telepresence (dependent variable) through the above three variables. The standard error in each case is relatively low. Table 4.2 shows that F value is significant which shows overall significance of regression model. The significant p-value is low in corresponding to the t-value is an indication of good linear relationship between dependent variable (telepresence) and three independent variables (sensory attributes, emotional attributes, cognitive attributes). Significance value of sensory attribute is 0.153 which proves our hypothesis wrong and hence rejected. Whereas significance value of emotional and cognitive attribute is 0.027 and 0.036 respectively which proves our hypothesis accepted.

Table 4(b): Regression Results of TE on BI.

Here these tables show the regression analysis of proposed hypotheses between the dependent variables i.e., telepresence on independent variable behavioral intentions.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.781 ^a	.611	.609	.53770

(a) **Predictors:** (Constant), TE

Source: Primary Data

Table 4(b): ANOVA*

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	140.491	1	140.491	485.921	.000 ^b
Residual	89.628	310	.289		
Total	230.119	311			

(a) **Dependent Variable:** BI

(b) **Predictors:** (Constant), TE

Source: Primary data

Table 4.b.3: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	T Value	Sig.
		B	Std. Error	Beta		
1.	(Constant)	1.046	.125		8.358	.000
	TE	.746	.034	.781	22.044	.000

(a) **Dependent Variable:** BI

Source: Primary Data

The regression results between behavioral intentions generated from telepresence of customers related to the hotel websites is shown in table 4.b. R² value is 61.1% which means 61.1% of variance is explained by independent variables (behavioral intentions) on dependent variable (telepresence) which is an indication that the predictability power is 61.1% and it is adjusted up to 60.9 %. Standard error is relatively moderate. This table is about analysis of variance between dependent variable and independent variable. It shows that F value is significant which exhibit overall significance of this regression model. A good linear relationship between dependent variable (behavioral intention) and three independent variables (telepresence) is evident with the values of p-value in correspondence to t-value.

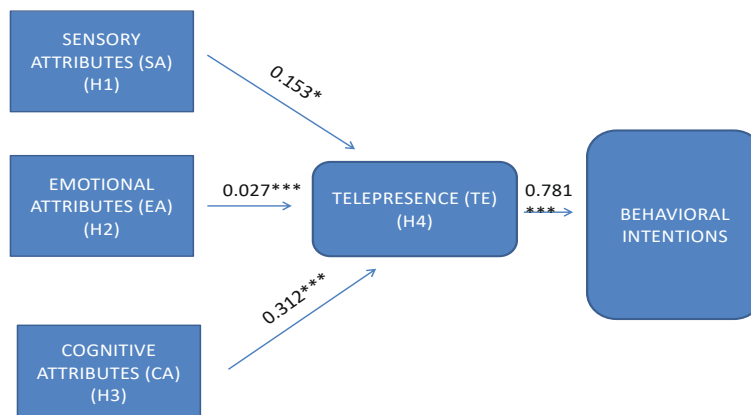


Fig. 2: Conceptualized Model to Measure the Impacts of Telepresence on the Behavioral Intention of Customer

Source: Authors

DISCUSSIONS AND IMPLICATIONS

It is critical to engage in a deliberate decision-making process and examine various variables, including sensory, emotional, and cognitive factors, in order to determine the factors contributing to telepresence. According to the findings of this study, there was no significant relationship between sensory characteristics and telepresence when people searched for hotels online. Table 5.1 shows the effect of sensory attributes on consumers' decreased proclivity to make future purchases (H1). The findings presented in Table 5.1 (H2), on the other hand, indicate that emotional factors play a significant role in determining individuals' use of hotel websites. According to Kim and Perdue (2013), when it comes to purchasing a hotel, a customer's emotional state plays a significant role in their decision-making process. According to the findings of this study, which are consistent with previous research, telepresence has a greater impact on customers when they visit hotel websites that effectively capture their interest and elicit intense emotions. This finding demonstrated that sensory elements have a limited impact on telepresence.

According to the findings presented in Table 5.1, when using the cognitive features provided by telepresence websites, users felt a sense of presence. This observation demonstrates that because telepresence is an intangible experience, it is associated with emotional and cognitive characteristics rather than sensory characteristics. Customers' cognitive characteristics were primarily focused on their utilitarian or pragmatic needs.

As shown in H4 table 5.1, telepresence has a positive impact on the intended actions of visitors to hotel websites. Suh and Chang (2006) discovered a link between two dependent and two independent variables.

Theoretical Contributions

This study has contributed to create a better understanding of the significance of telepresence theory by investigating its various antecedents and outcomes of the customers' telepresence on a hotel's website context. It has elaborated that higher telepresence leads to positive behavioral intention among customers. Previous researches show that the theory of telepresence has been underexplored in the context of hotel websites. So, a telepresence model in context of hotel industry where a positive experience before usage is required to develop customers' decision making has been proposed and empirically tested. Customer's had difficulty to decide upon their future experiences, thus telepresence plays an integral role in promoting usage of hotel websites, helping customers with their decision making and information processing.

Table 5.1: Comprehensive Picture of All Hypotheses and Their Results

Hyp. No.	Hypotheses Statements	Status
H1.	Sensory attributes positively influence customers' telepresence on the hotel's website.	Rejected
H2.	Emotional attributes positively influence customers' telepresence on the hotel's websites.	Accepted
H3	Cognitive attributes positively influence customers' telepresence on the hotel's website.	Accepted
H4	Telepresence on the hotel's website positively influences customers' behavioral intentions.	Accepted

Managerial Implications

The study's findings suggest that hotel website managers should think about incorporating telepresence technology to differentiate themselves in customers' perceptions and influence their purchasing behaviours. Customers responded positively to the hotel's website after establishing a cognitive and affective connection with it. These elements heightened their unintentional encounters. A well-executed website marketing strategy is essential for success.

(a) Prioritise the development of strong emotional connections with customers and the enhancement of their emotional states.

It is recommended that cognitive attributes be prioritised and given more weight than utilitarian traits in order to foster constructive behaviour.

It is critical to create an immersive experience for hotel guests by utilising emotional marketing strategies, evoking a sense of physical presence within the establishment. Given that customers typically conduct online research when selecting hotels, it is critical for hotel websites to make an emotional connection with potential customers in order to sway their decision in favour of the specific hotel in question. It is possible to establish a profound emotional bond by utilising technological advancements such as animation, music, aesthetically pleasing imagery, and positive feedback from previous clients.

Furthermore, the presentation of hotel websites' practical benefits to users can generate cognitive attributes. These qualities can be demonstrated by providing personalised services, cost comparisons, a diverse range of services, prompt responsiveness, and so on. The aforementioned characteristics contribute to a hotel website's efficacy in promoting telepresence as a persuasive tool to influence visitors' decision-making processes.

Limitation of the Study

- The study's ability to forecast the future is limited.
- The use of convenient sampling in this study reduces the likelihood of including participants from other groups, potentially influencing the results.
- The study's sample selection criteria reveal geographical limitations that may have an impact on future research efforts.
- Because of the study's limited scope, which only examined hotel websites, its findings should not be extrapolated to other contexts.
- This study concentrated solely on sensory, cognitive, and emotional characteristics. There was no investigation of social influences and their impact on individuals. Social influence can have a significant impact on Schitt 2000 customers' behaviour.

Future Scope

Future research should focus on this topic to gain insights into the impact of social factors on the telepresence of hotel websites and individuals' behavioural intentions. Furthermore, the use of advanced, innovative technology such as virtual reality has the potential to have a significant impact on customer concepts and strategies.

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Examining What Motivates Impulse Purchases

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▶ ABSTRACT ◀

Impulsive buying is a consumer buying behaviour where you buy something without thoughtful or without any planning. It is just immediate and on the spot purchase of an item. Several factors can affect impulsive buying behaviour including personal, situational and environmental factors. Personal factor include individual traits, such as self-esteem, emotional intelligence and self-control. Situational factor refers to the mood of the consumer and environmental factor include store atmosphere, product placement and promotions. Understanding these factors can help marketers develop effective strategies to influence consumer behaviour and increase buying behaviour with younger consumers, higher-income earners. The study also found that psychological factor such as: emotional state, self control and mood were identified as important determinants of impulsive buying behaviour.

Keywords: *Spot Purchase, Impulsive Buying Behaviour, Buying Behaviour, Environmental Factor, Situational Factor, Store Atmosphere, Product Placement, Emotional State, Effective Strategies, Self-Control.*

INTRODUCTION

Introduction to Impulse Buying: An Impulse buying is an condition in which an consumer going to buy the various types of products without planning. It is just immediate and on the spot purchase of an item. It may happen because of some need that emerge that moment suddenly, attractive or if he finds something at surprisingly low prices. An impulse purchase is somewhat different from a normal purchase, as the latter is planned prior to visiting a retail store while the former is spontaneous, and generally occurs all of sudden with no prior planning. This type of behavior can be called as impulse buying behavior. Impulse buying is a extremely

common conduct nowadays. Impulse buying is a major element of researchers in consumer performance and the advertising supplies. Impulse buying occurs though the buyers have no initiative or no conclusion previously. They come in the stores, so impulse buying is illustrate unexpected acquire manners. Impulse buying is also happen when unpredicted things occurs.

An impulsive purchase of a good or service is one made without prior planning. Impulse buyers or customers are people who frequently buy on the spur of the moment. [1]. According to the findings of the study, seeing or experiencing a product is the first step in making a purchase, and both logic and emotion play a role. “Big-ticket” purchases, such as automobiles and home improvements, can also be made on the spur of the moment. Automobiles are an emotional as well as a logical investment. As a result, auto dealers all over the world sold their vehicles quickly, as if they were at a fair. It was expected that this behaviour would spread throughout the world. Impulsive purchases impede a customer’s normal decision-making process. An illogical moment of self-satisfaction replaces the logical sequence of the consumers’ actions. People buy impulsively because they enjoy the sensation it gives them. Few items purchased on a whim are items that people use or require frequently. To control your impulsive purchases, make a budget before you go shopping and wait a while before making a purchase.

Author, Year	Definition
Rook (1987)	“It is a process triggered by sudden, powerful and persistent urge to purchase something immediately”.
Rook et al (1995)	“Impulse buying is a consumer’s propensity to buy unexpectedly, Unreflectively, instantly and kinetically”.
Beatty et al (1998)	“Impulse buying is defined as the tendency to experience a Unprompted and sudden urge to make instant purchases, and to act on those urges with little consideration or appraisal of their consequences”.
Jones et al (2003)	“Impulse buying is the tendency level to which a human being is likely to make unplanned, instant and unreflective purchases.
Dawe et al (2004)	“The tendency to engage in actions that involves rashness, a lack of forethought or planning, or behavior that occurs without Reflection or careful consideration”.
Friese et al (2009)	“Impulse buying attribute refers to the trait of certain persons who are generally impulsive in their purchase behavior”.
Virvilaite et al (2009)	“Behavior of impulse buying is a consumer’s reaction to spur Experienced in a purchase environment, it is an on the spot decision”.
Sharma et al (2010)	“Impulsive buying is defined as swift, persuasive, hedonically difficult purchase behavior in which the promptness of the impulse purchase decision preclude any thoughtful consideration of alternative or future implication”.

An impulse purchase is one that is made on the spur of the moment or with no other thought. An impulse purchaser or impulse buyer is someone who makes purchases on the spur of the moment. Impulsive shopping can also lead to the purchase of “big ticket” items such as automobiles and home appliances. Emotion and logic are especially important when purchasing a car. As a result, auto dealers all over the world are now marketing their products in a frantic, carnival-like manner that aims to elicit emotions rather than reason.

Background of the Study

With the emergence of new trends, needs and demands of people are increasing and they keep changing every moment. These needs are not those which are considered as primary or basic needs, but they might have emerged due to change in various income of consumer, change of taste and preferences etc and many more reasons. A number of researchers have tried to understand and observe the buying behavior and its impact on retail industry. It can be easily noticed that slowly and gradually, people are developing a habit noticing products in retail

stores, and checking various products with not an intention to buy all of them at once, but simply just looking and checking details like price, rating, features etc. This habit is making them somewhat develop a tendency to make an impulse purchase while they are simply checking it.

Retail Scenario

The Wal-Mart's and multiplex stores has become a big game changer in impulsive buying because in early times there was a small shop for purchasing various items and consumer was not able to know various new items because in that time the retailer only gave that item which is demanded by the consumer, but in today's scenario, consumer is going in big stores and Wal-Mart's for buying the products of their need but at that place there is various items placed at single place and consumer attracted toward it and also buying them, and due to this reason impulse buying is done.

Need and Importance of the Study

The need of study to know about the today's scenario of consumers' shopping pattern as well as the buying behavior. Since impulse buying is a phenomenon that is being observed these days, it is required to understand various factors that may influence a buyer to go for buying impulsively. On one hand, shopping is observed as a type of amusement, while they are the target of several promotional trigger while they shop. The aim of this paper is to study impulsive buying performance in shopping and the relationship with positive factors. This study will contribute to the understanding relating to the impulse buying incidence that occurs in the retail formats. Thus, the result would promote dissimilar entity such as retailers, customers and future researchers which may be associated into this matter.

LITERATURE REVIEW

Marketing and consumer behavior researchers have spent the last 40 years trying to understand the impulse buying model and have developed their own jargon in the process. We'll go over some of the solutions they've discovered right here. In a research perform by Cobb and Hoyer [2] impulsive trade is defined as an spontaneous purchase and this explanation can also be establish in the research of Kollat and Willett (1967). Beatty et al [3] said "impulse buying is a sudden and immediate purchase with no pre-shopping intentions either to buy the specific product category or to fulfill a specific buying task". Impulse buying is a natural purchase with modest thinking while unprepared. According to Hoch et al [4]the ability to maintain self-control and repel the impulse to buy depends upon the struggle between the two psychological forces of desire and will-power". Dholakia, [5]. Focused on the swiftness of the decision-making procedure, in which short duration of time stay alive from the beginning of an urge to purchase to its implementation and the improved frequency of rate of the urge to buy. The literature for this research defines impulse buying in the following ways as shown in, Table 1:

Since, the research aims at the exploration of the factors that influence the impulse trade behavior with extraordinary suggestion to the online shoppers, it considers the work of several researchers who not only defined impulse buying behavior but also helped in understanding these factors. After review of literature, a total of 62 factors were identified that directly or indirectly affect the impulse buying behavior. From the tabulation below, it can be observed that numbers of researches were conducted on this impulse buying behavior, making it clear about the importance of understanding this behavior.

Table 2. 1: Impulse Buying as Defined by Different Authors in Literature

Sl.No	Author, Year	Context	Type	Tool used	Description
1.	Angerla Hausman, 2000	Consumer Marketing	Exploratory research	Correlation matrix and ANOVA	People purchase items for a variety of reasons, including amusement, fantasy, and social or emotional fulfillment

2.	Coley et al., 2003	Fashion Marketing	Exploratory research	Principal component analysis, ANOVA	Females were more likely to engage in impulsive behaviour. Men and women behave very differently when it comes to impulse purchases, etc.
3.	Phau et al., 2004	Fashion Marketing	Exploratory research	Independent t-test and Bi-variate Correlation	Marketers should consider retail store layouts to appeal to innovators, initiate spontaneous purchase
4.	Park et al., 2006	Fashion Marketing	Causal research	Correlation matrix	The hedonic consumption tendency connects positive emotions and fashion involvement, as well as their positive effects on consumers' fashion-related impulse purchases.
5.	Tifferet et al., 2012	Gender difference	Causal research	Multiple regression	Females are more committed to a brand, consume hedonically and are more impulsive than men.
6.	Mohan et al., 2013	Marketing	Exploratory research	Correlation matrix AMOS	Store environment enhances impulse buying by inducing positive urge and affect.
7.	Vojvodic et al., 2013	-	Exploratory research	Factor analysis and one-way ANOVA	It was found that croatian online consumers are influenced by two major factors impulsiveness and recreational factor.
8.	Briei et al., 2013	Young Customers	Qualitative research	Manual and automated textual analysis, conceptual and thematic maps	It was found that there are clear differences between teenagers and adults towards impulsive buying.
9.	Chang et al., 2014	Retail & Distribution	Causal research	EFA, Regression analysis	It was found that ambient characteristics directly affect positive emotional responses to the retail environment

OBJECTIVE OF THE RESEARCH

- To identify the contributing factor affecting impulsive buying of consumer.
- To access the impact of contributing factor on impulsive buying behavior of respondents.

Research Methodolog

A variety of factors influence impulsive purchasing. The researcher must be able to communicate with respondents via a well-designed questionnaire and identify dependent, independent, and linking factors. The questionnaire was divided into two sections. The first section's goal was to learn about the respondents' demographics and

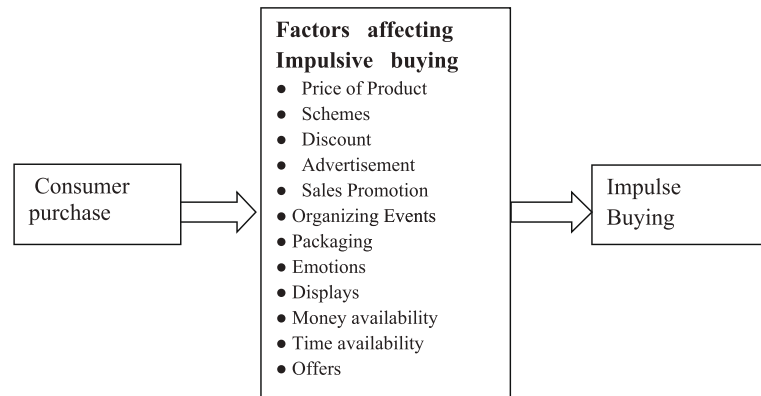
impulsive purchasing habits. The second section focused on the characteristics that customers found most appealing in the various produce options.

In this Research, we use questionnaire of different contrast:

- SEC (Store environmental characteristics)
- CPER (Consumer positive emotional responses)
- IB (Impulsive buying)
- SC (Situational characteristics)

Research Design

- **Sampling Area:** The research is based on on-the-spot purchases made by customers in Gwalior.
- **Sample Size:** The study closely monitored the volunteers who offered to use the tools independently. The survey received responses from 200 people in total.
- **Sampling Design:** The sample was chosen at random based on its simplicity.
- **Primary Data:** The vast majority of the researcher’s data came from a structured questionnaire distributed in Gwalior.
 - **Demographic characteristics** – Name, Age, Occupation, Income.
 - Dimension of customer cheerfulness for impulsive selling.
- **Secondary Data:** The secondary information was together from the available resource such as journal, reporters, magazine and websites.
- **Research Instruments:** A summated rate scale layout was use, with five choices per item range since “Strongly disagree” to “Strongly agree”.



DATA ANALYSIS & INTERPRETATION

All of this information has been classified based on the demographic questions in the survey. The demographic component of the study is discussed in this section.

Table 4.1

Demographic Profile of Respondents			
Variables	Values	Responses	Percentage
Gender	Male	153	75%
	Female	51	25%
Occupation	Agriculture	9	5%
	Business	38	18%
	Employees	61	30%
	Student	96	47%
Income (p.m)	less than 10000	97	47%
	10001 to 20000	8	4%
	20001 to 30000	47	23%

	30001 to 40000	22	11%
	Above 40000	30	15%
Age Group	18 to 25 years	94	46%
	26 to 35 years	47	23%
	36 to 45 years	32	16%
	46 to 55 years	12	6%
	Above 50 years	19	9%

Based on the data collected, this study made up from 51 Female respondents and 153 Male respondents. The age distribution of this study were 18 to 25 years (46%) were the highest scored respondents, age group followed by 26 to 35 years (23%) and 36 to 45 years old (16%). Most of the respondents are student (47%), occupation followed by employees (30%), Business (18%) and respondents involved with Agriculture (5%).

Reliability Test

The reliability test is used to determine the dependability of the data collection scales (questionnaires). The reliability test demonstrates the relationship between the scale items. It simply stated how each factor influences the others. It demonstrates how well each variable in the questionnaire matches the others. SPSS is used to assess the datasheet's reliability. For the reliability test, all of the measured items from the data sheet are chosen. According to the formula, the Cronbach's Alpha value is 0.835, or 83.5%. This is evident from the table. It simply states that the questionnaire's 83.5% accuracy is sufficient for further analysis. Using 20 scaled questionnaire variables, the reliability was calculated to be 83.5%. These 20 variables are 83.5% correlated with one another. Our data's dependability has now improved to the point where it can be used in the study, requiring additional analysis. To achieve their main goal, the researchers used an exploratory factor analysis. If the results are as expected, the analysis and interpretation will proceed as planned.

Table 4.2

Cronbach's Alpha	N of Items
.835	20

Exploratory Factor Analysis

Exploratory factor analysis is a statistical technique that helps researchers analyse multiple variables and constructs. Exploratory factor analysis is a technique that reduces a large number of variables to a small number of "factors" or "constructs." Constructs are created by determining the underlying factors that explain a previously observed pattern of inter-variable correlation. These "constructs" "explain," in terms of factor analysis, variations in the "dependent variable." Finally, exploratory factor analysis identifies constructs based on the total variances in the dependent variable for which they account. Typically, these "constructs" are simply a synthesis of survey responses. Furthermore, the researchers are free to call these "constructs" whatever they want.

KMO and Bartlett's Test of Sphericity

If your sample size is large enough, you can conduct an exploratory factor analysis. This can be accomplished using the Kaiser-Meyer-Olkin Measure of Sampling Adequacy. A factor analysis is required if the Kaiser-Meyer-Olkin (KMO) value is greater than 0.577. The value of KMO is 0.798%, as shown in the table. The sample size in our data sheet is 79.8%, which is sufficient for factor analysis.

To determine the relationship between variables in a population matrix, the Bartlett's Test of Sphericity is used. Bartlett's sphericity test is used to examine the relationship between the variables. It validates the correlation by using the identity matrix. Remember that an identity matrix demonstrates that no population variables are correlated. The datasheet's factor analysis is correct now that the study's variables have passed the KMO and

Bartlett sphericity tests. The constructs were removed using factor analysis and an Eigen value greater than one. In this scatter plot, the first five principal components are shown to be the most relevant and important. The factor loadings, total variances, and cumulative variances for each extracted construct are displayed.

KMO and Bartlett’s Test

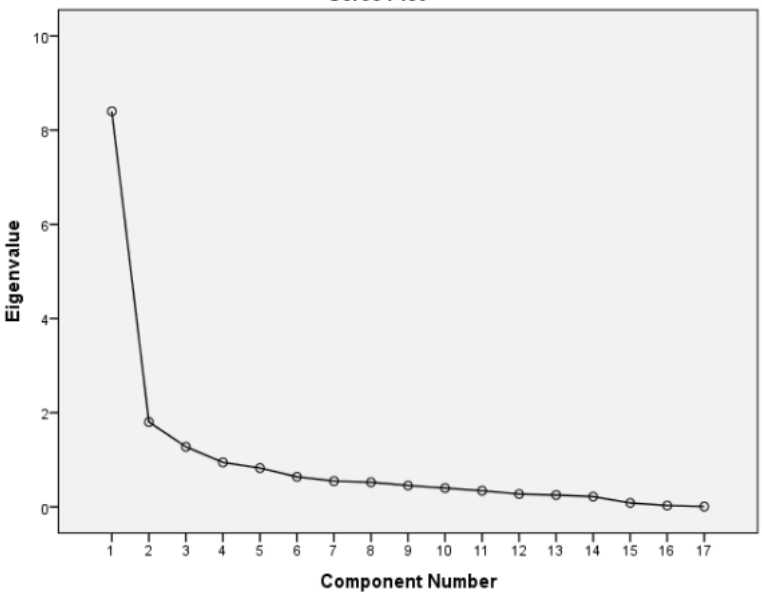
Kaiser-Meyer-Olkin		798						
								
Bartlett's Test of Sphericity		<table border="1"> <tr> <td>Approx. Chi-Square</td> <td>911.617</td> </tr> <tr> <td>Df</td> <td>190</td> </tr> <tr> <td>Sig.</td> <td>0.000</td> </tr> </table>	Approx. Chi-Square	911.617	Df	190	Sig.	0.000
Approx. Chi-Square	911.617							
Df	190							
Sig.	0.000							

Table 4.3: Summary of Extracted Factors (Table 4.2)

Extracted Factor	Statements	Factor Loading	PVE	CPTVE
S.E.C	This store was clean.	0.787	24.677	24.677
	This store was a relaxing place to shop.	0.772		
	The store has an impressive interior design.	0.633		
	The color of this store was bright.	0.736		
	Employees of this store gave customers personal attention.	0.614		
	The store’s employees willing to help customers.	0.729		
P.E.R	You feel excited at store.	0.534	8.963	33.641
	You feel enthusiastic at store.	0.591		
	You feel fun at store.	0.674		
	You feel inspired at store.	0.593		
	You feel happy at store.	0.636		

I.B.B	I had bought items that had not planned to purchase on this trip	0.566	6.732	40.373
	On the shop, you felt excitement for the shopping	0.636		
	You had limited time available to me for this particular shopping trip	0.75		
S.C	The amount of time pressure You felt on this shopping trip was “High”.	0.601	6.216	46.589
	You were not rushed for time on this shopping trip.	0.697		
	You did not feel you could afford to make any unplanned purchases on this trip.	0.594		

- **PVE** -Percentage of variance explained
- **CPTVE** – Cumulative percentage of total variance explained

Table 4.4

Rotated Component Matrix (TABLE 4.5)				
	Component			
	1	2	3	4
SEC#1		0.787		
SEC#2		0.772		
SEC#3		0.633		
SEC#4		0.736		
SEC#5		0.614		
SEC#6		0.729		
CPER#1	0.534			
CPER#2	0.591			
CPER#3	0.674			
CPER#4	0.593			
CPER#5	0.636			
IBB#1			0.566	
IBB#2			0.636	
IBB#3			0.75	
SC#1				0.601
SC#2				0.697
SC#3				0.594

- E Extraction Method: Principal Component Analysis.
 R Rotation Method: Varimax with Kaiser Normalization.
 a. Rotation converged in 12 iterations.

To do the regression analysis, it is necessary to club the underlying variables into constructs via compute variable function in SPSS. Compute variable is a tool that helps researchers to club a number of variables into a single construct by aggregating their responses.

Regression Analysis

In this study the association of independent variables with the dependent variables is computed using Regression analysis in SPSS.

R Square Test

In regression analysis, only r-square value has a major importance for study as it can tell us the association properties for the independent constructs with respect to purchase intention. R- Square is also known as “Coefficient of multiple determinations”.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.562 ^a	.316	.306	.46423

a. Predictors: (Constant), SC, SEC, CPER

This table shows regression statistics for SC, SEC, and CPER on PI. R² value is .316 % which means 31.6% of variance is explained by independent variables (SC, SEC, CPER) on dependent variable (PI) which is an indication that the predictability power is 31.6% and it is adjusted up to 31.7%. Standard error is relatively moderate.

ANANOVA^a

Model	Sum of Squares	Df	Mean Square	F	Sig.	
1	Regression	19.150	3	6.383	29.620	.000 ^b
	Residual	41.378	192	.216		
	Total	60.528	195			

a. Dependent Variable: I.B.B

b. Predictors: (Constant), S.C,S.E.C,C.P.E.R

This table is about analysis of variance between dependent variable and independent variable. it shows that F value is significant which exhibit overall significance of this regression model. Regression analysis generates an Analysis of Variance (ANANOVA) table, which is used in global tests to assess the overall performance of the model. The global test identifies how each independent variable affects the dependent variable’s overall behavior.

CO-EFFICIENT STATISTICS

A researcher can use the coefficient statistic to determine how much each independent variable influences the dependent variable. The coefficient of the study is shown in this table.

C Coefficients (TABLE 4.6)

Model		Un standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.992	.368		2.696	.008
	S.E.C	-.040	.098	-0.29	-.411	.681
	C.P.E.R	.441	.108	.331	4.085	.000
	S.C	.341	.077	.321	4.428	.000
						.

a. Dependent Variable: I.B.B

IBB = .992-.040SEC+.441CPER+.341SC

As the above shows that the significant value of all the independent variables (SEC, CPER, SC) is not value 0 it depicts that the hypotheses are rejected which says consumer behaviour of the impulse buying unplanned and immediately.

MAJOR FINDINGS

According to our research, the two most important factors influencing impulse purchases are motivation and the shopping environment. Credit cards, promotions, easily visible goods, and gender, on the other hand, influence impulsive purchasing. The shopping environment is the second most important and beneficial factor in a consumer's proclivity to make quick purchases. We used a five-point scale with the words "Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), and Strongly Disagree (SD)" to gauge people's feelings. The respondents' opinions were solicited. Our sample size was 204 people, with 113 of them being men. The rest were women. When women are present, impulsive purchases are more common than when men are present. The availability of funds and the clarity of the task description moderated the relationship between happy feelings and impulsive purchases. A store's layout can influence customers' behavior while they are inside the store without having a significant impact on their feelings, thoughts, or physical health.

RECOMMENDATIONS

Regardless of our discussion of the five internal and external factors, the following factors led to impulse purchases: Supermarkets should do more to create a welcoming environment because the majority of customers go straight to the store. Retailers should offer a variety of promotions to entice customers to make immediate purchases. Customers are drawn to a store by various types of promotions. Through appealing products and imaginative window displays, customers should be drawn to the entire Endeavour. This idea favors modern design and the use of eye-catching lighting and colors. To attract customers who are price conscious and looking for deals, supermarkets should offer cash discounts and coupons. Customers frequently buy non-essential items on the spur of the moment, so supermarkets should accept credit cards. Researchers interested in this topic should also look into Gwalior's other cities. As important factors that can influence a consumer's proclivity to buy, additional factors such as income level and investor's must also be considered.

LIMITATION OF THE STUDY

The study is based on data collected from a sample group that is representative of the entire population. Gwalior's entire customer base will thus be covered. The analysis has a flaw in that it was based on information gathered through interviews. The study's duration was limited due to a lack of data. Only customers are examined in this study. The field of study is only available to the city of Gwalior. The researcher is only interested in products that are purchased immediately. As information, only customer sentiment was gathered. A questionnaire-based survey was used to collect the data. This is not the best way for researchers to collect data. According to Cooper and Schindler (2003), this is because people do not frequently respond to surveys, the questions can be difficult to understand, and the surveys can be too long. The survey questionnaires were written in English. Some survey respondents only had rudimentary knowledge of the target language. The study was only conducted in Gwalior, India, and its findings may or may not be applicable elsewhere in the world. As a result, it is critical to exercise caution when making broad generalizations. As a result, the study may have contained some errors. The number of respondents varied depending on their age, gender, and level of income. The differences that resulted from this could have been different between the two groups.

SCOPE FOR FURTHER RESEARCH

The study focused on businesses that primarily serve affluent city dwellers. Customers with lower discretionary incomes could not be depicted in this way. It is recommended that a larger, more representative sample of other stores in the city be considered to see if their behaviours differ. According to the low R2 value, demographic

factors have little influence on consumers' propensity to make an immediate purchase. Others, such as the shopping environment, how products are displayed, where shelves are located and how far apart they are from one another, and a person's mood, may have a direct impact on impulse behavior. Future research must therefore investigate how these factors interact.

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Training Perceptions and its Effects on Employee Turnover

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▶ ABSTRACT ◀

Modern management researches have recognized the human resource of an organization as an asset. To enhance the commitment of the employee towards the organization, HR inventions such as training are effectively used. When an employee joins the organization, she/he may have personal desires such as career ambitions and salary expectations. This inherent dedication can be enhanced to the level of organizational commitment by an effective implementation of training program. The literature suggests that employees enhance their commitment towards the organization when the organization meets their expectations as regards fulfillment of their individual needs. Employee performance is one of the crucial measures emphasized by the top management, employees are more concerned about their own productivity and are increasingly aware of the accelerated obsolescence of knowledge and skills in their turbulent environment, by effectively training and developing employees, they will become more aligned for career growth – career potential enhances personal motivation. The perception of employees decides how much an employee is going to achieve by participating in training. Organizational commitment refers to the degree to which a person identifies with and works for a certain organization. Employee perceptions of the impact of training on organizational development and their likelihood of quitting are critical components in any company's growth and development. This offers workers the opportunity to enhance the organization and demonstrates how much the company values their efforts. Research methodology is the specific procedures or techniques used to identify select, process and analyze information about a topic. It describes and analysis methods, throws more light on their limitations and resources, clarify their pre- suppositions and consequences, relating their potentialities to the twilight zone at the frontiers of knowledge. The principle objective of this study is measuring the impact of employee perceptions of training on organizational commitment. This research methodology section explains about the questionnaire development, reliability and validity of the questionnaire, sample design and tools for data analysis.

Keywords: Employee Performance, Training, Organizational Commitment, Obsolescence of Knowledge, Enhance, Productivi.

INTRODUCTION

Modern management researches have recognised the human resource of an organisation as an asset. Earlier there was a misconception that employees work for salary only. But researches have shown that employees are a valuable asset to the organisation. If managed in a right direction, the committed employees can propel the organisation to new heights. To enhance the commitment of the employee towards the organisation, HR interventions such as training are effectively used.

According to social exchange theory individuals enter into a relationship with an organisation so as to maximise the benefits they obtain [1] Social exchange is based on an implicit agreement between employee and the employer, referred to as a psychological contract [2]. When an employee joins the organisation, she/he may have personal desires such as career ambitions and salary expectations. But employee also have an inherent dedication towards the organisation. This inherent dedication may be a result of cultural and social background of the employee. This inherent dedication can be enhanced to the level of organisational commitment by an effective implementation of training program. The literature suggests that employees enhance their commitment towards the organisation when the organisation meets their expectations as regards fulfilment of their individual needs [3] Higher organisational commitment benefits both the employee and the employer. For the employees, it provide job satisfaction and for the employer, it enhances the performance of employee and reduces the chances for the employees to leave the organisation. The employees' commitment towards the organisation is enhanced if the employees feel that their expectations are being fulfilled by the organisation. According to Cheng and Ho [4] "While employee performance is one of the crucial measures emphasized by the top management, employees are more concerned about their own productivity and are increasingly aware of the accelerated obsolescence of knowledge and skills in their turbulent environment. As the literature suggests, by effectively training and developing employees, they will become more aligned for career growth—career potential enhances personal motivation."

Organisations must develop training programs which reflect their organisational goals. Training is an essential activity enhance the employee skills, to provide information about rapidly changing market and to modify the employee behaviour according to the organisational goal. In a highly competitive market, having a skilled manpower with updated knowledge is a key to have a competitive advantage. Thus organisations spend a good deal of money and time on training and skill enhancement of their employees. Management expect the training programme to be effectively implemented, hoping to get good returns in terms of employee performance. Perception of employees about training programmes may differ. Some perceive it as a way to enhance skills; others see it as a useless thing. Many employees use training to increase their core competencies so that they can earn more in future. Some see it as a path for career advancement. In many public sector organisations, training programmes are usually associated to promotions and pay hikes. It is essential to make employees serious about the training programmes. If employees participate in training programmes with curiosity and show interest in learning, it will be beneficial for both organisation and employees. Thus perception of employees decides how much an employee is going to achieve by participating in training. It is essential for training programme developers to maintain a positive perception of training among the employees.

Sector wise analysis of impact of training on employee behaviour is being conducted by various researchers. We have tried to analyse how the employees across different sectors feel about the training. In this study, we assess the impact of training on employee behaviour towards their organisation. We have surveyed a wide class of employees like private sector employees and public sector employees. We have also surveyed education sector employees. This study provides a holistic analysis of employee behaviour.

LITERATURE REVIEW

Organisational commitment refers to the degree to which a person identifies with and works for a certain organisation. Employee perceptions of the impact of training on organisational development and their likelihood

of quitting are critical components in any company's growth and development. Several studies have been conducted to determine how employees perceive the impact of training on organisational growth and their likelihood of quitting their employment. Here are a few examples: Snower and Booth. According to the findings of this study, training and development not only assist the competent person become more productive, but also help other employees perform better. Employees in a company operate as a team, therefore the productivity of one department or individual is dependent on how well the others do. Employees, for example, may boost the efficacy of physical capital, such as machines.

Allen and Meyer in the 1990s. This study focuses on only two crucial elements: emotional commitment and continuance commitment. Affective commitment is defined as employee identification with and emotional relationship to their employer. This is an important trait since highly devoted employees stay with the firm because they care profoundly about it. On the other hand, the employee's projected cost of quitting the business is their commitment to continue working[5]. This might result in a loss of seniority or commercial benefits. An employee who is sincerely dedicated to the company will stay because of pride. Becker was released in 1962. There is no link between general training and employee churn, according to the study. This is because extensive training enhances knowledge and abilities that benefit the entire firm. Furthermore, he says that because general training benefits the entire organisation, it should be paid for by the employee rather than the employer. He stated that generic training posed a concern since other organisations may poach skilled employees. Furthermore, when employees leave their current company, they will carry those same talents to their new one.

Levhari and Weiss, 1974. Furthermore, because acquired skills cannot be separated from the student, person, or unique human resource and cannot be bought and sold, investments in human capital are extremely hazardous. We evaluated this study project based on the six factors listed below: - What employees think about training: Training and development programmes that assist workers in acquiring job-related skills are always required in company[6]. These training and development initiatives occur often in businesses, and management is always interested in how the programmes are regarded by employees. Training accessibility as perceived: Employees have the opportunity to increase their knowledge, skills, and abilities, which may lead to financial gain, through training and development. It is an important approach for retaining staff since they will feel obligated to the business for investing in their personal and professional development. When examining how HRM practises effect employee difficulties such as detention, determining the levels of analysis is still essential.

According to London (1993), a leader's support for training is determined by how well they get along with their subordinates. A supervisor may assist you by providing constructive criticism on your performance, assisting you in your professional development, and providing advise on your job and future. Training is a top focus for both employees and the firm. Training may help people enhance their knowledge, skills, and capacities. According to the concept of human capital, a reward like this will drive a corporation to increase its performance and efficiency[7].

Employees who have a say in corporate decisions are more likely to be dedicated to the organisation as a whole. This offers workers the opportunity to enhance the organisation and demonstrates how much the company values their efforts. People are enthusiastic about the subjects they support[8]. Turnover intention: Essentially, turnover intention outlines the measures made by employees who are considering leaving the organisation. Examining the real turnover rate is critical since it may be difficult to identify employees who leave and most individuals do not engage in surveys. Numerous studies have indicated that turnover expectations are the strongest predictor of actual turnover. Using the aforementioned research, we attempted to identify a relationship between how employees felt about organisational development training and whether or not they intended to quit their positions[9].

Research Methodology

Research methodology is the specific procedures or techniques used to identify, select, process, and analyse information about a topic. This is a set of systematic technique used in research. This simply means a guide to research and how it is conducted. It describes and analysis methods, throws more light on their limitations and resources, clarify their pre-suppositions and consequences, relating their potentialities to the twilight zone at the frontiers of knowledge.

The principle objective of this study is measuring the impact of employee perceptions of training on organizational commitment. For accomplishing this objective, researchers extracted five independent variables: Perceived Availability of Training, Perceived Supervisor Support for Training, Motivation to Learn, Co-Worker Support for training, Perceived Benefit of Training and one dependent variable as organizational commitment. For measuring this cross-sectional research, a self-completion survey questionnaire was used to gather data for hypothesis testing. This research methodology section explains about the questionnaire development, reliability and validity of the questionnaire, sample design and tools used for data analysis.

Questionnaire Development

For measuring this cross-sectional research, researchers used to structure questionnaire comprised of three demographic (age, gender, experience in current organization) and 31 questions on seven different constructs. Scale items have been adopted from the extensive literature review and found most appropriate scale of each construct in this study. A detail of this scale is presented in table 4.1. A five-item scale was developed to measure perceived availability of training adopted from Newman and Hui (2011[10]). Perceived Supervisor Support for Training was measured through 7-items scale adopted from Newman and Hui (2011). Co-Worker Support for training scale is comprised of 3 items scale and also taken from [11]. Motivation to learn was measured using three items taken from Noe and Schmitt (1986) study. Perceived benefits of training were measured by seven items taken from [12] Dependent variable Organizational commitment was measured using six items adapted from [13]. Each variable is evaluated through seven-point Likert Scale. The detailed of scale adopted and its reliability and validity of each construct are shown in Table 4.2.

Reliability and Validity of the Scale

The regularity or dependability of a construct's measurement is its reliability. To put it another way, do we receive almost the same answer each time we use this scale to measure the same object, providing the thing being measured does not change? An example of an erroneous measurement approach is your perceived weight in the perspective of others. Divergent measurements result from a variety of estimates given by distinct persons. As a result, the "guessing" strategy is inaccurate. If your weight has not changed between measurements, a weight scale may be more accurate. Unless your weight has changed, you'll most likely get the same reading every time you walk on the scale.

The term "validity," sometimes known as "construct validity," reflects how well a measure correlates to the item it is supposed to measure. Does a kindness scale, for example, genuinely assess compassion? Is it evaluating another attribute, such as empathy? Validity can be determined either theoretically or practically. Both strategies should ideally be used.

A measure can be reliable but not accurate if it consistently measures the same thing but the wrong item. As in the last example, a measurement can be both accurate and valid if it consistently measures the proper item. A reliable and valid multiple-item measure of a construct, as illustrated in Figure 4.1, consists of bullets that are all situated close to the centre of the target. Shots that are centred on the target but distributed uniformly will produce a valid but incorrect measurement. Instead, a multitude of missiles will cover the target. A collection of projectiles that are close together but miss their target is a reliable but inaccurate metric; thus, reliability and validity are both required to ensure that the constructions of interest are reliably measured.

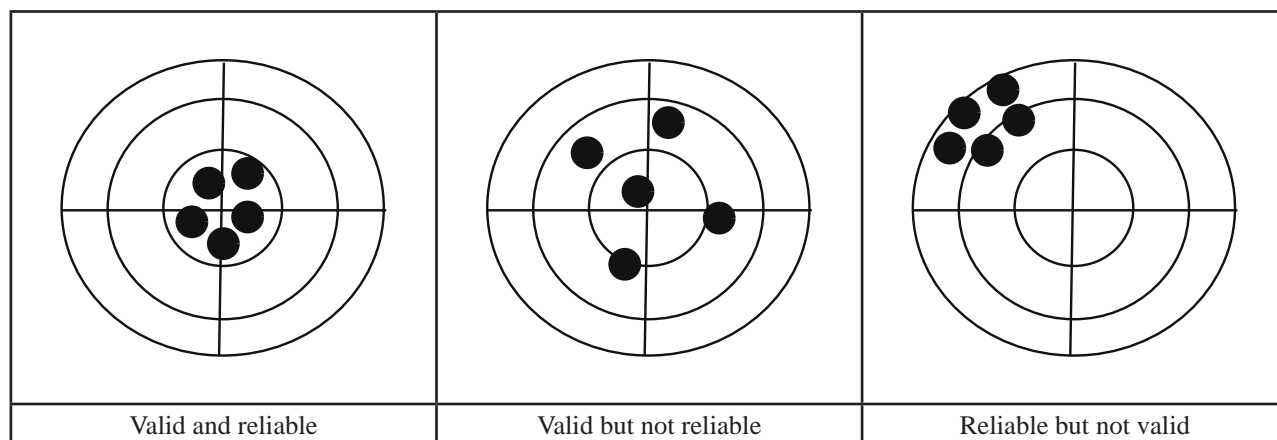


Fig. 4.1: Comparison of Validity and Reliability

The detailed of scale adopted and its reliability and validity of each construct are shown in Table 4.2.

Table 4.2: Reliability and Validity of the Scale

Var. No.	Construct	α	AVE	No. of items
1	Perceived availability of training	0.793	0.585	5
2	Perceived Supervisor Support for Training	0.866	0.673	7
3	Co-Worker Support for training	0.711	0.655	3
4	Motivation to Learn	0.714	0.614	3
5	Perceived Benefit of Training	0.813	0.683	6
6	Organizational Commitment	0.899	0.644	6

Sample Design

Target audience is private company's marketing team of financial products. We collected the data from 14/03/2020 to 15/05/2020 by conducting an online survey. And our sample size population is 192. We have chosen marketing department because this department is very crucial for any organization to collect the revenue and in any organization, we can easily get marketing people. Every organization seeks to expand their business to make money and marketing is an essential channel to reach that goal. It aims to expose the employees to real life situation (dealing with clients and convincing them), therefor enhancing their interpersonal communication skills and personality altogether.

Data Analysis Tools

For demographic data analysis, pie-chart and percentage method have been used. Normality of the data has been checked through skewness and kurtosis.

For testing the hypotheses that comprised of measuring the impact of independent variables (Perceived availability of training, Perceived Supervisor Support for Training, Co-Worker Support for training, Motivation to Learn, Perceived Benefit of Training) on Organizational Commitment as Dependent variable multiple regression technique has been used. All analysis has been done through SPSS 24.

DATA ANALYSIS AND INTERPRETATION

Data analysis and interpretation part is divided into three section: demographic analysis, Normality checking and hypotheses testing.

Demographic Analyses

The first section of the analyses comprised the demographic characteristics of the respondents to understand the sample demographics in-depth. In the questionnaire, we have asked three demographic questions on age, gender and experience in the current organization. Analysis of the same is as follows:

Table 5.1: Gender Profile of the Respondents

Valid	Frequency	%	Valid %	Cumulative %
Men	101	52.60	52.60	52.60
Women	91	47.40	47.40	100.00
Total	192	100	100	

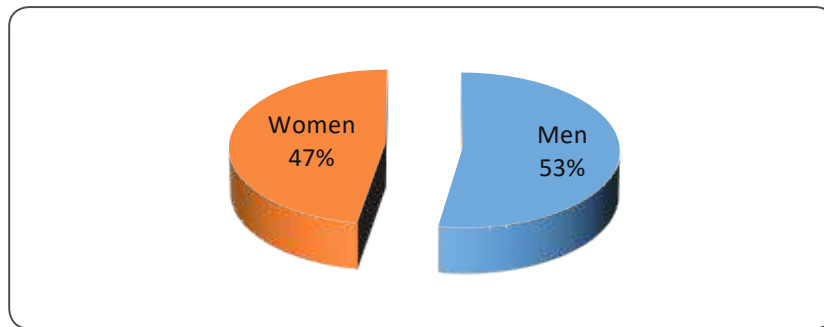


Fig. 5.1: Gender Profile of the Respondents

It is clear from the above Table 5.1 that 52.6% (101) respondents are male and 47.40% (91) respondents are female during the period of study. Also, the above Figure 5.1 shows the analysis of gender.

Table 5.2: Age Profile of the Respondents

Valid	Frequency	%	Valid %	Cumulative %
Less than 25	138	39.43	39.43	39.43
25-40	108	30.86	30.86	70.29
40-60	81	23.14	23.14	93.43
Greater than 60	23	6.57	6.57	100.00
Total	350	100	100	

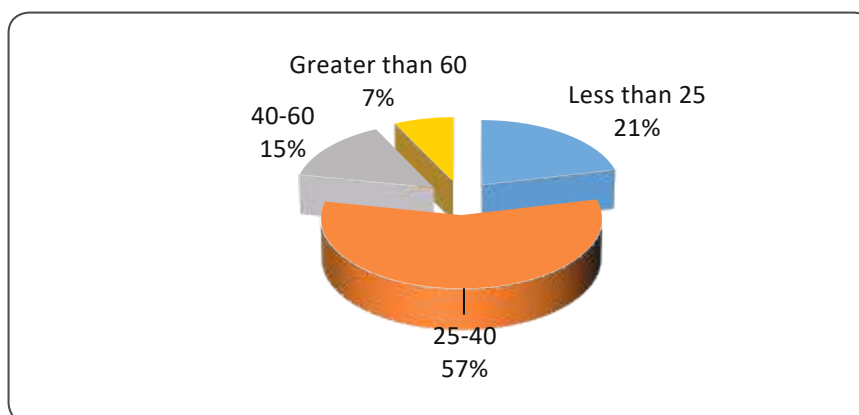


Fig. 5.2: Age Profile of the Respondents

It is clear from the above Table 5.2 that 39.43% (138) of the respondents belong to the age of less than 25 years, 30.86% (108) of the respondents belongs to the age group between 25 years and 40 years, 23.14% (81) of the respondents belongs to the age group lying between 40 years and 60 years and at last 6.57% (23) of the respondents belongs to the age greater than 60 years. Also, the above Figure 5.2 shows the age profile.

Table 5.3: Experience in Current Organization of the Respondents

Valid	Frequency	%	Valid %	Cumulative %
Less than 2 years	68	35.42	35.42	35.42
2-5 years	80	41.67	41.67	77.08
5-10 years	33	17.19	17.19	94.27
More than 10 years	11	5.73	5.73	100.00
Total	192	100	100	

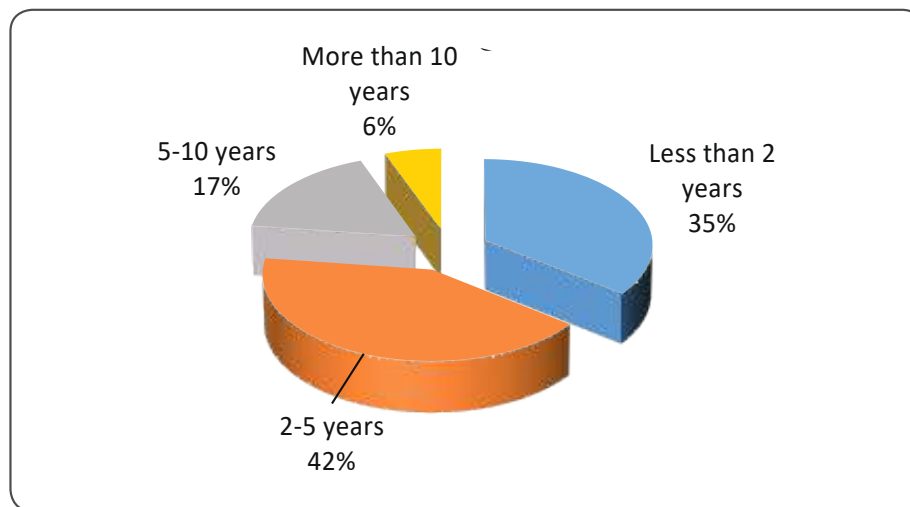


Fig. 5.3: Experience Profile of the Respondents

From the above table 5.3, it is clear that 35.42% (68) of the respondents have an experience of less than 2 years in the current organization, 41.67% (80) of the respondents have an experience ranging between 2 years and 5 years in the current organization, 17.19% (33) of the respondents have an experience lying between 6 years and 10 years in the current organization and at last, 5.73% (11) of the respondents have an experience of more than 10 years in the current organization. Overall, in the present study employees having experience of two to five have highest weightage of 41.67%. Also, the above Figure 5.3 shows the analysis of the work experiences of the selected employees.

Normality of the Data

For hypotheses testing, we are going to apply multiple linear regression. Key assumption for applying regression is that data should be normal. There exist a number of tests that can check whether the data collected from the respondents through the survey is normally distributed or not. One way to test the normality of data is to check the skewness and kurtosis of each item in the construct under examination, as can be observed in Table 5.4. The value of skewness provides an indication about the distribution of data in symmetry or not whereas the value of kurtosis presents information regarding the 'peakedness' of the distribution of data. All items complied with the skewness and kurtosis level indicates that all the items in the particular construct fall within the normality curve that is the values are below 3.

Table 5.4: Normality Statistics

		AT	SST	CST	ML	BT	OC
N	Valid	191	191	191	191	191	191
	Missing	0	0	0	0	0	0
Mean		5.24	5.42	5.38	5.43	5.46	5.43
Std. Deviation		1.396	1.166	1.229	1.176	1.243	1.225
Skewness		-1.495	-1.531	-1.235	-1.312	-1.597	-1.367
Std. Error of Skewness		.176	.176	.176	.176	.176	.176
Kurtosis		2.107	2.444	1.172	1.740	2.594	1.522
Std. Error of Kurtosis		.350	.350	.350	.350	.350	.350

Hypotheses Testing

The purpose of this study is to examine how organizational commitment is related to turnover intention in private company's marketing team of financial products. Several hypotheses have been constructed for the same which are as follows:

- H1:** There is a positive relationship between perceived availability of training and organizational commitment.
- H2:** There is a positive relationship between perceived supervisor support for training and organizational commitment
- H3:** There is a positive relationship between motivation to learn and organizational commitment
- H4:** There is a positive relationship between co-worker support for training and organizational commitment
- H5:** There is a positive relationship between perceived benefit of training and organizational commitment
- H6:** There is a negative relationship between organizational commitment and turnover intention

Table 5.5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.725 ^a	.525	.512	.855

a. Predictors: (Constant), BT, CST, ML, SST, AT

Table 5.5 explains the R Square which is also called as the coefficient of determination. It shows that 52.5% of variance is explained by independent variables for dependent variable which is considered good for any research model. Also, the Standard Error of the estimate is also considered good for the model as the value of the Std. Error is relatively low which is less than 1.

Table 5.6: ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	149.640	5	29.928	40.924	.000 ^b
	Residual	135.292	185	.731		
	Total	284.932	190			

a. Dependent Variable: OC

b. Predictors: (Constant), BT, CST, ML, SST, AT

Table 5.6 explains the Anova, which helps in assessing the overall significance of our model. As $p < 0.05$, this means that our model is significant.

Table 5.7: Coefficients^a

Model B	Unstandardized Coefficients		Standardized Coefficients	t	Sig. Tolerance	Collinearity Statistics		
	Std. Error	Beta				VIF		
1	(Constant)	.799	.345		2.320	.021		
	AT	.201	.068	.229	2.963	.003	.430	2.325
	SST	.181	.077	.173	2.352	.020	.475	2.104
	CST	.217	.066	.218	3.289	.001	.585	1.711
	ML	.107	.077	.103	1.398	.164	.472	2.119
	BT	.156	.077	.158	2.010	.046	.416	2.403

a. Dependent Variable: OC

Table 5.7 explains the different coefficients lying under it. The Standardized Beta Coefficients gives the measure of the contribution of every variable to our model. Since the significance value of the AT, SST, CST and BT (independent variables) is less than 0.05 which are .003, .020, .001 and .046 respectively, means they are significantly contributing in explaining the OC (dependent variable). However, on the other hand, ML is not significantly contributing in explaining organizational commitment as its significance value is not less than 0.05 which is 0.164.

Also, the regression equation formed from the above table is as follows:

$$OC = 0.799 + AT (0.201) + SST (.0181) + CST (0.217) + ML (0.107) + BT (0.156)$$

CONCLUSION

The purpose of this study is to examine the effects of training on employee perception towards organisational commitment and vice-versa. The findings of this study suggest that training is an important asset for any organization and its employees as well. It imparts knowledge and skills to the individual which in turn enhances his overall performance. Every organisation should provide the training to increase the productivity and motivate its employees towards their work. It ensures employees commitment towards the objective of organizational development. Commitment of the employees towards the organisation is to achieve the organisational goal. Trained employees tend to increase the productivity in both quantitative and qualitative manner. Training teaches better resource management to the employees which help the organisation to reach its financial goals. Intention towards training, benefits of training are always being discussed and debatable in the corporate world.

MAJOR FINDINGS

The results recommend a strong relationship between two variables: perceived supervisor support for training and organizational commitment and perceived availability of training. On other circumstances the perceived benefit of training establishes no significant impact associated to organizational commitment whereas all other variables have significant impact on organizational commitment. This research also supports an active inverse associates between organizational commitment and turnover intentions. The regression test is organized to resolve that there is an evince of a linear relation between arrangement of training to employees and their return in the pattern of retention.

The research also implements that there is a significant impact on training to employee retention. The research also contributes empirical proof that upholds the induce of training and it enact on employee retention. I also found that relation between training and employee retention have a significant relationship and my study has tested that employee's decision to remain for a more period of time in the organization can be determined by its training.

Recommendations

The limitations and findings that cited above, technologically, future research demands to be established on unbiased indicators and from various origin or sources. Further there should be other long-term investigation with similar groups, so that causality can be thoroughly well established.

- Firstly, it is forming a negative relation between perceived benefit of training and organizational commitment for that I recommend that the top authority in the organization should establish and implement a guideline of collaboration and relocation of experience between eldest employee and inexperienced employee in the area of work.
- Another shortcoming appeared as a result of irrelevant act and governance and moreover no legal association among training program, financial assistance, and motivation happened. The merger of these two (financial assistance and motivation has an exceptionally substantial negative response on commitment. And for that I will recommend that the higher authority in organization should be conscious of the seriousness of the motivation that should be given to their employee and should organize an honor to the good performer. Lastly, I belief that these would be convenient in developing the level of training of employees and parallelly the level of commitment.

Limitations of the Study

We have made every attempt to contribute to the overall results, but as we all know, each component has its own restrictions. One of the study's minor flaws is its limited sample size (only 192 participants responded), which is just one of many. In my work, I used quantitative research, which may help explain what happened if there are a lot of responses. Future scholars can use interviews to study the connection. Furthermore, because different employees will join the training with varying attitudes and levels of knowledge, forecasting the outcome is difficult. This investigation employed multiple regression as a sampling strategy, which is also a disadvantage. The purpose of this study was to determine how employees' perceptions of training affect their company loyalty and plans to leave. This is because, as additional data is gathered, a functional relationship established between two or more variables based on a short amount of data may no longer be valid. Following the investigation of a direct link, more research can be conducted using contingency factors that are likely to have an impact on the relationship.

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A Study on Management of Non-Performing Assets by Commercial Banks

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▶ ABSTRACT ◀

The study of non-performing assets (NPAs) and its management in commercial banks has been a crucial topic of research in recent times. NPAs are loans and advances that are not repaid within the stipulated time, causing financial losses to the banks. The primary objective of this study is to identify the reasons for the rise in NPAs in commercial banks and analyze the various measures employed by banks to manage these NPAs and appropriate suggestions to avoid future NPAs. The study adopts a descriptive research design and uses quantitative research method to collect and analyze data. The data is collected from various secondary sources such as journals, reports, and websites related to the banking sector and surveys from banks staff. The study finds that the major reasons for the increase in NPAs are poor credit appraisal, economic slowdown, ineffective recovery procedures, and interest rates. The study also finds that banks use various strategies to manage NPAs, such as loan restructuring, fixing interest rates, and securitization. Additionally, banks also employ credit monitoring systems, loan recovery mechanisms, and credit rating agencies to manage NPAs effectively. The study concludes that NPAs are a significant concern for commercial banks and need to be managed efficiently to maintain the financial stability of banks. Banks should adopt a proactive approach to prevent the accumulation of NPAs and continuously monitor their loan portfolio. Moreover, banks should employ effective recovery procedures and adopt innovative strategies to manage NPAs effectively.

Keywords: *Non-Performing Assets(NPA), Funds and Investments, Securitization, Credit Appraisal, Stock Prices.*

INTRODUCTION

Loaning cash and tolerating stores are the significant job of banking area. There is no hazard while getting stores for what it's worth to be reimbursed by the bank itself at whatever point it is requested by the client. In the event of cash loaning, there is consistently a sureness of danger of non-installment. The wellspring of cash loaned is the cash acknowledged from people in general as stores. In this way, banks ought to be exceptionally careful while loaning cash. The hazard engaged with loaning cash influences the dynamic intensity of the financial division. Hence appropriate evaluation is required while authorizing advance or probably it will offer ascent to NPAs. (Ms. Shalini H. S.,2013)[1] The financial part of India involves both businesses just as helpful banks, out of which over 90% of banking of area include business accounts. Near various remote banks and private banks, there are various open banks (bigger part value holding being with the administration), State bank of India (bigger part value holding is with the RBI) and partner banks of India (bigger part value holding being with the SBI). These banks close by the provincial rustic banks comprise the open area banking system of India. As we realize that advancement arrangement in 1991 lead a goliath influence over financial industry and credit organization. Before progression approach 1991, the banks scarcely engaged over the benefit quality however were basically focused over execution targets such as opening wide branches, improvement of provincial areas, need section loaning, and higher business generation. As we know around the fundamental work of banks that is to credit cash as advance to various divisions such as agribusiness, industry, individual development, lodging advance and so on. In any case, in front line period banks have been able to be particularly cautious in growing advances[2]. The need of supervision or fitting financial system lead to mounting Non Performing Assets and nowadays these are one of the significant worries for banks in India.

Financiers are the unparalleled who are overseers and wholesalers of fluid capital of nation. Consequently, the principle capacity of banks is to assemble the investment funds and channelize them into the most beneficial reason. Consequently, they are otherwise called trustee of excess of equalization of open. Store activation is one of the significant explanations for the improvement of economy. So as to prepare banks play out its essential capacity by tolerating stores through different store plans fit to various segment of individuals and the assistant things that is capital, save and borrowings from the wellspring of assets for the banks. In this way, loaning and conveyance work is absolutely reliant upon the essential exercises of banks. There are a few resources in the books of banks, for example, money close by, money at bank, speculation, credits and advances, fixed resources just as different resources[3]. The association of Non-Performing Assets is constrained to credits, advances and ventures. In the event that benefits produce the normal pay without revealing any hazard aside from typical hazard, at that point it is a performing resource and on the off chance that it neglects to create anticipated pay, it is Non Performing Asset.

NON-PERFORMING ASSET is otherwise called Non Performing Loans. It is made by banks itself or money organizations over which reimbursement or premium become unpaid. A credit or advance is an advantage for the banks as the premium and head installment become stream of incomes. Banks essentially make its benefit from the reimbursement of premium. Banks as a rule treat resources as Non Performing Asset in the event that they stay unpaid for now and then[4]. A significant level of NON-PERFORMING ASSET is the significant indication of issue. On the off chance that we see structure the perspective of banks, at that point the credit resource become NON-PERFORMING Asset when it stops to make pay that is without premium commission, or some other levy for over 90 days. NON-PERFORMING Asset is where portion of intrigue or portion on head or both remain unpaid for a time of more than or equivalent to 2 quarters and if they have been able to be "past due". Past due is the unpaid credit for over 30 days. All the suggestions doled out from the NARSIMHAN COMMITTEE to distinguish and diminish the NON-PERFORMING ASSET are to be treated as notional need. Advantage and benefit of banks are essentially impacted due to Non Performing Assets number. On the off chance that we see out the NON-PERFORMING Asset, we may come to realize that inside the year 1995 Non- Performing Assets were Rs 38385 crores and made sense of it Rs 71407 crores in 2011 in open area and similarly inside the year 2001, the Non-Performing Assets were Rs 6410 crores and come to Rs 17972 crores in 2011 in private banks[5].

Non-Performing Assets (NPAs) of Indian System were 0.9% in 2011 but increased to 1.2% in 2012. In case of PSU banks, this percentage has risen from 1% in 2011 and reached to 1.5% in 2012. The NPA stock has also increased during this period. The slippage ratio of banking system which was declining during 2005-08 showed a sudden increasing trend during 2008-12. Government of India has taken various measures to minimize NPA by way of recovering bad debts and strengthening credit appraisal system and pre and post disbursement monitoring system [6]. Along with the speeding up in the growth of gross NPA with lower provisioning coverage, net NPA has also shown a great growth. On comparing public, private & foreign banks, public banks have higher NPA ratio. The State Bank of India (SBI), Punjab National Bank (PNB) and Bank of Baroda (BOB) took the first, second and third rank in large credit portfolio. In 2011, HDFC was seen as a top ranker in maintaining strong Net Interest Margin ratio and lower NPA ratio while at the same time ICICI with the fourth position in large credit portfolio reported the high NPA [7]. (Dr. Hanif U. Kanjer, Dr. Pankaj Trivedi, 2007)

There is a wide impact of NPA over the quality of assets, liquidity, and profitability and even it arises a doubt over the survival of banks. Credit risk also becomes one of the major problems. The problem of sustainability of the banking sector has been there in existence for more than 25 years. At present, Public Sector Undertaking Banks (PSU) is facing more problems than Private Sector Banks (PRSB). Economic and Financial degradation are the two major matters of concerns arising as the impacts of NPA as it signifies adverse investment climate. (Dr. Ujjwal M. Mishra, Jayant R Pawaskar, 2017) [8].

Types of NON-PERFORMING ASSET

(a) Gross NON-PERFORMING ASSET

"GROSS NON-PERFORMING ASSET" is such sort of NPA which has aggregated from earlier quite a long while where there isn't so much as a solitary possibility of recuperation.

(b) Net NON-PERFORMING ASSET

Net NPA is calculated by deducting from the GNPA the total amount set aside for past-due and suspect accounts (BDDR). Banks established the BDDR as a reserve to protect their loan assets in the event that some of those assets fail or become non-performing assets (NPAs) [9]. If NPAs cause significant bank losses, this is a way to protect shareholders' interests.

Net NON-PERFORMING ASSET is Obtained by the Following Factors:

- (a) NPA could be (Gross NPA - Interest due but not yet received)
- (b) Partially or fully recovered from suspense account which has been transferred in NPA. (Vishwanath Panwar & Ayub Ahmas KS, 2016)

NPA Classification for Banks

Banks are required to make sub institutionalization of the non-performing assets (NPA) into the accompanying sort of four general gatherings :

1. **Standard Assets:** Those advantages which have remained non-performing assets for a time of a year or under a year and the risk of the asset are normal are called standard assets.
2. **Substandard Assets:** For a period of longer than a year, non-performing resources are named as unsatisfactory resources. Such sorts of advances have more than standard hazard and the monetary adequacy of the borrower is extremely weak. Banks are regularly arranged to take some hair style on the credit totals which are arranged under this benefit class.
3. **Doubtful Debts:** For a period which is outperforming eighteen months, non-performing resources go under the characterization of suspicious resources. Far fetched obligations itself suggests that the bank is extremely questionable of the recovery of i Abstract The study of non-performing assets (NPAs) and its management in commercial banks has been a crucial topic of research in recent times. NPAs are loans and advances

that are not repaid within the stipulated time, causing financial losses to the banks. The primary objective of this study is to identify the reasons for the rise in NPAs in commercial banks and analyze the various measures employed by banks to manage these NPAs and appropriate suggestions to avoid future NPAs[10]. The study adopts a descriptive research design and uses quantitative research method to collect and analyze data. The data is collected from various secondary sources such as journals, reports, and websites related to the banking sector and surveys from banks staff. The study finds that the major reasons for the increase in NPAs are poor credit appraisal, economic slowdown, ineffective recovery procedures, and interest rates.

The study also finds that banks use various strategies to manage NPAs, such as loan restructuring, fixing interest rates, and securitization. Additionally, banks also employ credit monitoring systems, loan recovery mechanisms, and credit rating agencies to manage NPAs effectively. The study concludes that NPAs are a significant concern for commercial banks and need to be managed efficiently to maintain the financial stability of banks. Banks should adopt a proactive approach to prevent the accumulation of NPAs and continuously monitor their loan portfolio. Moreover, banks should employ effective recovery procedures and adopt innovative strategies to manage NPAs effectively.

Author	Title	Description	Findings	Citation
Sangwan K. & Chaturvedi A. (2018)	“Non Performing Assets management in co-operative banking sector a study of all district central Cooperative banks in	To know the trend and cause of NPA in District Central Co-operative Banks of Rajasthan.	Reason of NPA include willful defaults of the borrowers, non availability of trend staff, and submission of unrealistic projects	(Kanchan sangwan, 2018)
Panwar v. & Ahmed A. (2017)	“A comparative study of NPAs in Private Sectors Banks in India”	Comparative Analysis of 3 public and private banks and suggesting the measures ignoring the future consequences.	NPA affects the profitability, and economy and also it shows the ratio of NPA is more in public than private bank	(Vishwanath Panwar, Ayub Ahmed KS, 2016)
Singh V. R (2016)	“A study of non-performing assets of Commercial banks and its recovery in India”	The study seeks to observe the status of NPA in Indian SCBs, its impact recovery,	Higher NPA in public sector than private sector because of better secured loan policies in private sectors	(Singh V. R. 2016)
Dahiya M. & Bhatia S. J. (2016)	A study of non-performing assets of public sector banks in India- an Intersectoral Comparison	This research paper studied about the reasons behind occurrence of NPA, its management as well as trend analysis of public sector.	This conclude by highlighting the importance of supervision by banking staff over the post sanctioning of loan and making formal as well as informal reports of borrowers showing credit worthiness.	(Monika Dahiya, Supreet Johal Bhatia, 2016)

Mondal S. (2015)	“A study on non-performing assets of Foreign Banks in India”	The study seeks to observe the volume and trend of NPA of Foreign Banks in India in comparison to gross and net advances.	From year 2001-02 to 2012-13, % of NPA to total assets and of NPA to gross & Net Advances of Foreign Banks in India has been decreasing.	(Mondal,2015)
Satpal A. (2014)	“A comparative study of non- performing Assets in public and private sector Banks in the New Age of Technology”	This paper seeks to study the status of NPAs in last 5 years with sample of 3 Public & Private sector banks & make a comparative study.	NPA is more because of large borrowers & comparatively more in Indian banks than in foreign banks & that is a threat for growing economy	(Satpal,2014)
Singh A.(2013)	“Performance of NPAs in Indian Commercial Banks”	To know if NPAs affect current profit, future profit, which lead to loss of long term beneficial Opportunity.	Higher NPA in public sector than private sector because of better secured loan policies in private sector	(Singh A.2013)

Keywords: Non-Performing Assets(NPA), Funds and Investments, Securitization, Credit Appraisal, Stock Prices.ts Advances.

The collection of such kind of advances is extremely defective and there is the least probability that the development entirety can be recovered from the borrower. Such kind of advances put the bank liquidity and notoriety in danger.

Loss Assets

The last classification of non-performing resources is misfortune resources where the development has been perceived either by the bank itself or an external evaluator or internal analyst that the development entirety gathering is foolish, and a bank needs to take an imprint in its bookkeeping report. The Bank, for this circumstance, needs to discount the entire credit whole exceptional or need to make a game plan for full entirety which needs to discount in future.

Need of Research

The financial segment of India involves open, private, helpful banks and outside banks . Be that as it may, among these four kinds, open segment and private segment banks despite everything overwhelm the financial business, with approx 85% of piece of the pie in absolute stores and advances of industry[11]. The banks assume a critical job in Indian economy, by contributing straightforwardly to GDP, activating investment funds and channelizing them into most gainful use . In any case, in the wake of rendering the exhibition and administration, banks despite everything face one of the significant difficulties that are NON-PERFORMING ASSET. It become challenge for the bank to deal with and it become probably the hardest thing. As higher the NON-PERFORMING ASSET, higher the unfavorable effect over the advancement of Indian economy and Indian monetary framework.In this way, the present paper attempts to draw a view on the status of NON-PERFORMING ASSET in business banks and its effect over money related framework and how they attempt to oversee it.

Scope of Study

- The scope of study is limited to Gwalior district only.
- Total public sector banks and private sector banks are selected for study.

Research Gap

The various parts of writing identified with Non-Performing Assets of analysts throughout the year have been gathered and utilized for this investigation. A large portion of the examination and studies are being done on quantitative premise utilizing past figures of Non-Performing Assets and locale of Gwalior and Morena region isn't secured by any investigation.

REVIEW OF LITERATURE

Chatterjee C. , Mukherjee J. & Das R. (2012)	“Management of NPA- a current scenario”	A comparative study of Public, Private and Foreign banks & seek to find relationship b/w NPAs net profits & advances.	NPA affect productivity, deployment policy & decrease in time period to declare a loan as NPA is good to reduce its level.	(Chandan Chatterjee, Jeet Mukherjee, Dr. Ratan Das, 2012)
Prasad G.V.B. & Veena D. (2011)	“NPAs Reduction Strategies for Commercial banks in India”	The study seeks to provide preventive and curative measures for handling NPAs.	NPAs don't contribute in interest incomes but provisions must be made from current profits. Return of assets of banks is also badly affected	(G.V. Bhavani Prasad, D. Veena 2011)
Prasad V.B and Veena D. (2011)	“NPAs Reduction Strategies for Commercial banks in India”.	This paper seeks to study about the strategies to reduce NPA as well as to show the importance & management.	It concluded that the strategies can be increase recovery of NPA, increase in gross loans, decline in fresh slippage and formation of ARC to help prevent NPA	(Prasad V.B., Veena, D.,2011)
Jayasree M. and Radhika R. (2011)	“ Non- performing Assets: Astudy of schedule commercial banks in India”	A study to compare NPA sector wise from 2004-05 to 2008-09	They fund higher level of NPA in new private sector & foreign banks & its negative impact on profits and positive impact of RBI norms on asset quality.	(Jayashree M, Radhika R,2011)
Karunakar M, Vasuki K. & Saravanan S. (2008)	“Are non-performing assets gloomy or greedy from Indian Perspective?”	They figure out the various norms and guidelines formed for the proper functioning of banks	The problem of NPA can be solved with proper credit assessment and risk management mechanism at the market stage of credit consolidation.	(M. Karunaka, Mrs. K. Vasuki, Mr. S. Saravanan 2008)
Das S. (2008)	“Management of NPA in Indian Private sector banks with special reference to Jharkhand”	This research paper tried to find out the reasons behind NPA so as to manage it	It conclude the lack of entrepreneurship And market failures are the reasons of banks as well as borrowers respectively.	(Das,2008)
Bhatia A. (2007)	“NPAs of Indian Public, Private and Foreign sector Banks: An empirical assessment”	This seeks to explore the fundamental factors impacting NPA. A model is used for studying behaviors of NPA of 3 banks	The factor included in the model explain 97.1%(adj. R-square value of regression) of variations in NPAs of Public banks & 76.9% of private banks.	(Gourav Vallabh, Anoop Bhatia, Saurabh Mishra, 2007)

Ragesham C.H. nad Rajendra K. (2007)	“Management of NPAs in Indian Scheduled Commercial banks”	A study for the assessment of causes and consequences of NPA	They suggested that only through string political system, NPAs can make their way to reduction	(Ranjan R., Dhal S.C.,2003)
Shiralashetu and Akash (2006)	“Management of non- performing assets in commercial banks-some issues”	A study on NPA during the period of 200304 bank wise and sector wise	They concluded that priority sector especially SSI sector contributed to NPA where the PSBs contribution is more than private sector banks	(Shiralashetu A.S., Akash S.B., 2006)
Maruli & Krishna (2006)	“Ensuring qualitative credit growth through effective monitoring of advances”	A study t talk about credit growth but not with increase in NPAs	There is a rapid increase in advancing activity because of large surplus funds and investment losses but strict monitoring of NPA is required	(Maruli S., Prasad K.P.S., 2006)
Jain R.K (2003)	“The role of NPA management in the success of financial sector reforms in the Indian economy”	This paper studied about the importance of mechanisms and measures as well as schemes taken by banks to control NPA.	In this upcoming future, besides collateral security and quality relationship with borrower credit risk taking would be one of the important tools for better management.	(Kumar Jain, 2003)
Ranjan R.& Dhal s.c.(2003)	“Non- performing loans and terms of credit of public sector Banks in India; An empirical Assessment”	This paper uses empirical approach to evaluate how the NPAs of banks get affected by three factors i.e. terms of credit, Included risk preferences & macroeconomic shocks	They concluded that designing appropriate lending policies & credit culture, economic & financial factors will be helpful in reducing NPA	(Rajiv Ranjan, Sarat Chandra Dhal, 2003)
Reddy P. K (2002)	“A comparative study of non-performing assets in India in the global context similarities and dissimilarities, remedial, measures”	This paper studied about the mechanism other Asian countries are following to handle NPA and effects of those reforms.	The paper concluded with suggestion that macroeconomics variable and systematic issues should be stressed upon just like foreign countries banks.	(P.K.2002)
Reddy R., Reddy v. &	“Management of NPA in	This paper stands against the	It suggest some ways to reduce NPA which	(Ramachandra Reddy, Vijayalu
Sakuntala (2001)	Public Sector Banks”	international norms of income recognition, asset classification.	are Publication of defaulters list with threat of social exposure, confiscation of properties and imprisonment; the NPA cannot be recovered.	Reddy and Sakuntala,2001)

Balasubramaniam C.S (2001)	“Non- performing assets and profitability of commercial banks in India: assessment and emerging ssues”	The study seeks to do a factual discussion of NPAs and overall profitability in banks.	NPA can be reduced with efforts to improve asset quality in B/S good internal control procedures & it’s a challenge in competitive era.	(C.S.Balasubramaniam, 2001)
Balchandra Nair K.K (1999)	“Banks and non-performing assets”	This paper studied about the NPA and its categorization into gross and net NPA.	Measures like acceleration of credit growth should be adopted. Shortcut methods like granting a new loan to recover the previous only contribute in increasing NPA.	(K.K.1999)
Patel K.V & Kaveri V.S. (1998)	“Non- performing advances in Priority Sector- A study”	This paper seeks to analyze the repayment pattern of borrowers.	They cannot up with 11 different behaviors including full, partial and non-repayment	(Patel K.V., Kaveri V.S., 1998)
Shuklah H.S. (1197)	“Managing NPAs- A professional approach”	This study used a different approach and suggested measures related to leadership activities in the banks.	Managing NPAs require a good leader who can build up a motivated staff and require training & education in this regard.	(H.S., 1997)
Toor N.S (1996)	“NPA Concepts and Evolutionary Process”	This paper focus on the internal as well as external reasons behind NPA.	Lacks of supervision, lack of adequate information of borrowers, government policy are the factors responsible for NPA.	(N.S.1996)
Bhagawat T.K.K. (1996)	“Management of NPA in Banks”	A study to suggest the ways for tracking NPA	He concluded that enhancing the portfolio quality & credit appraisal & supervision can be useful. However loan losses can’t be eliminated fully in practical.	(T.K.K. 1996)
Murugadoss R. (1993)	“Effect of NPA on the health of commercial banks in India”	A study to measures the health commercial banks which was a matter of concern due to the emergence of large sized NPAs.	RBI suggested that performance of banks should be measures by their recovery measures and not by deposit growth & credit expansion.	(R., 1993)
Shinde S.R. & Kaveri V.S. (1992)	“Management of non- performing advances”	A study to prevent loan becoming NPA, identify early signals to adopt required measures.	The study suggested that taking non-legal remedial measures like discounting of debt & decrees, encouraging mergers & acquisitions etc.	(Shinde S.R., Kaveri V.S., 1992)

RESEARCH OBJECTIVES

To find out the reason behind the Non-Performing Assets of private and public banks.

- To know the impact of Non-performing assets on private and public banks.
- To know the measures taken by private & public banks to recover the Non-Performing Assets.

To make appropriate suggestion to avoid future Non-performing Assets and to manage existing NPA in banks.

Research Methodology

Sampling Design

Descriptive design is followed in this study.

Sample size

Sample Size in this study: 4 Banks.

Private Banks and 2 Public Banks are taken sample

Sampling Method

Non Probability sampling (Convenience sampling) is used in this study.

Sample Local

The research is conducted in GWALIOR and MORENA districts.

Sample Selection

The sample selection in this research is limited to private and public banks.

Data collection & Data sources

Primary data and secondary data

Tools to be used for data **collection**

Survey from banks staff

Hypothesis

Objective 1

H₀: There is no significance difference between public and private banks regarding reasons of **NPA**.

H₁: There is significant difference between public and private banks regarding reasons of NPA.

Objective 2

H₀: There is no significant difference between public and private banks regarding impact of NPA.

H₁: There is significant difference between public and private banks regarding management of NPA.

Objective 3

H₀: There is no significant difference between public and private banks regarding management of NPA.

H₁: There is significant difference between public and private banks regarding management of NPA.

Research Procedure

1. Understanding the various research paper related to our topic.
2. To obtain the objective of our research where data has been collected through survey from bank staff
3. The question of survey is divided into 2 parts about the performance or non-performing of assets
4. The data is analyzed by t-test
5. Data adequacy has been checked through cronbach's Alpha value

DATA ANALYSIS & INTERPRETATION

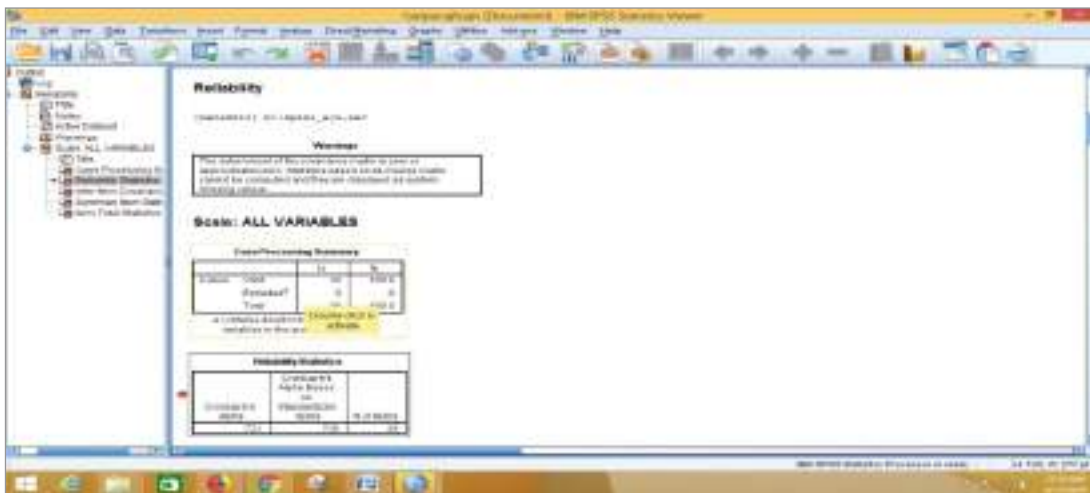
Reliability Test

		N	%
Ca	Valid Exculded	30	100.0
	Total	0	.0
	ses	30	100.0

Case Processing Summary

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Item	N of item
.721	.729	29

Reliability Statistics



Reliability is that characteristic of a test tool which when measures shows the same results consistently or dependably every time.

As shown in above tables and figure, the test for reliability is done considering the 30 responses out of whole sample and done using the Cronbach's Alpha value.

The reliability score lies between 0.70-0.79 as shown above indicating an adequate reliability of test.

Objective 1

T-test Table

	Variables	Mean Private Public		Standard Deviation Private Public		t-value	p-value
1	Default by customer	4.1923	4.1154	.74936	.86380	.328	.746
2	Lack of supervision	3.2308	3.2692	.86291	.87442	-.189	.852
3	No proper appraisal	3.0769	2.8846	1.01678	.99305	.739	.467
4	Political influence	3.3077	3.2692	1.25759	1.25085	.103	.919
5	Change in government Policy	3.3077	3.0769	.97033	.93480	.923	.365
6	Diversification of funds	3.5769	3.8462	.98684	.83390	-1.022	.317
7	Competitive Pressure	3.3077	3.3462	1.01071	.89184	-.140	.890

8	Inadequate current credit appraisal system	2.8077	2.7692	.98058	.95111	.137	.892
9	Inadequate mechanism to gather and disseminate credit information	3.0385	3.2308	.91568	1.03180	-.723	.477
10	Relaxation of credit norms due to competitive Pressure	2.9231	2.8846	.79614	1.07059	.153	.879

Interpretation

From above table, it can be noticed that there is no significant difference between the opinions given by bank managers of private and public banks regarding reasons for having NPA as the p-value are greater than significance value i.e. $0.05(p > \alpha)$. Thus H_0 is accepted.

As it can be seen from table no. 3, default by customer in repayment of loan and diversification of funds by the borrowers have the highest and second highest mean respectively as compared to other variables.

However, inadequate current credit appraisal system and relaxation of credit norms due to the competitive pressure posed by emergence of local and international banks do not have that much significant mean in both as well as public sector

Objective 2

T-test Table

S.no	Variables	Mean Private Public		Standard Deviation Private Public		t-value	p-value
1	Decline reserves and Surplus	3.6923	3.7308	.88405	.77757	-.143	.887
2	Decrease in profitability	3.7308	3.8462	1.18516	1.18970	-.500	.622
3	Decrease in stock market	3.3077	3.4231	.97033	.90213	-.400	.664
4	Loss of capital	3.7308	3.5769	1.07917	1.06482	.625	.538
5	Increasing spread	3.5000	3.5000	.76158	.81240	.000	1.000
6	Liquidity of banks and income generating Capacity	4.0385	4.0000	.77360	.89443	.182	.857
7	Interest rate	3.2692	2.8462	1.00231	1.04661	1.520	.141
8	Attitude towards fresh credit proposal	3.8846	3.7692	.71144	.81524	.531	.600
9	Dependency on subordinated debt at high cost	3.7692	3.6538	.86291	1.01754	.440	.664

Interpretation

From above table, it can be noticed that there is no significant difference between the opinions given by bank managers of private and public banks regarding impact of NPAs over banks as the p-value are greater than significance value i.e. $0.06(p \geq \alpha)$. Thus H_0 is accepted.

According to the survey responses, it has been found out that liquidity of banks and the income generating capacity of banks are the factors having the highest mean in both private as well as public sector. At the same time the bankers' attitude towards the fresh credit proposal also has significant means in private sector but it's the profitability in public sector.

Whereas as it can be seen from the above table that the factor 'interest rates charged by banking sector has comparatively less mean. Also, the factor 'stock price of banks' does not show the significant mean in both sectors.

Objective 3

T-test Table

S.No.	Variables	Mean Private Public		Standard Deviation Private Public		t-value	p-value
1	Report frauds to RBI	4.2692	4.2692	1.31325	1.28243	.000	1.000
2	Increasing the collateral requirement	3.8462	3.5769	1.08415	.80861	1.000	.327
3	Sound assessment mechanisms	3.8846	4.0385	1.1487	1.11286	-.509	.615
4	Compromise on settlement schemes	3.4231	3.3462	.85665	.93562	.337	.739
5	Releasing willful defaulters list	4.4615	4.3077	.76057	.67937	.724	.476
6	Improving loan appraisal system	3.9231	4.0000	.79614	.56569	-.402	.476
7	Maintaining relationship with borrowers	3.8077	3.9231	.49147	.79614	-.618	.542
8	Providing loan according to quality of borrower	3.3846	3.6538	.94136	1.01754	-1.045	.306
9	Promoting corporate governance	3.4615	3.5000	.76057	.98995	-.166	.870
10	Involvement of chamber of commerce in decision making	3.5000	3.6154	.81240	.85215	-.461	.649

Interpretation

From the above table, it can be noticed that there is no significant difference between the opinions given by bank managers of private and public banks regarding measures taken by them for management of NPA as the p-value are greater than significance value i.e., 0.05 ($p \geq \alpha$). Thus H_0 is accepted.

Here, we can interpret that releasing the list of willful defaulters publicly is the measures having the highest mean in both private as well as public sector and reporting frauds to RBI is having the second highest mean in this list of measures adopted and that too in both sectors. However, it can also be noticed that in the case of private banks, in the list of measures to manage NPA that is having the lowest mean is providing loans i.e. securitization, fixing interest rates or processing fixing charges according to the quality of borrowers. While in public sector, it is the compromising on settlement schemes, which is having the least significant mean.

CONCLUSION

Major Findings

Objective 1

After analyzing the table, we came to conclusion that the major reason behind the rapid increase of NPA is due to willful default of borrowers in both the sectors taken under study.

Whereas inadequate current credit appraisal system and relaxation of credit norms due to the competitive pressure posed by emergence of local and international banks are the factors which contribute least to the occurrence of NPA. Thus, we can say that NPA is increasing continuously due to external rather than internal factors.

Objective 2

From the t-test table of impact of NPAs, we found out that liquidity of banks and the income generating capacity of banks are the factors that are mostly affected due to NPA in both sectors.

1. Meanwhile, bankers' attitude towards fresh credit proposal is appeared to be affected due to NPA in private sector whereas profitability gets affected in case of public sector.

On the other hand, the interest rates charged by banks do not get that much affected due to NPA. Also, the factor 'stock prices' being the second lowest is not counted as a significant impact of NPA.

Objective 3

1. Now, after being analyzed, t-test tables of management of NPA shows that releasing the list of willful defaulters publicly is the highest rated measures being adopted for the management of NPA while reporting frauds to RBI is accepted as the second most productive measures for managing NPA.

2. On the other side, we can see that providing loans i.e. securitization, fixing interest rates or processing fixing charges according to the quality of borrowers, in the list of measures is the least accepted or adopted one. While , compromising on the settlement schemes is found as not so affective measures to manage NPA so as t being adopted.

Major Recommendations

1. After interpreting and analyzing the data, it is recommended that the banks should make strict loan policies so that it can help while sanctioning a loan and there should be a strict and throughout study of the background of borrowers before disbursement of loan.
2. Another recommendation is to control the liquidity of banks either by charging the higher rate of interest on loans so that it will control the excess credit flow in market.
3. Also, RBI can take efforts to revise its quantitative measures especially its reverse repo rate to control NPA

Limitation of the Study

1. As we know that this research paper is conducted to check the features of banking sector regarding NPA which totally represent about the quality of banking system and for this we have conducted a qualitative survey which give rise to the risk of business while giving the responses.
2. Due to lack of time and money, only one district has been taken for study.
3. Another limitation is less response out of total sample due to the busy schedule of banking staff (closing and audit week) and non-cooperative behavior of banking officials.

Scope for Further Research

1. The study can further be conducted in various metropolitan cities to find out the major impact over the economy.
2. All categories of banks can be focused altogether

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The Impact of High-Performance HR Practices on Staff at Private Universities

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▶ ABSTRACT ◀

An educational institute cannot flourish and progress without teachers as teachers are considered to be the most important pillar of an educational institute. As stated above the chances of progress is only possible with the help of teachers but what if teachers are not satisfied or happy with their job or disappointed due to any factor, in that case what will be the impact of these factors on the teaching style, attitude, emotions and creativity of the teacher overall what will be the impact on teachers' self-efficacy and perception is the matter of point or study in this research. Understanding of the root cause which leads to reduction in motivation for continuing the job of teaching through this research will help one to understand the future consequences of his current applied techniques not only that this research will also help one to avoid those factors which may lead to reduction in self-efficacy and negative perception for the organization.

Keyword: *Self-Efficacy, Perception, Organizational-Citizenship Behaviour, Self-Commitment, Intelligible System, Eraction, Inferential Statistics.*

INTRODUCTION

Educational institutions need teachers. Teachers teach students and develop learning environments that meet their needs. Diverse roles vary between educational institutions and academic levels for educators. To feel work satisfaction and gain confidence in their professional duties, teachers need thorough training, ongoing support, and incentives. Ugandan teachers experience a lack of motivation, poor working and housing conditions, limited personal growth, and low pay [1]. The above issues have lowered teaching standards, forcing many teachers to quit. The amendment allows people to keep working or leave an organization. The writers planned to examine

the salesperson's methods to discover whether they planned to leave their job, pursue other career paths, or stay in their current position while actively seeking a change. The participants accounted for the negative effects of low self-efficacy and perception on sales target attainment. Due to poor working circumstances, several instructors resigned, leaving a scarcity of substitutes. With a 60.5% vacancy rate, the above openings have been rising annually. Organizations should develop "maintenance problems" to let their best workers leave. A company's training and investment time is lost when its staff diminishes. The remaining employees may feel less secure in the organization. The cost of replacing departing staff adds to organizations' high costs. This issue could weaken organizational strength and make it harder for educators, particularly Gwalior teachers, to teach children [2]. This study also reveals how teachers' self-efficacy and job satisfaction affect their career choices. This study examines the factors that affect teachers' self-efficacy, which assesses their perceived professional competence.

Teacher Self-Efficacy

Self-efficacy is a person's confidence in their capacity to complete a task. Teachers' self-efficacy is their belief in their abilities to help students learn. Self-efficacy affects teachers' methods and students' learning. Self-efficacy helps teachers feel good about their jobs and gain confidence. Self-efficacy affects teachers' behavior and educational institution expectations [3]. Teachers are vital in school because they help students understand the school's goals. Self-efficacy affects teachers' cognitive, affective, behavioral, and professional engagement with teaching. Additionally, it affects educators' cognitive processes, emotional states, behavioral tendencies, and professional practices. Self-assured teachers work hard and behave well in class. Teachers who believe they can improve their students' learning are more likely to try new methods, create effective organizational systems for themselves and their students, and stay positive and enthusiastic [4]. Teachers who feel incompetent are more likely to experience occupational stress, which impairs cognitive clarity and perceptual sharpness. When people are unhappy with their jobs, they're more likely to quit in education. The self-efficacy of teachers affects their understanding of their major responsibilities, their capacity to plot and coordinate, and their ability to communicate with students.

Perception

Perception is an individual's subjective appraisal of their job satisfaction, both internal and external. Educators feel accomplished, curious, and challenged. The individual's cognitive reflections on personal matters are included. This means that a positive work attitude increases job satisfaction, while a bad attitude decreases it. Job satisfaction increases job retention. This shows that perception does not increase sales. The company's operational history and alternative job prospects limit the decision to cease employment. Thus, companies with high employee satisfaction are more productive [5]. The overall impression includes people's pleasure across domains. The widespread feeling among people about their jobs or careers indicates job satisfaction. This remark suggests that inherent elements, not external ones, cause happiness. Remuneration, fringe benefits, job classification, performance-based incentives, retirement plans, teaching allocations, career advancement chances, supervisory dynamics, and colleague interactions might affect perception.

Educators are trained to provide high-quality education, give effective feedback, optimize academic performance, create positive working conditions, promote collegiality, and create a conducive school environment. The American Science Research Journal covers scientific research technologies. The cause of instructors' discontent affects students' academic performance and makes them want to leave teaching. Deeply comprehending educators will always prioritize instructional material. Perception affects employee engagement, absenteeism, turnover intentions, and sales performance. It also strongly influences instructors' job choices. A teacher's decision to quit and stay or leave their school depends on their job happiness.

This assertion is true if the task doesn't meet the teacher's sales goal. Educators are willing to forgo retirement benefits and other benefits to find suitable jobs. Employment requires collaboration with coworkers and superiors, adherence to organizational procedures and laws, performance targets, and often substandard conditions. This

suggests that job satisfaction is linked to teacher retention, while job dissatisfaction indicates a preference for easier-to-enter careers [6]. To reduce teacher turnover, identify work satisfaction variables. Teacher perception is influenced by internal factors, external satisfaction sources, and demographic data. The teacher's expectations and job results also impact perception. Internal variables determine a teacher's future, while external forces alter their perception and passion to the job.

Job Satisfaction

Employment satisfaction is how happy someone is with their employment and its perks. In education, occupational satisfaction includes a sense of accomplishment, personal engagement, and stimulating activities. It's a set of ideas a person values and thinks cognitively relevant. This means that a positive work attitude increases job satisfaction, while a bad attitude decreases it. Job security increases job satisfaction, since individuals with a decreased risk of job loss are happier. This suggests no link between sales performance and job satisfaction. Issues like the company's longevity and the ability to find new work might further complicate the decision to change careers. Higher employee satisfaction leads to higher operational efficiency. The idea of overall job satisfaction includes subjective ratings of numerous employment aspects[7]. The general attitude toward work reflects job satisfaction among employees. This remark implies that intrinsic rather than extrinsic variables determine an individual's contentment. Compensation, employee benefits, employment status, performance-based incentives, retirement plans, job assignments, career advancement prospects, supervisory relationships, and colleague dynamics affect job happiness.

This phrase applies if the occupation fails to meet the teacher's sales goal. When educators find jobs that meet their needs, they may forgo retirement benefits and other perks. The position requires communicating with coworkers and superiors and following company policies. Compliance with performance criteria and adaptability to poor working conditions. Job happiness is favorably associated with teaching employee retention, while job discontent is positively connected with a preference for easier-to-enter occupations [8]. Job satisfaction variables must be identified to reduce teacher turnover. Teaching job satisfaction is affected by internal and external factors, demographics, and the alignment between instructors' goals and job outcomes. Internal factors affect teachers' career prospects, whereas external influences affect job satisfaction and dedication to the profession.

Intention to Leave

The intention to leave is essentially the feeling that the employees are leaving the profession, also known as "the intention to make a profit. The intention to leave, along with commitment and job satisfaction, is one of the most common predictive factors of actual sales (job abandonment). The intention to leave is inversely proportional to work performance, as the high performance of the teacher leads him to be motivated internally and externally, which increases job satisfaction.

Job-Related Factors

Work-related factors are specific characteristics of work that influence the teacher's intention to leave work, essentially wages, working conditions and work experience. This group of work-related factors emerged from the theory of human capital. Human capital theory classifies these factors based on the benefits of human capital as wages based on monetary benefits, working conditions with non-monetary benefits and professional experience in professional development.

Monetary Benefits

Monetary prizes directly influence a person's decision when they decide to give up work. The monetary benefits of this study are wages, bonuses and performance appraisals. The monetary benefits directly affect the teacher's intention to leave the profession, as an employee's salary is the most attractive reward that motivates the teacher to do his best while teaching students. Higher wages with an additional performance-based bonus reduce the likelihood of sales.

Non-Monetary Benefits

Non-monetary benefits such as working condition at the workplace. The working conditions for this study indicate the organizational climate in a particular educational institution. The work environment of the educational institution includes administration support services, staff, students, parents, cooperative behaviour lesson control, student behaviour workload, security, etc. workplace working conditions have demonstrated the influential predictors of teacher turnover. If the school/college work environment is of a high standard, more teachers would like to remain happy for longer.

Professional Development Benefits

The advantage in job development is the last factor linked to work; the VET experience is the predictor that influences decisions on staff turnover. The benefits of CPD have focused on on-the-job training, which has accumulated more company-specific human capital than generic human capital. In this study, the VET experience referred to teachers' assessments of VET programs they had participated in in order to improve professional competence and adapt to school culture.

Individual Teacher Characteristics

The individual characteristics of the teachers are essentially the moderation variables to examine the differences in the relationship between work-related factors, job satisfaction, intention to make a purchase and actual sales. In this study, the teacher's characteristics include gender, race, ethnicity, educational level, type of certification and teaching experience. teachers with advanced degrees and certificates are more likely to change schools or leave the classroom.

Private University Characteristics

The characteristics of the university, the type of university, the location of the school, the size and demographic data of the students are the most important characteristics considered for the university in this study. teachers with a high percentage of low-income students with low incomes and minorities are more likely to leave their profession. Further research has been undertaken to obtain a complete and in-depth understanding of the factors influencing employee satisfaction and teacher self-efficacy and to influence the teacher's intention to quit the job. In this study, the teacher's satisfaction, the teacher's self-efficacy are the independent variables that concern the dependent variable of the teacher's intent. The facet approach is used in this study to assess the satisfaction of teachers by subscribing to facets such as remuneration, promotion, marginal benefits, rewards, operating conditions, employees, type of work, communication.

Because these face help to increase or reduce job satisfaction[9]. A good apprenticeship gives satisfaction and motivates the teacher to do his job quite well, in contrast to the work- intensive teaching work that puts a strain on teachers. This stress has a negative effect on satisfaction and leads the teacher to leave work or change jobs. The teaching was classified among the highest stress professions.

Overall, human capital theory has indicated that turnover occurs when the expected benefits of changing jobs over those of remaining relatively high. It was certainly expected that teachers would leave a job with relatively low wages, poor working conditions and lack of training opportunities for universities with better and more attractive opportunities[10]. Furthermore, the theory of social learning and the theory of job satisfaction suggest that the psychological factors associated with the work environment, such as affective experience, attitudes, values and satisfaction, are also an important level in the decisions of sale. Teachers who receive less emotional / emotional support and less satisfaction are more likely to leave work. The research was conducted by distributing questionnaires to teachers. Subsequently, the entire report was guided through the data collection process and the careful interpretation of the data to obtain actual analysis results.

LITERATURE REVIEW

Strategic Human Resource Management Approaches to Human Resource Practices

Multinational firms use these tactics to improve worldwide operations. SHRM improves company performance. Most Strategic Human Resource Management (SHRM) researchers agree with Barney's research-driven view of human resources' impact on organizational performance. The resource-based concept holds that an organization's resources can give it an edge over competitors (11). This shift in perspective involves moving from external considerations and strategic positioning in a competitive market to internal exploration of how the company might use its own resources to gain a competitive edge.

Employees Perceptions of HR Practices

These human resources methods should immediately affect employees' behavior and cognition. The literature suggests that in 1997, managers' employee evaluations were influenced by HR management. The behaviors and attitudes of coworkers can impact HR practices. It's important to analyze how affective organizational commitment, organizational citizenship conduct, desire to stay, and absenteeism affect attitudes and behavior.

High Performance HR Practices and Effective Commitment

Three ratios affect normative confidence and extension certainty. This excellence is maintained by diligently studying these topics. The evidence shows that affective commitment is strongly linked to positive job outcomes including reduced absenteeism and increased organizational citizenship. More importantly, it bridges high-performance HR practices with organizational activities. Previous research has supported the SHRM method, boosting its repute [12].

Organizational Citizenship Behaviour

“Different behaviour that is subtle, not in a straight line or overtly known by the formal reward system, and in the total promotes the competent and actual operational of the organization”

Intent to Remain with the Organization

High performance HR practices have been empirically linked to retaining and revenue. The underlying machines of this connection remain uncertain. He conversation observed behaviour as a negotiator revenue relation. Even though, Designed HR administration research has well-known a important suggestion between high-performance HR practice.

Hypothesis

The SHRM books cover two main concepts that drive most research and activities in the field.

1. Interconnected intelligent HR systems give better performance results than personalized approaches.
2. HR tools vary in validity. This essay emphasizes the importance of building close relationships between employees and supervisors, which affects workers' diverse attitudes and performance. Human resource practices improve employees' emotional states and help organizations achieve their goals, according to extensive research. The purpose of this study is to determine if HR initiatives improve job happiness and productivity.

HR Practice

Implementing a human resource system improves an organization's performance, helps employees gain skills, and helps the firm maintain a competitive advantage. Human resources practices include building a company's culture.

Performance

HRM practices affect employee happiness, trust, loyalty, and organizational equity, according to many scholars. Management's reimbursement technique motivates workers to improve performance and output. Compensation for excellent performance improves job performance but lowers salary.

Attitude

A person's perception or comprehension is their "sense of" something. It includes cognitive and emotional aspects. The ability to influence and mold individuals' competences, mindsets, and actions to help them fulfill their tasks and achieve the organization's goals is called attitude [13]. A firm's HR strategy can boost employee work satisfaction and commitment.

Objective of Research

- To examine the relationship of teachers' commitment and job perception with intention to leave.
- To examine relationship between the teacher self-commitment and job perception.
- To examine the relationship between the positive relationship organizational citizenship-behaviour absenteeism and intention to leave.

Universe of study

Universe covers the whole defined field which the study is based. The present was cover in Private university Central region.

Sample size

It is defined as the process of selecting the number of observations of the respondent to be included in the statistical sample. In this research study, we take a sample of 200.

Sample Method

The sampling method is a process for selecting sample members from a population. In this research report, we use practical topics selected for their ease of accessibility and proximity to researchers. Sampling method is a non-probable sampling method. Out of various sampling methods, Convenience sampling method is used because it is both the time saving as well as easy method of picking up sample.

This is the most popular and simplest method of sampling.

Sample locale

In this study, we cover the Gwalior region for study, or in other words, we can say that the data is collected by the respondents. The example localization briefly describes the position of the study.

Contact Method

There are different types of contact methods, but in our research report we use the personal contact method to fill in the respondent's questionnaire and collect data in the Gwalior region.

Data Collection & Data Sources

We use primary data as a data source. They consist original information collected for specific research. The primary data for research study was collected by direct survey to obtain a mainly structured questionnaire. We use a data collection questionnaire that will be analyzed. The questionnaire is a series of questions in which we have adopted a series of questions to learn about the response of the respondent to data analysis.

Data Collection & Data Sources

Data source	Primary data
Data collection instrument	Questionnaire
Data collection procedure	Questionnaire filled by respondents physically

1. In our research study, the survey questionnaire was completed using convenient sampling in the Gwalior region.
2. Secondary data is data that already exists. We have collected secondary data from secondary sources
 - From website like, www.google.com and another related web pages
 - Books, journals and research papers.

Research Design

Every undertaking begins with a strategic plan. Before starting a task, it summarizes the complete work. Exploratory enquiry is used here.

Questionnaire Design

The questionnaire is a structured technique used to collecting primary data in a survey.

DATA ANALYSIS & INTERPRETATION

Reliability Test

The dependability test evaluates the questionnaire's correctness. Stability tests the balance's multiple components' compatibility and integration. This suggests a correlation between the variables. Check sure all questionnaire components are uniform. The technical data sheet is verified using SPSS version 20. For the reliability test, all scaled data sheet components are chosen. Table 4.1 shows technical data sheet reliability.

Reliability of Teacher Commitment

Case Processing Summary

		N	%
Cases	Valid	200	100.0
	Excluded	200	.0
	Total	200	100.0

Reliability Statistics

Cronbach's Alpha	NO of Items
.915	11

Table 4.1 shows Cronbach's Alpha at 0.915. It simply states that our survey is 91.5% accurate enough for further research. This 91.5% dependability comes from 11 scaled questionnaire components. Thus, these 11 factors are linked 91.5%.

Reliability of Teacher Job Perception

Case Processing Summary

		N	%
Cases	Valid	200	100.0
	Excluded	0	.0
	Total	200	100.0

Reliability Statistics

Cronbach's Alpha	Based on Standardized Items	No of Items
.908	.885	29

Table 4.2 shows Cronbach's Alpha at 0.908. It simply states that our questionnaire is 90.8% accurate enough for further research. This 90.8% dependability is based on 29 survey scaled parameters. Thus, these 29 factors are 90.8% linked.

Reliability of Intention to Leave

Case Processing Summary

		N	%
Cases	Valid	200	100.0
	Excluded	0	.0
	Total	200	100.0

Reliability Statistics

Cronbach's Alpha	Based on Standardized Items	No of Items
.931	.958	4

Table 4.3 shows Cronbach's Alpha at 0.931. Our poll had 93.1% accuracy, indicating enough data for further study. The evaluation's four scaled questions yielded 93.1% reliability. These four criteria are 93.1% correlated. Our numbers exceed the 0.6 criterion, ensuring their dependability. To reach our first research objective, the study may proceed to further investigation after a preliminary analysis. The research and interpretation will now follow the goals.

To understand how an independent variable is related with dependent variable, regression analysis has been used in this research.

Objective 1: To Examine the Relationship of Teacher's Commitment and Job Perception with Intention to Leave.

Regression Analysis

Regression analysis tells how independent variables impact the dependent variable. In our case, the relation of independent variables with the dependent variable is computed using regression analysis in SPSS.

Table 4.1.1 R Square

Model Summary

Change Statistics										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.926 ^a	.857	.855	.456	.857	588.989	2	197	.000	3.060

(a) **Predictors:** (Constant), TSE , TJF

(b) **Dependent variable:** ITL

In this figure, the value of r square is 0.857. The independent construct shows 85.7% of relation. The r square value lies between 0 and 1. The degree up to which r square value is closely to 1, regression model is highly fit. In our study, it is 85.7% which shows a good percentage of relation.

Durbin Watson statistic is to test for autocorrelation in the residual from a statistical regression analysis the Durbin Watson statistic will always have a value from 0 to less than 2.0.

Table 4.1.2**Coefficients**

Model		Unstandardized Coefficients	Std. Error	Standardized Coefficients Beta	T	Sig.	Collinearity Statistics Tolerance	VIF
1	B	6.372	.175			.000		
	TJF	-.306	.096	-.182	-3.183	.002	.222	4.000
	TS E	-.894	.067	-.761	-13.302	.000	.222	4.000

a. Dependent Variable: ILT

STEP 1: Hypothesis

H1: There is statistically significance relationship between teacher commitment and teacher perception with intention to leave.

STEP 2: Significance level

$$\alpha = 0.05$$

STEP 3: Conclusion

STEP 4: Since p-value=0.002<0.05, value of p is less than 0.05 hence, the null hypothesis rejected.

STEP 5: Since p value is 0.002 which is less than 0.005, hence there is enough evidence to says there is statistically significance relationship between teacher commitment and teacher perception with intention to leave.

From the above output, regression equation is: $ITL = 6.372 + (-0.306) (\text{Perception})$

$ITL = 6.372 + (-0.894) (\text{teacher commitment})$

Objective 2: To investigate the association between teacher commitment and perception.

Correlation Analysis

Correlation analysis determines the presence, degree, and positivity of a link between two variables. A scientific study of several connections is correlation analysis. Negative to positive on the scale. When r approaches zero, variables are uncorrelated. Positive r indicates that the variable has increased or that the two components are positively correlated. If r is negative, one variable rises while the other decreases, showing no link between the two variables.

Correlations

		TJS	TSE
TJS	Pearson Correlation	1	.502**
	Sig. (2-tailed)		.000
	N	200	200
TSE	Pearson Correlation	.502**	1
	Sig. (2-tailed)	.000	
	N	200	200

Correlation significant 0.01 level (2-tailed)

Significance value is $0.000 < 0.05$ therefore it can be stated that null hypothesis “there is no significant association between teacher commitment and perception” will get rejected. we can say that there is statically significance association between teacher commitment and perception will get rejected.

Objective 3: To examine the effect of organizational citizenship behaviour on perception and intention to leave.

ANOVA analysis

For the analysis of objective third which is the assessing of significance level of difference between perception and intention to leave via various organizational citizenship behaviour we will use the ANOVA test which is done on the SPSS.

Hypothesis will be for the organizational citizenship behaviour are:

H0: There is an no significance difference between male and female perception towards perception and intention to leave.

H1: There is a significance difference between male and female perception towards perception and intention to leave.

ANOVA

TJS	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.335	4	.084	.161	.958
Within Groups	101.260	195	.519		
Total	101.595	199			

As we see that table shows the analysis of different dependent component with cities group as organizational citizenship behaviour and in this analysis it shows that the significance value is .958 which more than .05 it indicates that it cannot be accepted hypothesis which means that there is significant difference between the male and female regarding intention to leave with respect to their cities.

So the null hypothesis is rejected by considering cities as organizational citizenship behaviour in this case.

ANOVA

TJS	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.428	4	.107	.101	.982
Within Groups	207.072	195	1.062		
Total	207.500	199			

As we see that table shows the analysis of different dependent component with cities group as organizational citizenship behaviour and in this analysis it shows that the significance value is .982 which more than .05 it indicates that it cannot be accepted hypothesis which means that there is significant difference between the male and female regarding intention to leave with respect to their cities. So the null hypothesis is rejected by considering age group as organizational citizenship behaviour in this case.

T Test

The T test is one type of inferential statistics. It is used to determine what ether there is a significant difference between the means of two groups. With all inferential statistics, we assume the dependent variable fits a normal distribution.

(Teacher Perception)**Table 4.3.3****Group Statistic**

	Gender	N	Mean	Std. Deviation	Std. Error Mean
TJS	Male	114	3.56	.704	.066
	Female	86	3.52	.731	.079

Independent Samples Test

		Levene's Test for Equality of Variances F	Sig.	t-test for Equality of Means t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
TJS	Equal variances assumed	.375	.541	.373	198	.710	.038	.102	-.164	.240
	Equal variances not assumed			.371	179.492	.711	.038	.103	-.165	.241

Independent samples t tests were computed to examine the effect of teacher perception. The result indicates that the significant value is .541 thus the hypothesis cannot be accepted which means that male and female have difference towards perception.

(Teacher commitment)**Table 4.3.4****Group Statistic**

	Gender	N	Mean	Std.Deviation	Std. Error Mean
TSE	Male	114	3.56	.978	.092
	Female	86	3.53	1.081	.117

Independent Samples Test

		Levene's Test for Equality of Variances F	Sig.	t-test for Equality of Means t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
TSE	Equal variances assumed	2.378	.125	.181	198	.856	.027	.146	-.262	.315
	Equal variances not assumed			.179	172.772	.858	.027	.148	-.266	.319

Independent samples t tests were computed to examine the effect of teacher commitment. The result indicates that the significant value is .125 thus the hypothesis can be accepted which means that male and female have difference towards teacher commitment.

CONCLUSION

University throughout Gwalior and other cities are challenged to keep high-performance teachers. Knowing why teachers want to give up teaching can contribute to a better bond. Although teachers have given several reasons to leave the teaching profession or leave the teaching profession, in this study I focused on three factors that help teachers stay in the workplace: perception and self-efficacy implementation in schools and universities.

In this project, I used the positive aspects of my research data. He showed that the teachers were satisfied with their colleagues and were proud to work with the necessary components of an effective SPS: teamwork and collaboration. For this project study an evaluation system was developed that allows interested parties to verify the effectiveness of cooperation between universities and school staff. The general objective of the evaluation plan of this project study was to answer and questions with the implementation of the SPS, the teachers felt that their concern, which reduced the intention of the teachers to leave.

The organizational framework of nonfiction work interactions has been extensively discussed. Scholars have mostly examined individuals when drawing conclusions about work relationships. Alternatively, there has been little research on how employment ties affect people. This study synthesizes material on psychological contracts and human resource practices to show how they shape individual-level constructs like psychological contracts. Positive attitudes and exceptional behavior keep employees in good standing with the organization. Agentive devotion helps some teachers form positive relationships.

LIMITATION OF STUDY

- The time period given to us for the completion of the project was short in such a short span of time it is difficult to complete any project in detail
- We sometime denied disclosing some important financial matters, which can be helpful in this study.
- Limited area of study: we are not able to get the data from other cities and town.
- Sometimes incomplete information might be provided which needs to be cross checked and verified.
- In the field of methodology there is lack of knowledge.
- Unavailability of more data.
- Time constraint.

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A Study on How Students Use Digital Learning Platforms in the Ed-tech Sector

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▶ ABSTRACT ◀

Technology is making huge changes every day in the life of people and based on that people are reacting to it. Online learning platform is used to learn new things basically related to studies but at the comfort of your home. Digital learning is focusing on providing wide range of courses related to every educational background. Most of the users which use digital learning as a medium for learning are interested in short duration courses. Major players in online education providing company: Byju's, Vedantu, Unacademy, Physics Wallah Etc. There are many forms of data collection – mail, internet, data base, questionnaires, interviews, and etc. . The questionnaire was developed based on 5 likert scale and the respondents were asked to think about the digital platform to which they can relate well. Thus it can be concluded that many respondents consider several factors before using a platform. The study also showed that Price also impacts Digital platform. The digital learning helps them in learning concepts in a lot more easier way than compare to classroom study.

Keywords: *Technology, Ed-tech, Entrepreneur, Subscription, Fragmented, Risk Management, Traffic, Safety.*

INTRODUCTION

There is an old saying “Nothing is permanent except change” here it means technology is making huge changes every day in the life of people and based on that people are reacting to it. Soon after reliance take over the telecom market the average internet user in India also seen a rise, as any business is nothing but a opportunity for something new, here comes Learning with the help of internet, it is true that these were also available before Jio but after jio there has been huge growth in digital learning sector.

Online learning platform is used to learn new things basically related to studies but at the comfort of your home, the idea of anywhere study was so good that it opens the door for many entrepreneur in this particular sector today the ed-tech industry is worth more than \$ 500 billion across the globe[1].

Emerging Trends in Digital Learning

Nowadays digital learning is focusing on providing wide range of courses related to every educational background such as science, arts, commerce etc, not only that they have also started giving material for preparation exams such as medical entrance and engineering entrance exams. Along with that subscription fee charged by such platforms is economical in nature[2].

Most of the users which use digital learning as a medium for learning are interested in short duration courses like three months, six months, or for a year, these courses can be of many types such as gaming, language, tourism, etc based on the performance of an individual certificates are provided which will work as a symbol of completion of a particular course.

Major Players

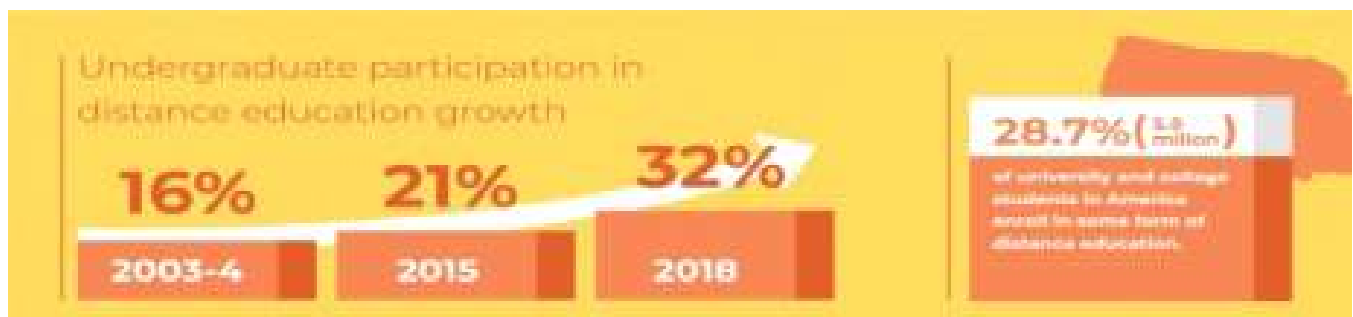
1. **BYJU'S:** An Indian online tutoring firm founded in 2011 by Byju Raveendran at bengaluru, Shahrukh khan is brand ambassador for the company, its revenue till date is 520 crores INR
2. **VEDANTU:** It was also founded in 2011 at bengaluru, an online tutoring firm with revenue of \$ 280 million.
3. **UNACADEMY:** founded in 2016 by an Ex IAS Officer Roman Saini, it is fastest growing online platform with a revenue of \$ 300 million.
4. **Extra Marks Education:** Founded in 2007 by Atul kulshreshtha, it has \$ 28 million as revenue till date.

Online Industry in India.

The online education market in India, which was worth INR 39 billion in 2018, is expected to grow at a CAGR of 43.85% between 2019 and 2024, reaching INR 360 billion. A wide range of study materials, flexibility, and ease of learning have all contributed to the industry's growth.

India's highly fragmented online education market has greater long-term growth potential, with 3,500 edtech start-ups operating. Because of the country's large population, many foreign players are currently making inroads.

Facts & Figures



LITERATURE REVIEW

CarloDeMedio^a et al. (2020) This article inspired the development of a learning management system add-on. A practical experiment is also shown. The significance of new technologies in education has never been overstated.

Cedric Bheki Mpungose . (2020), This paper looked at how students can learn using social media platforms such as WhatsApp in addition to e-learning platforms. According to the studies, students learn more effectively even when they do not use a personal e-learning platform that combines Moodle and WhatsApp[3].

NS Alseelawi, EK Adnan, HT Hazim, and H Alrikabi, (2020), This paper will outline a strategy for developing an e-learning platform that will facilitate communication between instructors and students at Iraqi universities while also providing a number of benefits for addressing some issues with traditional education[4].

RJM Ventayen, KLA Estira, MJ De Guzman, (2018), This paper looked at the role of electronic learning in training and education in the twenty-first century. The primary goal of this essay is to evaluate and assess Google Classroom as a learning management system (LMS)[5].

KT Adams, AD Walker, E Searson and J Yosaitis (2017), In this paper Founded that Education Experience of the patience education center were positive. Patience and healthcare response collected then analysis the feasibility of using this approach in Future education[6].

A Ogura, N Hayashi, T Negishi and H Watanabe,(2017), In this paper considered that Education using the e-learning platform is effective for explanation of chest radiography results. E-learning is particularly effective for the interpretation of chest radiography images containing ground glass shadow[7].

RK Kanth, MJ Laakso, (2016), In this paper founded that the appropriateness of the development platform (“VILLE” e-education platform) toward Indian elementary level courses[8].

B Na, J Park, S Rho and E Hwang, (2016), In this paper they studied that there are two platform Traditional NIE (Newspaper in Education) and TNIE (Twitter Newspaper in Education)[9] . In NIE there is one way interaction but in TNIE there is reverse interaction, they provide latest news with good content.

RB Babo, AI Azevedo & J Suhonen, (2015), It founded that e-assessment an outstanding task regarding theoretical topics, it becomes even more challenging when the topics under evaluation are practical. In this paper the analysis of the questionnaires are presented and discussed[10].

E Abele, J Metternich, M Tisch & G Chryssolouris,(2015), It founded the seven variety of learning factory, First is Industrial Application Scenario, Second is Academic Application Scenario, third is Remote Learning Scenario, Fourth is Changeability research scenario, Fifth is Consultancy application scenario, Sixth is Demonstration scenario, Seventh is Future prospective[11],

OBJECTIVE AND RESEARCH METHODOLOGY

This section of the report comprised of research objectives of this study and adopted methodology for achieving these objectives.

Objective of the Study

1. To study the contributing factors for students adoption towards E-learning platforms.
2. To measure the impact of these factors on the Ed-tech industry.

Need of the Study

“Digital learning is the new thing which is evolving in the market in recent times. One of the main reasons behind this change is the increase in usage of smart phones by the people in past few years, Entrepreneurs have guessed this change early and they thought of a new idea of learning which today known as online learning or digital learning. In this particular study several factors which are related to online learning is studied deeply in order to find some useful information.

Similarly with growing technology it becomes necessary to conduct such a study in order to know the mindset of the consumers.

Research Methodology

This research is descriptive in nature. Methodology can be explained by survey conducted; sample and sample profile and tool for analysis, all given below-

Data Collection

Data for research can be collected in a variety of ways, including the mail, the Internet, a database, questionnaires, interviews, and so on. However, in order to use a specific method of data collection, a number of prerequisites

must be met (Fowler, 2002)[12]. According to Waters (1994), the method of data collection will be determined by its intended use. The two components of data collection in this section are first-hand information and second-hand information[13].

Primary Data Source-Questionnaire

A questionnaire was used to get the opinions of 250 respondents on how well can they relate themselves to online learning or digital learning they use. The questionnaire used is an Open ended one, where the questions are based on several factors such as easily accessible, economical, wide range of courses, and user interface. The questionnaire was developed based on 5 likert scale and the respondents were asked to think about the digital platform to which they can relate well. 17 questions were used to examine the relationships among variables.

Sample and Sample Design

Subject of the present study are from the age group of 18 to 40. Since this age group people use Internet to the great extent. This consists of Students, Private organization employees, Govt. employees and faculty members of various institutions. In present study the researcher has used descriptive research design. Descriptive research is a type of quantitative research that seeks information about a population sample for statistical analysis. It is a popular market research tool because it makes gathering and describing data about a specific population simple.

Statistical Tool Used: Collected data is analysed with the help of Pie charts in order to understand the nature of responses on the questions asked in the questionnaire.

Table 1: Reliability and Validity

S. No	Variable Name	Reliability	AVE	N	Scale
1	Easily accessible	0.927	0.71525	5	Aggarwal and McGill (2007) puzakova, Kwak, and Rocereto (2013)
2	Economical	0.843	0.72567	4	UrskaTuskej,
3	User interface	0.753	0.77167	3	UrskaTuskej, KlementPodnar, (2018)
4	Live interaction	0.843	0.72567	2	KlementPodnar, (2018)
5	Digital learning	0.781	0.73753	3	Dodds monroe and grewal (1991)

The above table depicts that all the values of reliability is more than 0.7 and Average variance extracted is more than 0.5, so all the constructs are therefore reliable and validated.

Analysis of Data

Analysis of data is a practice of stimulating, cleaning, transforming or changing and modelling data with the objective of finding useful information, proposing conclusion and supporting decision making.

Interpretation of Data

Interpretation of data is the process of making logic of numerical data that has been collected, analysed and presented. It is the act of elucidating, reframing, or otherwise showing your own understanding of collected data.

DATA ANALYSIS AND INTERPRETATION

Table 2: Demographic Characteristics of Respondents

Demographic Characteristics		
Age		
	Frequency	%
Between 18 to 25	176	70.4
Between 25 to 40	74	29.6
Between 40 to 60	0	0
Above 60	0	0
Gender		
	Frequency	%
Female	97	38.8
Male	153	61.2
Qualification		
	Frequency	%
High school	0	0
Intermediate	50	20
Graduate	56	22.4
Post graduate	144	57.6
Occupation		
	Frequency	%
Govt service	17	6.8
Private service	54	21.6
Business person	28	11.2
Unemployed	38	15.2
Student	113	45.2
Marital Status		
	Frequency	%
Married	48	19.2
Unmarried	202	80.8

Table 2 depicts the demographic profile of respondents. As seen in the table the highest numbers of respondents were from age group of 18 to 25. The rising number in using Smartphone as their daily need is the prime reason behind this study because online education platforms are heavily dependent on internet.

By targeting such age group only. Example- A desire to learn things fast and also at the comfort of their home is mostly in such age group.

Meaning

The process of giving logic and meaning to data or information from qualitative research before using it to address a client's issue. The most important step and component of research is data analysis. Following data collection, the next step should be data analysis and interpretation in order to find a real solution to the problem using critical tools and techniques.

Analysis of Data

Analysis is the process of stimulating, purifying, transforming, or otherwise modifying data and modelling it. The goal is to gather relevant information, make recommendations, and provide decision-making support.

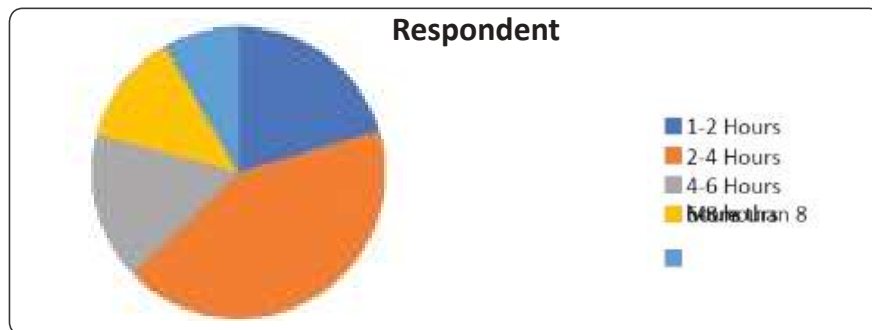
Interpretation of Data

Interpretation of data is the process of making logic of numerical data that has been collected, analysed and presented. It is the act of elucidating, reframing, or otherwise showing your own understanding of collected data.

QUESTIONNAIRE

1. Generally how much time you spent on internet?

Working hours	Respondent	Percentage (%)
1-2 Hours	51	20.4
2-4 Hours	106	42.4
4-6 Hours	41	16.4
6-8 hours	31	12.4
More than 8 hours	21	8.4

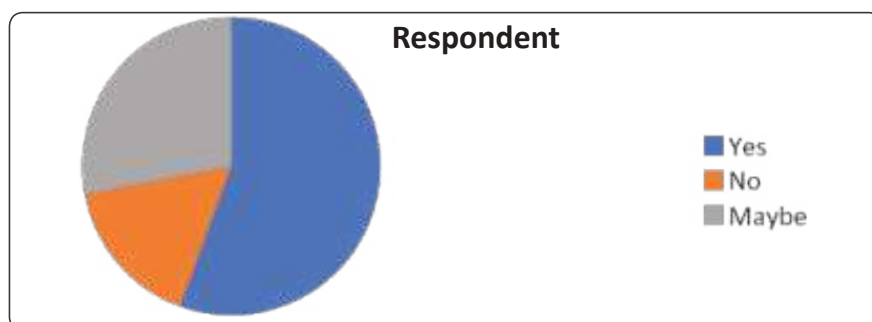


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 20.4% uses internet for 1-2 hours, 42.4% uses 2-4 hours, 16.4% uses 4 to 6 hours, 12.4% uses 6 to 8 hours and 8.4% uses internet for more than 8 hours, the analysis shows that no of internet users are growing day by day.

2. Do you know about online Learning Platform?

Options	Respondent	Percentage (%)
Yes	139	55.6
No	41	16.4
Maybe	70	28

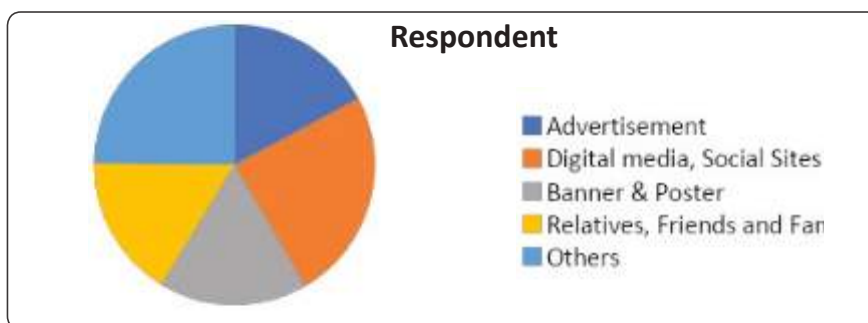


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 55.6% are people who know about online learning platform and 16.4% says they do not know about the same while 28% are not sure about the same. The analysis shows that most of the people in recent times are aware of online education platforms.

3. If Yes, Where did you get to know about Online learning Platform?

Options	Respondent	Percentage (%)
Advertisement	43	17.2
Digital media, Social Sites	61	24.4
Banner & Poster	43	17.2
Relatives, Friends and Family	41	16.4
Others	62	24.8

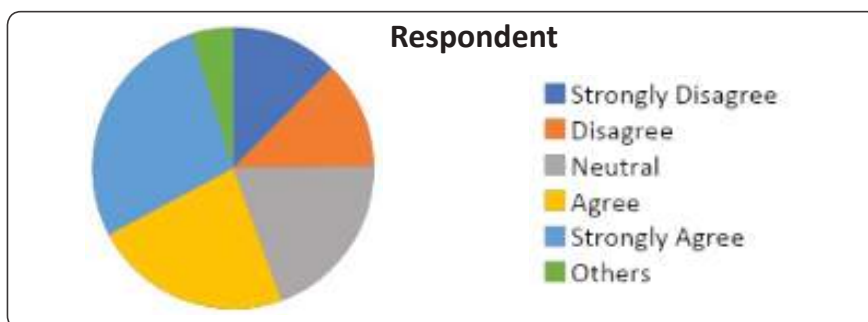


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 17.2% says they came to know through advertisements, 24.4% knows from social sites, 17.2% knows from posters, 16.4% knows from their friends and family while remaining 24.8% is not sure about how they came to know about online learning. The analysis shows that most of the people do know about these platforms.

4. Do you feel these online learning platforms are easily accessible?

Options	Respondent	Percentage (%)
Strongly Disagree	31	12.4
Disagree	31	12.4
Neutral	49	19.6
Agree	57	22.8
Strongly Agree	70	28
Others	12	4.8

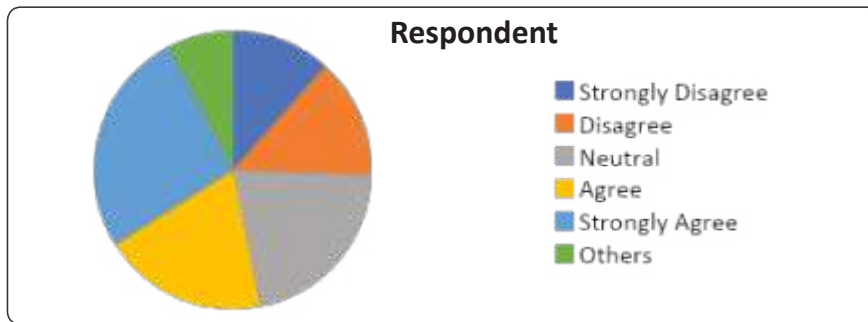


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 12.4% says strongly disagree, 12.4% says disagree, 19.6% are neutral, 22.8% are agree, 28% are strongly agree while 8% are not sure about what to say, the analysis shows that more than 50% people find online learning platforms are easily available.

5. Do you feel these online learning platforms are suitable for children also?

Options	Respondent	Percentage (%)
Strongly Disagree	29	11.6
Disagree	35	14
Neutral	53	21.2
Agree	48	19.2
Strongly Agree	66	26.4
Others	19	7.6

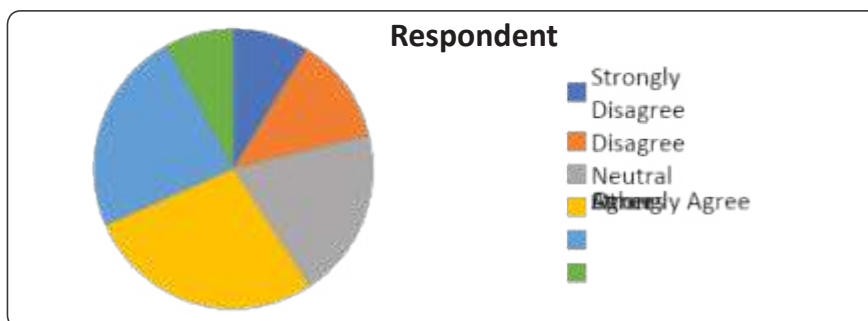


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 11.6% says strongly disagree, 14% says disagree, 21.2% are neutral, 19.2% says agree, 26.4% says strongly agree and 7.6% prefer not to say anything. The analysis shows that more than 45% people feels that it is suitable for children also.

6. Do you feel these online learning platforms help students in learning beyond classroom?

Options	Respondent	Percentage (%)
Strongly Disagree	22	8.8
Disagree	31	12.4
Neutral	49	19.6
Agree	69	27.6
Strongly Agree	59	23.6
Others	20	8

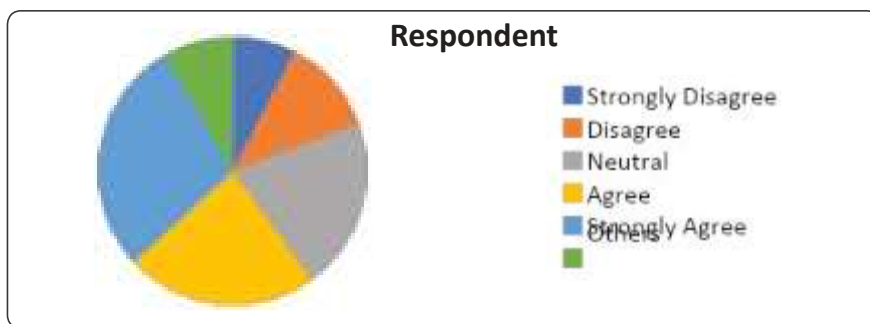


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 8.8% says strongly disagree, 12.4% says disagree, 19.6% says neutral, 27.6% says agree, 23.6% strongly agree, 8% prefer not to say anything. The analysis shows that more than 51% people believe learning beyond classroom is a good step.

7. Do you feel learning from anywhere is also a factor due to which students are shifting towards online platforms?

Options	Respondent	Percentage (%)
Strongly Disagree	19	7.6
Disagree	29	11.6
Neutral	52	20.8
Agree	58	23.2
Strongly Agree	71	28.4
Others	21	8.4

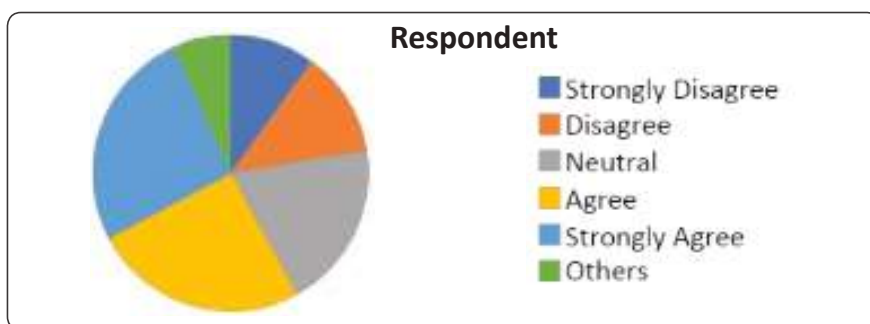


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 7.6% says strongly disagree, 11.6% says disagree, 20.8% says neutral, 23.2% says agree, 28.4% says strongly agree, 8.4% prefer not to say anything. The analysis shows that more than 51% thinks that learning from anywhere is a good concept.

8. Do you feel learning from comfort of your home is also a factor for using such platforms?

Options	Respondent	Percentage (%)
Strongly Disagree	25	10
Disagree	31	12.4
Neutral	49	19.6
Agree	63	25.2
Strongly Agree	65	26
Others	17	6.8

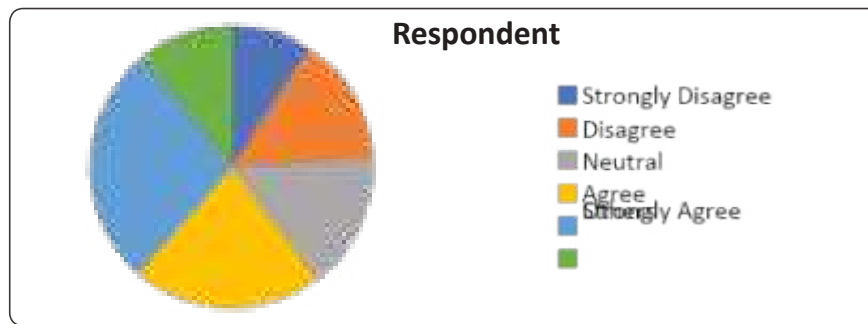


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 10% says strongly disagree, 12.4% says disagree, 19.6% says neutral, 25.2% says agree, 26% says strongly agree, 6.8% prefer not to say. The analysis shows that more than 51% people believe they feel comfortable in learning from home.

9. Do you believe courses which are available on these platforms are economical in nature?

Options	Respondent	Percentage (%)
Strongly Disagree	23	9.2
Disagree	37	14.8
Neutral	39	15.6
Agree	55	22
Strongly Agree	69	27.6
Others	27	10.8

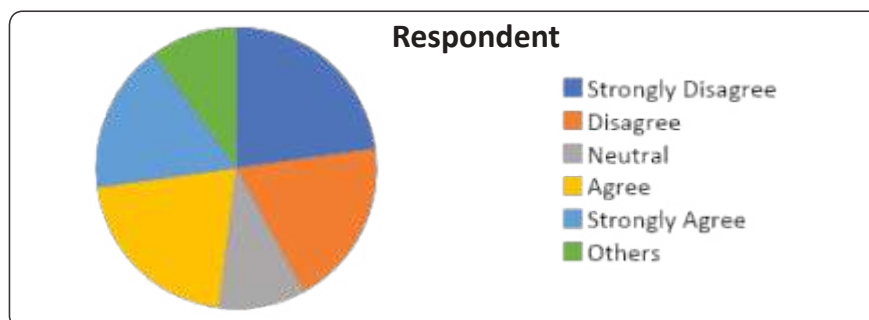


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 9.2% says strongly disagree, 14.8% says disagree, 15.6% says neutral, 22% says agree, 27.6% says strongly agree and other 10.8% prefer not to say. The analysis shows that nearly 50% people thinks courses offered are economical in nature.

10. Do you think it is cheaper than classroom study?

Options	Respondent	Percentage (%)
Strongly Disagree	57	22.8
Disagree	48	19.2
Neutral	25	10
Agree	52	20.8
Strongly Agree	43	17.2
Others	25	10

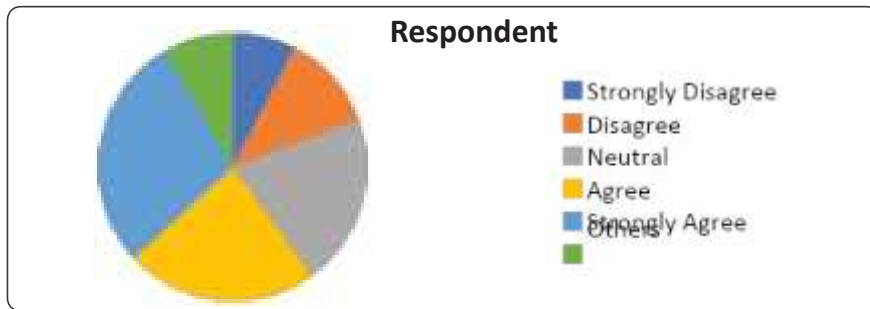


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 22.8% says strongly disagree. 19.25 says disagree, 10% says neutral, 20.8% says agree, 17.2% says strongly agree while 10% prefer not to say anything. The analysis shows that nearly 40% people think it is cheaper than classroom study.

11. Do you think the low price of courses is also the reason why people are interested in these platforms?

Options	Respondent	Percentage (%)
Strongly Disagree	44	17.6
Disagree	39	15.6
Neutral	37	14.8
Agree	92	36.8
Strongly Agree	37	14.8
Others	1	0.4

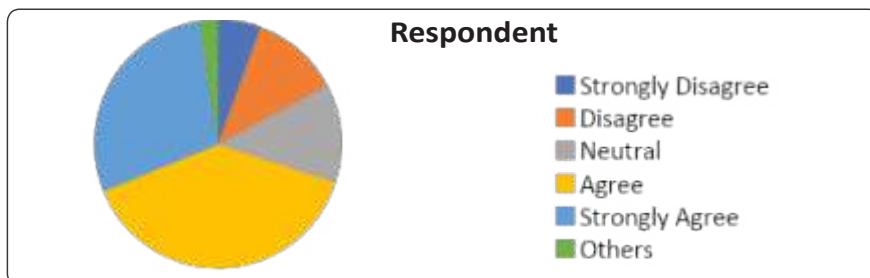


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 17.6% says strongly disagree, 15.6% says disagree, 14.8% says neutral, 36.8% says agree, 14.8% says strongly agree, while 0.4% prefer not to say anything. The analysis shows that more than 50% people believe that low price is one of the major factor why people are interested in digital learning.

12. Do you think based on their low price model they can attract even more students on their platform in near future?

Options	Respondent	Percentage (%)
Strongly Disagree	14	5.6
Disagree	29	11.6
Neutral	32	12.8
Agree	97	38.8
Strongly Agree	72	28.8
Others	6	2.4

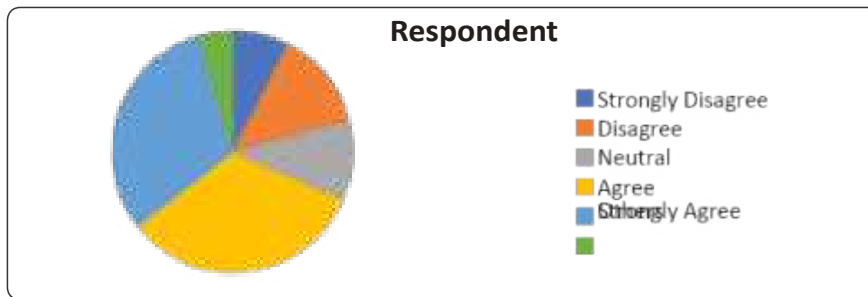


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 5.6% says strongly disagree, 11.6% says disagree, 12.8% says neutral, 38.8% says agree, 28.8% says strongly agree, while 2.4% prefer not to say anything. The analysis shows that nearly 60% people believe that due to low price model there will be growth in these platforms in coming future.

13. Do you think there is wide range of courses on these platforms?

Options	Respondent	Percentage (%)
Strongly Disagree	19	7.6
Disagree	33	13.2
Neutral	27	10.8
Agree	82	32.8
Strongly Agree	77	30.8
Others	12	4.8

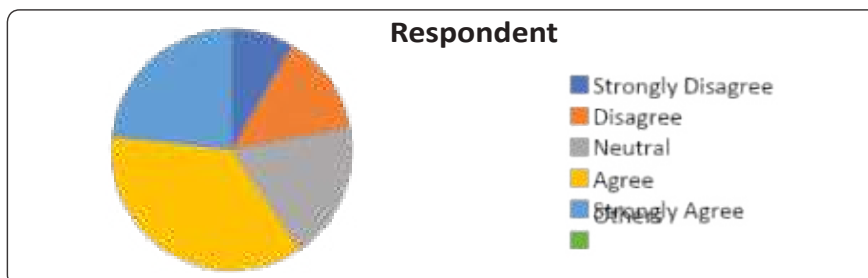


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 7.6% says strongly disagree, 13.2% says disagree, 10.8% says neutral, 32.8% says agree, 30.8% says strongly agree, while 4.8% prefer not to say anything. The analysis shows that more than 63% people believes that students can choose from wide range of courses according to their need on these platforms.

14. Do you think there is all type of courses for students of different educational background?

Options	Respondent	Percentage (%)
Strongly Disagree	21	8.4
Disagree	34	13.6
Neutral	46	18.4
Agree	91	36.4
Strongly Agree	58	23.2
Others	0	0

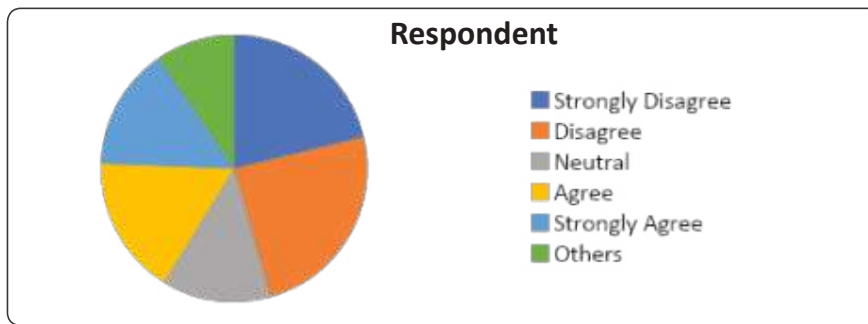


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 8.4% says strongly disagree, 23.6% says disagree, 18.4% says neutral, 36.4% says agree, 23.2% says strongly agree, the analysis shows that nearly 60% people believes there is wide range of courses available for different educational background on these platforms.

15. Do you think children are more interactive on such platforms because they focus on learning with fun?

Options	Respondent	Percentage (%)
Strongly Disagree	53	21.2
Disagree	61	24.4
Neutral	33	13.2
Agree	42	16.8
Strongly Agree	37	14.8
Others	24	9.6

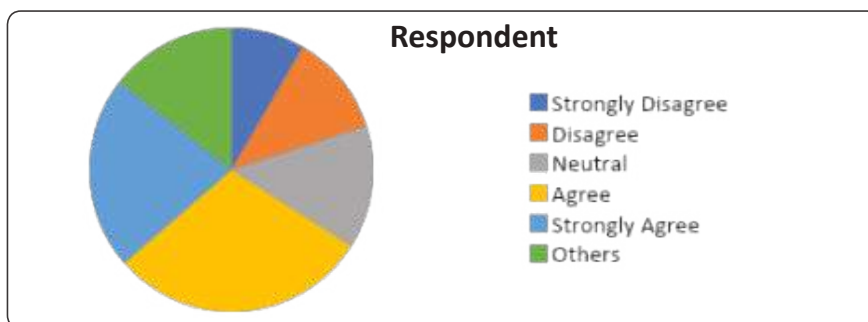


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 21.2% says strongly disagree, 24.4% says disagree, 13.2% says neutral, 16.8% says agree, 14.8% says strongly agree, while 9.6% prefer not to say anything. The analysis shows that 30% people thinks children enjoy learning with fun on these platforms.

16. Do you think these platforms are having user friendly interface?

Options	Respondent	Percentage (%)
Strongly Disagree	21	8.4
Disagree	29	11.6
Neutral	35	14
Agree	74	29.6
Strongly Agree	55	22
Others	36	14.4

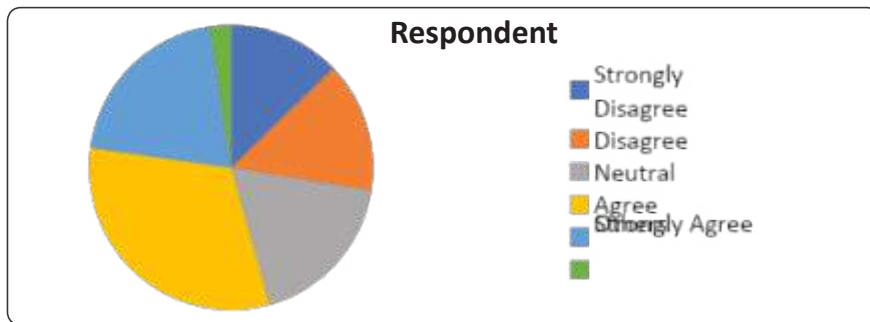


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 8.4% says strongly disagree, 11.6% says disagree, 14% says neutral, 29.6% says agree, 22% says strongly agree while 14.4% prefer not to say anything. The analysis shows that more than 51% people believe that these platforms have user friendly interface.

17. Do you think these platforms focuses more on learning than grades is also a reason for growth in this sector?

Options	Respondent	Percentage (%)
Strongly Disagree	32	12.8
Disagree	37	14.8
Neutral	45	18
Agree	79	31.6
Strongly Agree	51	20.4
Others	6	2.4

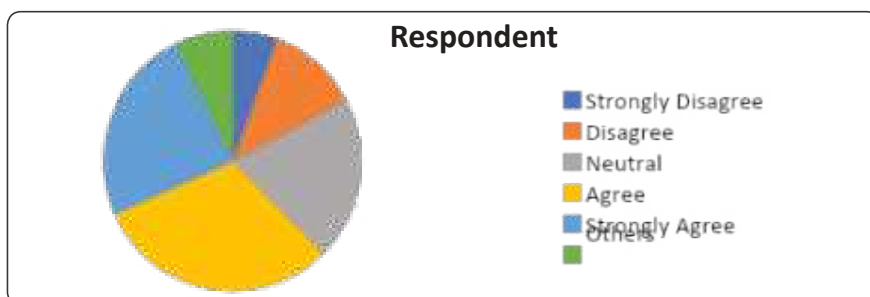


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 12.8% says strongly disagree, 14.8% says disagree, 18% says neutral, 31.6% says agree, 20.4% says strongly agree while 2.4% prefer not to say anything. The analysis shows that more than 52% people believes it focuses on learning more than grades.

18. Do you think excellent application performance of these platforms also play a key role in the growth of such platforms?

Options	Respondent	Percentage (%)
Strongly Disagree	14	5.6
Disagree	29	11.6
Neutral	51	20.4
Agree	77	30.8
Strongly Agree	61	24.4
Others	18	7.2

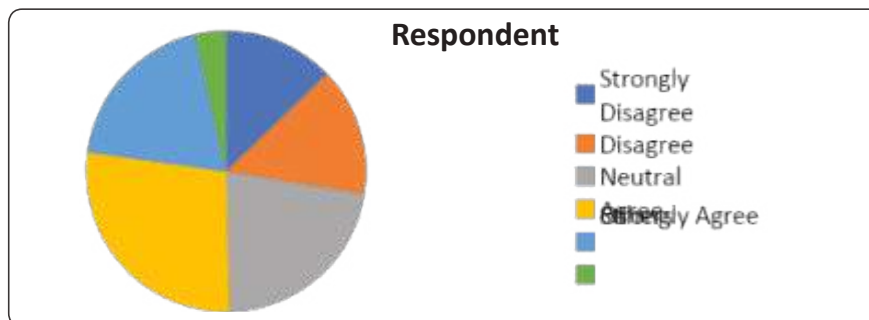


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 5.6% says strongly disagree, 11.6% says disagree, 20.4% says neutral, 30.8% says agree, 24.4% says strongly agree while 7.2% prefer not to say anything. The analysis shows that more than 55% people believe excellent application performance is also a key factor for these platforms.

19. Do you think it saves a lot of time while learning things compare to classroom learning?

Options	Respondent	Percentage (%)
Strongly Disagree	19	7.6
Disagree	32	12.8
Neutral	49	19.6
Agree	79	31.6
Strongly Agree	63	25.2
Others	8	3.2

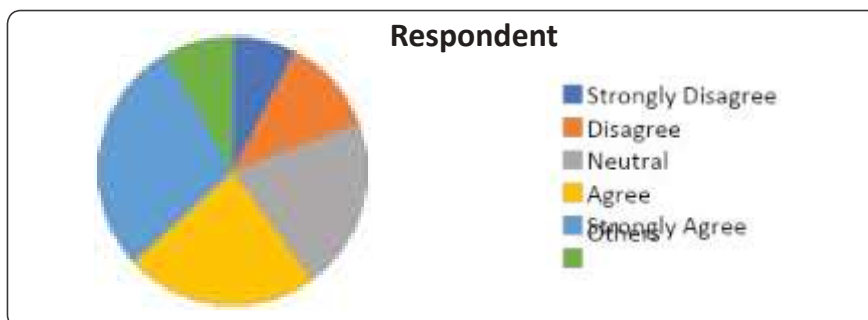


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 7.6% says strongly disagree 12.8% says disagree, 19.6 says neutral, 31.6 says agree, 25.2% says strongly agree while 3.2% prefer not to say anything. The analysis shows that nearly 57% people believe it saves a lot of time.

20. Do you think live interaction with mentors of respective fields is also a reason for growth in these platforms?

Options	Respondent	Percentage (%)
Strongly Disagree	32	12.8
Disagree	37	14.8
Neutral	55	22
Agree	69	27.6
Strongly Agree	48	19.2
Others	9	3.6

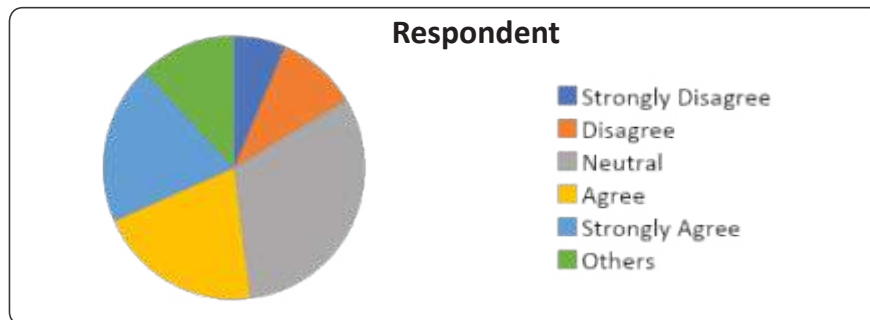


Analysis and Interpretation

From the above table it shows that out of 250 respondents, 12.8% says strongly disagree, 14.8% says disagree, 22% says neutral, 27.6% says agree, 19.2% says strongly agree while 3.6% prefer not to say anything. The analysis shows that nearly 47% people think live sessions with mentors is also a reason of growth for these platforms.

20. Do you think live interaction feature is plus point for these platforms?

Options	Respondent	Percentage (%)
Strongly Disagree	16	6.4
Disagree	25	10
Neutral	79	31.6
Agree	51	20.4
Strongly Agree	49	19.6
Others	30	12



Analysis and Interpretation

From the above table it shows that out of 250 respondents, 6.4% says strongly disagree 10% says disagree, 31.6% says neutral, 20.4% says agree, 19.6% says strongly agree while 12% prefer not to say anything. The analysis shows that 40% people believes live interaction feature is a plus point for these platforms.

FINDINGS AND CONCLUSION

Major Findings

Theoretical Description

The gender distribution of survey respondents revealed that the majority of respondents were male (61.2%), while women comprised 38.8% of the total population. The majority of survey respondents were between the ages of 18 and 25, accounting for 70.4% of the total population. This demonstrates that digital learning is popular among youth. The second finding is that the majority of respondents were Postgraduates. The majority of respondents to the survey were unmarried (80.8%), while the remainder were married. In general, the results of the study indicate that the dependent variable, digital marketing, is influenced by factors such as cost, user interface, and accessibility. Thus, we can conclude that many respondents consider multiple factors prior to utilising a platform. They also feel as though the platform is a family member or close friend. The study also showed that Price also impacts Digital platform. Thus the respondents feel that if price is economical the chances of getting more students are high. Also the respondents agreed that the platform used reflects the mindset of the consumer. The consumers who consider digital platform as a medium of education have also agreed the platform they use is of very upscale. The platform they use is also of very high status. The dependent variable i.e. Digital learning is found to get impacted by all the independent variables. The contribution of these factors ads has helped a lot in promoting the online platform.

Managerial Description

- More than 50% respondents say that these online platforms are easily accessible.
- More than 51% respondents say that learning from anywhere is one of the reasons towards growth of these platforms.
- More than 51% respondents believe that the price is quite reasonable for different courses on these platforms.
- Nearly 70% respondents believe because of low price model of these platforms, it will soon gain more customers on their platforms.
- Nearly 65% respondents say that there is wide range of course for different educational background students on these digital learning platforms.
- More than 55% respondents say that excellent application performance is one of the reasons of satisfaction of students while using online learning platform.
- Nearly 50% respondents believe that live interaction with mentors of particular field will be the reason of growth of this sector in coming future.

CONCLUSION

Digital learning platform is on the path of growth in coming future, the main reason behind this statement is simple as in today's time most of the people want knowledge with limited resources, so with the help of the online platform everyone can access thousand of courses from anywhere at any time, another reason for the success of this sector is its low price model as developer knows the per capita income of a common person in the country and based on that they have fixed the prices of such courses on these platforms which are quite affordable in nature. It is also found out in the study that few years back there was a low rate of growth of this sector but soon after internet and Smartphone outbreak the rate of growth of this sector is increasing rapidly day by day, also there are several factors which are also all together responsible for the growth such as user interface which is quite user friendly in nature and live interaction with mentors also plays a key role in the growth of online learning industry. The respondents consider the digital learning helps them in learning concepts in a lot more easier way than compare to classroom study as in this they can learn from anywhere to a shopping mall, a restaurant or at the comfort of their own home.

Limitations

- Concerning the use of online questionnaires as instrument. When using this method, the researcher has no control over the participants. It cannot be monitored whether the participants were paying full attention to the questionnaire and whether they were concentrated. There is limited no. of respondents.
- Sample size is too small.
- Scarcity of funds availability.
- Only the elite class customer is being targeted.
- The result may differ from region to region.

Suggestions

- First of all the current study should be repeated with a larger sample size and more differentiated age groups. By this the results of the study can be generalized more and the result would be more representative.
- The future study should be expanded to a wide range of people including more factors.
- The sample was also relatively narrow in certain areas, for example when drawing conclusions from age group, there was an age group with an 'n' of just 0. This was therefore impossible to draw any conclusions from that would have had any meaning. This concept also continues into the fact that the sample was part of a relatively specific demographic, well educated 18 to 25 year olds. This also makes it hard to draw meaningful conclusions from the analysis, outside of our demographic boundaries

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Posting Purchases Behavior on Social Media

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▶ ABSTRACT ◀

Social media has become an essential platform for businesses to market and sell their products. With the increasing use of social media, consumers are more likely to share their purchasing behavior with others on these platforms. Posting purchases behavior on social media has become a popular trend among consumers. This behavior refers to consumers sharing their recent purchases on social media platforms, such as Facebook, Twitter, and Instagram. This study aims to explore the relationship between social media use and posting purchases behavior. The research method used in this study is a survey, which includes questions about social media use, purchasing behavior, and posting behavior on social media. The findings of the study suggest that there is a significant relationship between social media use and posting purchases behavior. The study found that consumers who use social media are more likely to post their purchasing behavior on these platforms. Moreover, the study also found that consumers who are influenced by social media advertisements are more likely to post their purchases on social media. The findings of this study can help businesses to develop more effective marketing strategies on social media and better understand the motivations behind consumers' posting behavior. Additionally, this study can also help consumers to be more aware of their behavior on social media and the impact of their posts on their personal brand and social relationships.

Keywords: *Social Media, Consumer Digest, Purchasing Behavior, Social Influence, Posting Purchase, Social Influencer, Pre-Purchasing Stage, Conspicuous Donation Behavior.*

INTRODUCTION

The potential for users to review things, recommend them to friends or acquaintances, and link current and future purchases via status updates and Twitter feeds is one of the most important corporate uses of social networking. Social networking is also a useful tool for businesses since satisfied customers can notify others

who might be interested in their product or service. In practise, panels and product reviews that used to appear in magazines like as "Consumer Digest" are being swiftly supplanted by social media. People used to frequent respected institutions and rely on the competence of the employees in each department (Dar and Jamal, 2021) [1]. People nowadays frequently seek advice and business insight from a friend or acquaintance in their social media network.

People are social creatures, thus modern consumers engage in a wide range of online activities, such as content consumption and the exchange of knowledge, stories, and opinions with other customers (Jamal et al., 2009) [2]. As the Internet has risen in popularity, so has the relevance of online social networks and virtual groups as a medium of communication. Over the last 10 years, as people discovered new means to communicate online, there has been an increase in the number of online communities. (Jamal et al., 2009) Even though some groups never interact in person, they might still influence behaviours, such as shopping decisions (Haris et al., 2017)[3].

New consumer venues have evolved in the social milieu of the Internet. OTX analysis from 2008 Social networking sites, blogs, and virtual communities can all be utilised to influence customer purchasing decisions. Numerous social networking websites have expanded their market share (Scaglioni et al, 2018)[4]. Facebook, for example, climbed by 0.22 percent between November 2011 and October 2011[5]. YouTube has the highest gain of any social networking site between November 2011 and October 2011. More people are now active users of online social networks, according to these statistics (Pallis et. al., 2011)[6]. Every day, people buy products to help them fulfil their desires. They are making purchasing selections at the same time. Specific consumer behaviour refers to the behaviours that consumers engage in when purchasing, utilising, and discarding goods and services (Ioană and Stoica, 2014)[7].

Social media has now infiltrated every area of our life. Social media has a big impact on how people do business. According to Hutton et. al., [8] social media has transformed customers from passive to active providers of content about products and their interactions with them. Instagram users have submitted over 9 million and over 22 million images of Starbucks and Nike, respectively, according to Singh and Khandelwal, [9]In truth, user-generated content (UGC) about brands is increasingly taking over the Internet. According to Singh and Khandelwal[9] user-generated content accounts for about 25% of search results for the top 20 names in the world. In truth, many people often broadcast their own details about their purchases on social media platforms. A fan of Apple, for example, posts a photo of her new collection of Apple watches to Instagram. A person on the weekend tweets about a happy hour. When posting about their purchases on social media, consumers are unable to express their sentiments or ideas to their followers. As a result, unlike internet reviews, this type of writing is about expressing yourself rather than assisting other customers in deciding what to buy (Khandelwal and Singh, [10] Social media has altered how people communicate, share information, and pursue their interests.

Customers cannot rate, interact, or receive peer recommendations on business-critical social media sites such as Facebook status updates and Twitter feeds. Through the use of social media by a business, a happy consumer can introduce a new customer to a product they have previously purchased. In layman's terms, it could indicate that client reviews should be updated. Businesses nowadays aim to capitalise on the growing number of customers who make purchases via social media. Social media advertisements are becoming more frequent among India's astute businesses[11]. This year, 83% of the 48 national enterprises with a substantial social footprint polled by Ernst & Young used social media advertising. 42% of this group used these commercials to promote an online campaign or contest. Furthermore, social media accounts for a sizable portion of these organisations' overall marketing budgets. 42% of individuals asked said they spend between 1% and 5% of their time on social media, while 37% said they spend between 6% and 10%. Furthermore, 22% of businesses reported that social media spending exceeded 10% of their marketing budget.

Businesses spend the majority of their social media time on Twitter and Facebook. Using the purchasing decision process, describe the stages a client takes to make a purchase. It consists of five steps: identifying the problem, gathering information, considering the benefits and drawbacks of various solutions, deciding to buy, and carrying out the purchase decision. The Internet has grown significantly in recent years, providing businesses with new

channels for doing business. People with an Internet connection can communicate via social media sites such as Facebook, Twitter, and email without having to meet in person. Many businesses gain from social media by increasing the attractiveness of well-known brands and expediting word-of-mouth marketing. It is also essential for increasing sales, conveying corporate information, and providing social assistance to customers. Social media networking draws people together who share common values, which is beneficial to trust. Given the prevalence of social media and SNSs, it is becoming increasingly important to examine how individuals utilise them [12]. This is because social media is likely to influence corporate marketing efforts by improving consumer trust and influencing online purchasing behaviour. The vast bulk of the network's material is generated by users, which contributes greatly to the network's size.

A huge amount of academic research reveals that people's behaviour and the goods they buy are heavily impacted by social, economic, cultural, psychological, and other personal factors that are beyond marketing's control. As a result, the purchase choice is influenced by a complicated mix of internal and external variables. We may use online social networking to better our interactions with others. Furthermore, as more individuals utilise social media, the word-of-mouth effect grows [13]. As a result, marketers frequently attempt to find or even build opinion leaders for their products by addressing them in their marketing efforts. Individuals can distinguish themselves from other marketers by sharing their purchases on social media.

People love to talk about the things that make them happy, which could be their company or their product.

In this context, a "social influencer" is someone who has a large following. Because these influencers receive a lot of daily attention, businesses frequently leverage their articles to sell their products. For example, if an influencer posts on Instagram about some new trousers she recently purchased and says how comfortable and affordable they are, her followers are likely to be interested in learning more.

Make sure to tag the store or brand name of the items you use in your posts so that your followers may quickly make purchases. Because of this activity, supporters may quickly identify their favoured brand and merchant. 80% of individuals are more likely to purchase a product if a buddy recommends it. But before you can irritate a total stranger, you need a customer to trash your items on social media.

Aside from what has already been stated, a company's social media presence has a significant impact on how customers behave while making purchases. In other words, even if consumers and social influencers pay close attention to a company, convincing anyone of its credibility will be difficult if it has a bad social media presence. With a constant feed that illustrates how their things are used and provide value, the likelihood that people would follow and buy from them will increase.

Understanding this issue can help you uncover the variables influencing trust and social commerce intentions on SNSs. This essay has four objectives. The study first investigates how online discussion forums, communities, ratings, and reviews—all forms of social media—affect e-commerce trust. Second, it looks into the relationship between trust and the proclivity to buy. Third, this study investigates how a site's perceived utility (PU) and legitimacy influence a person's motivation to make a purchase [14].

These businesses recognise the value of social media, but they haven't been very effective at monitoring their performance. When asked how social media use influenced their company's income, the clear majority (78%) claimed they didn't know or hadn't measured the impact.

As consumers have been more active on the internet, business and academic experts have been striving to better understand, control, and forecast how individuals express their ideas online during the last year. This has occurred, for example, in the entertainment industry. The market is frequently discussed on the Internet (see box office.com). As a result, several industry-wide attempts to track and study customer feedback have emerged, such as Liu [15] investigation of the relationship between social media use and television viewing. Among other things, Relish MIX investigates online activity to determine "how to drive engagement" for business entertainment marketers.

For example, one recent study (Duan et al., 2008; Godes and Mayz, 2004; [16] Oh and Sheng, 2011) investigates what happens when people express themselves online. This study explores who shares thoughts, where they are

shared, and when they are shared in order to fill a gap in the literature. Charities and non-profit organisations are well aware that social media platforms, particularly those used by younger generations, can have a huge impact on how people react. Facebook's ALS Ice Bucket Challenge raised four times as much money as the previous year (Zillman, 2014)[17]. Despite the fact that philanthropic groups' social media marketing largely targets this age group (O'Leary, 2016), this is true. This study investigates the phenomenon known as conspicuous, virtual "donation" behaviour (CDBE), which occurs when young people discuss charity on social networking platforms but do not make monetary contributions. It investigates how personality qualities influence CDBE and whether virtual CDBE stimulates in-person giving of time or money. Younger consumers worry, "while matures walk the walk" (Black, 2021)[18].

In recent years, academic studies have focused a lot of emphasis on problems such as how people complain online (Bachet. Al., 2012; Sparks et.al., 2010) [19]. This study focuses on the motivations for and benefits of online complaints. Customers who are dissatisfied with a service may be able to complain directly (face-to-face, for example) or indirectly (in writing, for example) to a person or company (Singh et al., 2019). Furthermore, blogs, Facebook, Twitter, and other social networking platforms make it easy for people to disseminate negative information to the general public (Seidman, 2013). Thus, social networking sites serve as a platform for knowledge sharing as well as a means for dissatisfied clients to communicate their displeasure (Sanchez Franco 2012)[20].

Need of Study

This research is going to explore such new consumers. Posting purchases on social media is different from traditional word of mouth or traditional conspicuous consumption. With the help of social media, we are aware the consumers about the products and services. From the social media we are sharing the best knowledge to the consumers.

REVIEW OF LITERATURE

Prior research on posting purchasing on social media has focused on the themes such as posting anything on social media, behavior of the consumers and happiness of the customers perception of the behavior towards the social media; attitude towards the social media (Raghuwansh and Jain, 2017). Awareness about any brand and customer trust & experience. A few further papers have attempted to summarise the state of the research and make recommendations for its future direction. The findings of the investigations are diverse. It was discovered that consumers acted consistently regardless of gender. Younger consumers are more responsive to social media, demonstrating the importance of age.

Various types of research were done by various researchers, taking in to consideration the different types of variables. In the research, it is explained that posting purchase on social media increases happiness and positive influences on consumer this research was given by (Duan and Dholakia, 2017) [21].

Katja Hulter and Fulia Hotz and Severin Dennhardt in their study analyzed the impact of user interaction in social media on brand awareness and purchase intension and the result of this article that are analyzed the influence of brand on social media activities and participant social media involvement on the purchasing decision process of customers. In this research their findings demonstrate and engagement with a Facebook fan page has a positive effect on consumers regarding brand awareness, word of mouth activity and purchasing decision.

One research was noticed which is about the role of social media during the pre- purchasing stage and providing the positive relations with consumer decision and also providing the knowledge about the product [22]

Different researcher have different perspective, like, Yen (2016)[23] considered the factor enhancing the posting negative behavior in social media. In this research they are talking about the positively affect the posting the negative behavior and increases the effect of venting negative emotions. Various researchers talked about social media opinion sharing: beyond volume according to the Josebh Cabosky said that social media is a good platform for sharing the positive opinion about the product more than negative once and sharing rates increased after

products release.. In this research paper their findings with relation to social media usage by team and the way in which team communicate on Facebook, twitter, WhatsApp, and Instagram etc.

Wallace et al., [24] in their research investigate the exploring the conspicuous donation behavior on social media platforms and tell form this research increases the self- esteem self-oriented, high self-monitoring to the other. It is positively associated with donation attention consumers are more likely to engage both form CDBE on Facebook.

According to studies such as "Social Media's Slippery: Challenges, Opportunities, and Future Research Directions" (Peltier et al., 2003)[25] the majority of social media marketing attempts entail providing sales pitches to those who are already interested in the business. This study demonstrated that online service design elements caused and identified a set of customer value perceptions that influence customer feedback and collaboration plans, and that the theoretical framework supported the bulk of the hypothesised relationships. According to the findings, user interaction varies depending on the day of the week and the hour at which a brand posts on its page

Objectives of Research

In this study we found that Attitude and behavior of the consumers towards the social media. And the objectives are given below:

1. To measure the attitude towards the posting purchases on social media
2. To identify the underling dimensions of the attitude towards posting purchases on social media

RESEARCH METHODOLOGY

Sampling Design: A sample design is made by two elements which are sampling method or estimator. Sampling refers to the set of laws and procedure through this we can pick some element from the population that is called sample. Estimator helps in in calculate sample statistics by estimation process.

Sample size: for this study includes the youth of the Agra, Mathura, Aligarh, Hathras and NCR region. Out of 350 samples we are got the 227 respondents.

Sampling Method

1. **Sample Location:** Samples were taken from Jhanshi, Gwalior, Morena, Agra, Mathura.
2. **Sample Selection:** Sample selection decision was taken on the basis of purchasing behavior of the consumers towards the social media.

Data Collection & Data Sources

There are two sources of data collection which is primary data and secondary data collection.

Primary Data: This is the 1st time data collection collected through the different sources like: questionnaire, survey and interviews. Questionnaire consists of many questions, person need to answers accordingly. They may be males and females. This data is collected by the person who is doing research on the topic.

Tools Use for Data Collection: Primary data is collected through the questionnaire filled by the people and in this study; we are observed the behavior of the social media consumers. Therefore, we are using the tool (Exploratory Factor analysis).

Secondary Data: Internet, research paper, Journals, Books etc.

OBJECTIVE 1

To Measure the Attitude Towards the Posting Purchases on Social Media

According to this objective we are measure the attitude of the consumer on social media. Because On the social media the consumers attitude may be positive and negative. But in this research the result is positive and according to the questionnaire most of the respondents are given the positive responses.

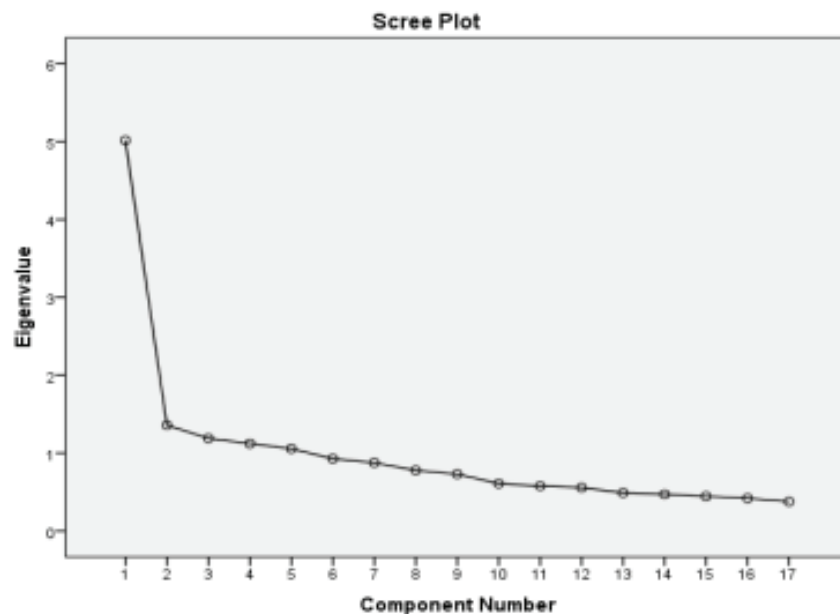
Table 4.1: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
V1	227	2	5	4.03	.648
V2	227	1	5	4.12	.644
V3	227	2	5	4.03	.783
V4	227	2	5	4.20	.654
V5	227	1	5	3.81	.789
V6	227	2	5	4.17	.579
V7	227	2	5	4.17	.677
V8	227	2	5	4.11	.808
V9	227	2	5	4.09	.723
V10	227	2	5	4.12	.582
V11	227	2	5	4.04	.727
V12	227	2	5	4.09	.673
V13	227	2	5	3.70	.676
V14	227	2	5	3.97	.519
V15	227	2	5	4.01	.701
V16	227	2	5	3.99	.602
V17	227	3	5	3.90	.473

The initial output of the study is a table of descriptive statistics for each variable under consideration. This table frequently includes the mean, standard deviation, and total number of respondents. Taking the average into account, we may conclude that the most essential factor in convincing buyers to purchase a product is its reputation. It has the highest mean of 4.170<

The KMO the value should be higher than .5 then it is acceptable and when the KMO value is higher than .8 then it shows the high correlation in between variables and in this research our KMO value is more than .8 than this research is showing the higher correlation between variables.

And Bartlett's Test of Sphericity value is 136<



Interpretation of Scree Plot

The scree plot is a graph that shows how each element affects the Eigen values. The line can be used to determine how many objects to maintain. When the hill begins to flatten, things start to become interesting. The curve begins to flatten between factors 5 and 6, and factor 6 has an Eigen value less than one, thus only the first five factors have been retained.

Table: Frequencies of the responses to the question concerning the attitude towards RAPO.

Rotated Component Matrix

	Component					Communalities
	1	2	3	4	5	
variable1	.344	.226	.215	.596	.072	.576
variable2	.158	.143	.067	.776	.030	.653
variable3	.599	.231	.078	.050	.146	.442
variable4	.151	.110	.498	.307	.063	.381
variable5	.359	-.059	.277	.065	.531	.495
variable6	.292	-.036	.740	-.186	-.025	.670
variable7	.365	.605	.184	-.001	-.173	.563
variable8	.694	.057	.039	.230	-.084	.547
variable9	.657	.117	.024	.118	.142	.481
variable10	.074	.686	.009	.255	-.026	.542
variable11	.577	.249	-.007	-.091	.091	.412
variable12	-.142	.200	.659	.202	-.038	.537
variable13	.061	.336	-.045	-.179	.777	.754
variable14	.217	.704	.138	.095	.217	.618
variable15	.691	.029	.082	.146	.072	.512
variable16	.636	.069	.140	.105	-.003	.439
variable17	.001	-.204	-.127	.301	.570	.473

Extraction Method: The Eigen value of rotate component matrix more than 1 (1.056)

% of variance: 6.214

% of cumulative: 57.318

(a) Rotation converged in 7 iterations.

The analysis is simpler to interpret when it is rotated. The data above can teach us about consumers' social media posting and purchasing behaviours, as well as their level of product expertise. We can conclude that accessing social media boosts users' pleasure, contentment, and knowledge of their social position.

Communalities: The table of communalities appears next in the output, showing the percentage of the difference attributable to communalities. Communities with values greater than 0.5 must be considered for further analysis. If a variable's value is less than .5, it should be eliminated, and factor analysis should proceed without it.

OBJECTIVE 2

To Identify the Underling Dimensions of the Attitude Towards Posting Purchases on Social Media

With the help of the factor analysis we are measure the attitude of the customer towards the social media and we are found the positive result respectively.

Rotated Component Matrix

	Component				
	1	2	3	4	5
P 8	.694	.			
P15	.691				
P 9	.657			.	
P16	.636				
P3	.599				
P11	.577				
P 14	.	.704			
P 10		.686			
P 7		.605			
P 6			.740		
P12			.659		
P 4			.498		
P 2				.776	
P 1				.596	
P 13					.777
P17					.570
P 5					.531

Rotation is used to reduce the number of factors that place a high value on the variables being researched. Although rotation has no effect, it makes it easier to understand what is going on. Looking at the variables listed below, we can see that there is information about the importance of social media, how consumers can use social media, how social media makes it difficult to make decisions, how social media has provided platforms for happiness and satisfaction, and how social media functions as a platform for increasing consumer awareness

Factor no	Name of dimension	Statement levels	Statement	Factor scores
1	Importance of social media	P 8 P 15 P 9 P16 P 3 P 11	Social media make your decision making more Complex.you are posting anything on social media for taking the attention of people you people posting anything on social media for Increasing the views. For instance, advertisement/blog posts/ fb user Review on social media influence you to try new Brands/products/services. You people spend your time in posting anything on social media you people posting anything on social media for Showing your status.	Rotated Component Matrix
2	Uses of the social media for consumers	P14 P 10 P 7	With the social media sites, you are able to seek Out products/services info initiatively Social media increased and enhance our knowledge Regarding different product and servicesYou feel encourage to voice out your opinion after a purchase via social media platform	.704 .686 .605

3	Makes a complex decision	P 6	Social media provides an effective and powerful Platforms For consumer to communicates with Each other and with the companies. The information searching is easier via social media Comparing to mass media (e.g.TV, radio, news paper And so on) Social media has provided more Effective platform to new products	.740
		P 12		.659
		P 4		.498
4	Social media as a Satisfactory platform	P 2	You people posting anything on social media For own satisfaction and happiness. You people are posting anything on social Media for taking the suggestion and reviews	.776
		P 1		.596
5	As an awareness platform for customers	P 13	Information regarding product and services has a Higher credibility on social media than on mass Media channels because the info beyond the Company's control Sometimes you people don't post anything Because lack of time than you feel not good The advertisement/review blog post etc. Have a higher credibility than advertisement/ Editorials/others marketing means of mass media	.777
		P 17		.570
		P5		.531

Findings of Research

Introduction

The findings and conclusions of the survey, as collected from the respondents, are provided in this document. This chapter investigates the reliability of general demographic data for all respondents. In one half of the study, we examine how social media influences the pre-purchase stage, while in the other, we examine how social media influences the purchase stage

Response Rate

We have engaged our respondents for the research area (Aligarh, Agra, Mathura, Hathras) These included mostly youth. We have got 227 respondents out of 400 questionnaires.

Response	Frequency	Percentage
Responded	227	56.75%
Not responded	173	43.25%
Total	400	100%

Gender of the Respondents

This study Sought to the gender of the respondents, 44.9% were caroused to be female while male comprised of 55.1% percent of the sample population as shown in the given table:

Gender	Frequency	Percentage
Male	125	55.1
Female	102	44.9
Total	227	100%

Age of the Respondents

In this research we are interested to start the age of the study participants in relation social media use, 55.9% are the age of 20-25, 29.1% comprised the age of 25-30, 8.4% are the age of 30-35, 5.7% are the age of 35-40, and the least no. age is .9% are the age of 40 or more as given in the table.

Age of the Respondents	Frequency	Percentage
20-25	127	55.9%
25-30	66	29.1%
30-35	19	8.4%
35-40	13	5.7%
40 or more	2	0.9%
Total	227	100%

Social Media Tools

Preference of the social media tools impacts on consumer decision making. This study therefore, sought to regulate the preferred social media tools. 37.9% respondent are preferred what's App and 14.1% respondents are preferred Face book, and 35.7% respondents are using the Instagram, and 3.5% respondent are use the Twitter, and remain the respondents (8.8%) are preferred the other social media. Table is given below:

Social media tools	Frequency	Percentage
What's app	86	37.9%
Face book	32	14.1%
Instagram	81	35.7%
Twitter	8	3.5%
Other	20	8.8%
Total	227	100%

Time (Approx.) Spent on Social Media Sites Per Week

In this research 20.7% respondents are spent the time on social media 1-3 hours, and 20.7% are spent their time on social media 4-6 hours, and 27.8% respondents spent their time on social media, 30.8% of respondent are spent their time on social media as given in table

Time approx.	Frequency	Percentage
1-3	47	20.7%
4-6	47	20.7%
7-9	63	27.8%
10 or more	70	30.8%
Total	227	100%

Users of social media are more likely to trust the information and product reviews they discover there. Furthermore, people are virtually as likely to trust recommendations from friends, visitors, and other customers as they are reviews from complete strangers. As a result, businesses may offer discounts or other perks to customers who advertise their products on social media.

- Many internet users have looked for information on products they want to buy online. Travel, leisure, and applications are the most common purchases.
- Its two most important qualities are the effectiveness of information search for searching and how people perceive the optimal search method.
- Social media platforms appear to be trustworthy information providers. Social media is an excellent instrument for marketers to employ to achieve their goal of boosting awareness.

- Social media reviews can make or break a transaction. As a result, marketing can encourage customers to share their great experiences on social media. Customers are also encouraged to file complaints on the company's official website.
- Social media does not appear to have a significant impact on clients based on gender or age. Demographic characteristics may not be the ideal method to categorise social network users, especially given how they make purchases.
- Consumers are more likely to buy when they see encouraging tips and comments on social media. As a result, using social media to spread positive word of mouth will increase sales.

Limitations of Research

- The survey's chances of being limited increase as it is displayed online. This survey includes just people who meet certain criteria and use social media. It will be more beneficial to investigate how psychographic factors may influence the purchasing process.
- However, information posted on social media has an impact on how people shop. Future research could look at why people aren't more likely to share this type of information.

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A Quantitative Analysis of the Growing Popularity of Health Apps Among Youth

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▶ ABSTRACT ◀

Mobile software applications known as “health apps” process health-related data on or for their users. Despite the fact that there are a lot of mobile health apps accessible today, users frequently stop using them after a short while, and are unwilling to use them at all, or are unaware that such apps exist. Responses from roughly 113 persons were obtained for this study work, which was entirely based on primary research. Responses were chosen at random locations and at convenient times. To determine how the elements interact with one another in accordance with the conceptual model, two statistical tools correlation and regression were applied. To evaluate how different juvenile age groups are affected by various circumstances. The available research supports the abundance and appeal of customizable applications for mental health in young people. Contrary to the findings, students are using health apps more frequently because they benefit from them in a variety of ways. Although individual variances in gender, age, and educational achievement are prevalent, demographic factors have less influence on how people use mobile devices. Youths favour various app features like calorie, weight, and step tracking. Due to their features, health apps are currently very popular among youth.

Keywords: Mobile Devices, Software Applications, Demographic Factors, Youth, Regression and Correlation.

INTRODUCTION

Compact advancement use has grown exponentially since the introduction of phones, stimulating a delicate extension of companion (applications). Mobile phone entrance is high among progressively energetic section get-togethers, with 73% of youngsters developed 13–17 years in the United States moving toward a PDA and 58% having downloaded applications. Flexible prosperity intercessions using PDAs are continuously sent in clinical settings to build calm guidance, correspondence, watching, and wearisome illness the officials, and there

are at present a colossal number of business mobile phone “prosperity applications”— applications planned to help prosperity the board.

M-Health applications recollect the usage of phones for social event organize and clinical prosperity data, transport of human administrations information to experts, researchers and patients, consistent seeing of patient urgent signs, the quick game plan of care (through flexible telemedicine) similarly as planning and joint exertion of prosperity workers. While m-Health undeniably has application for industrialized nations, the field has ascended starting late as, all things considered, an application for making countries, originating from the speedy climb of PDA penetration in low-pay nations

There are a growing number of flexible applications open for youth with passionate health issues and an extending energy for engrossing compact prosperity (m-Health) into mental prosperity organizations. Flexible prosperity contraptions and applications were basically invited for the people who done have the chance to manage their health or those how are bit languid to go to the activity community, people have made assorted kind of prosperity application for their wellbeing, there are various application. Made by the people to measure their step by step plan like there steps , there calories use in the day , there water utilization , there napping daily practice and moreover there are application that notice to you what you should do to stay fit in the step by step presence without taking off to the rec focus, there are various application that illuminate you concerning you weight are the sort of activity your body like to do and besides the application that make challenge to you to give you some particular health in a particular time period like the 30days test for different things , there are various application that help you to take care about your prosperity for helping you in your consistently plan these can end up being extraordinary prosperity instruments. Not simply have degrees of progress allowed propelled cell phones to be used as symptomatic devices (would associate the consolidation with rest following handiness), anyway the fundamental fact that such an enormous number of us have contraptions ready for action helps make therapeutic administrations progressively accessible. Various gadgets have been envisioned after the production of prosperity application after in dispatch of prosperity application in the propelled cell there are gadgets like watches that take care for your prosperity and health. The overall compact prosperity (m-Health) (application) publicize has been creating at gigantic rate, and it is depended upon to continue flourishing.

1. **Sport and Fitness Activity Tracker:** An activity tracker, in any case called a health tracker, is a device or application for checking and following wellbeing related estimations, for instance, partition walked or run, calorie usage, and now and then heartbeat and nature of rest. It is a kind of wearable PC. The term is right now fundamentally used for smart watches that are synchronized, a great part of the time remotely, to a PC or PDA for long stretch data following.
2. **Diet and Nutrition Apps:** Whether or not you’re managing your glucose or following a low-carb diet, these applications causes you adequately see what percent of your day’s calories have been from starches, fat, and protein so you can manage your affirmation. You can in like manner put versatile targets and separate your starch settlement for each dinner or goody to help you with staying on target.
3. **Weight Loss Coaching Apps:** Get Slimmer in Just a Few Days is a weight-loss approach that is both quick and safe. Nutrition regimens are available in addition to planned activities. It is implied that doing so will aid in the preservation of your health and financial security. Google Fit can monitor your exercise and calorie intake. If you stick to the plan, your body will be in the best form it has ever been. The plan includes exercises for your arms, buttocks, stomach, and legs, which will help you lose weight and shape your body. Because of the liveliness and visual direction, you can be certain that every movement has the proper structure. You can do your tasks whenever and wherever you desire, without the use of any instruments.
4. **Sleep Cycle Analysis:** Loosen up, rest better and wake up feeling rested with Sleep Cycle application, the splendid morning clock. Track rest from rest time to morning, and get point by point assessment with the application that causes finding a workable pace the start of the day essentially that bit less difficult. Track rest using your phone and start your day feeling animated with our astute morning clock and rest tracker. Its wonderful arrangement just stirs you while you’re in your light rest organize. Besides, you’ll

get quick and dirty reports as Sleep Cycle application screens your rest plans, from rest time until you're arousing.

REVIEW OF LITERATURE

1. Belen Cruz Zapata (2015)

Convenience of m-Health Apps: A Systematic Literature Review

The creating gathering of phones and tablets has empowered their utilization in prosperity systems, in this manner provoking the ascent of the term m-Health. M-Health courses of action have been used starting late to help the two authorities and parental figures, despite patients encountering a wide collection of diseases, for instance, dementia or compound lopsidedness. Convenience is one of the basic blocks to the determination of m-Health structures, primarily because of customers with phenomenal necessities, as increasingly settled adults or youths. Examiners and architects often survey the convenience of their m-Health suggestions by working with accurate procedures that incorporate certified customers[1]. This paper has separated 22 examinations that perform convenience evaluations of m-Health applications. Our disclosures show that m-Health applications started their advancement in the year 2013, and investigate is in this way in spite of everything creating. We have recognized the need to use modernized appraisal instruments, considering the way that practically 73 % of the papers picked use just gatherings or reviews to evaluate the applications[2].

2. David Pierric (2018)

Going past killer applications: building a predominant m-Health evidence base

Though some may be disappointed by the nonappearance of 'blockbuster' m-Health fundamentals, we are optimistic that the confirmation base for m-Health will grow liberally in coming years. Explicit troubles remain, especially in low-compensation and focus pay country settings where capability, prosperity training, unavailability of mobile phones and compelled access to strong data arrange all stance allocation challenges. Nevertheless, these components are improving rapidly, and the open entryways for future advancement are liberal[3]. With extending data on what works and what the challenges are, we will appear at a more nuanced appreciation of the activity of m-Health in improving prosperity and social protection.

3. Bethany C. Wangelin(2016)

Tele prosperity headways

m-Health has different potential central focuses, including growing accessibility of treatment material and of treatment assignments to be done outside of meeting. Regardless of the way that investigation taking a gander at the effects of m-Health on mental messes is in its starting periods, the couple of studies that have been coordinated to date are promising. This may be especially substantial for individuals who report noteworthy degrees of interest and comfort while using development (Gruber et al., 2001)[4]. Regardless of the way that the usage of m-Health as an extra to EBPs may not by and large impact reaction decline, it could energize better homework consistence and reducing grouping concerns.

4. Karandeep Singh(2017)

Flexible Health

The evidence base supporting the use of uses uninhibitedly of various interventions stays slight, and this has incited wariness among huge clinical relationship about the requests for employment may play in human administrations. Taking everything into account, applications continue dislodging increasingly prepared advances in a couple of territories, for example, by swapping committed specific devices for individuals with synthetic irregularity and displacing clinical gatherings with clinical ID fused with mobile phone lock screens.

Preventions, for instance, security concerns and nonappearance of fuse into the electronic prosperity record have confined the impact of utilizations, anyway m-Health can reshape therapeutic administrations transport later on[5].

5. Hafiz Fawad Ali (November 22, 2018)

Aware Attitude Among University Students

This assessment study surveys the relationship among various components that sway prosperity perceptive mindset. Prosperity mindful manner insinuates keeping up a procedure in which understudies know about taking incredible thought of their prosperity. The examination highlights on five free factors like preparing, lifestyle, eating tendencies, purchase desires and upgrades[6], got from composing and their impact on the dependent variable for instance prosperity.

6. MladenMilošević, Michael T. Shrove, Emil Jovanov, (2011)

Compact prosperity applications in workplace prosperity headway: a planned determined choice framework

This study tries to fill that vacuum by investigating the significance of mobile health apps as a component of workplace health advances and the underlying reasons why people use mobile health applications at work. As an issue of first significance, the association between observed earnestness and considered helplessness to be general starts and considered accommodation to be coordinating the enjoyed method for movement is new to prosperity lead and prosperity advancement affirmation composing, like the guiding activity of prompts to action in the desire direct relationship[7]. Thusly, the proposed model can fill in as a critical wandering stone right presently ask about, be tentatively attempted, and provide guidance to also analyze. (Johann MelznerJörgHeinze, Tobias Fritsch, 2014)

7. MladenMilossevick, Michael T. Shrove, Emil Jovanov, (2011)

Employments Of Smartphones For Ubiquitous Health Monitoring And Wellbeing Management

Capacities of the current period of phones and potential applications for all inclusive prosperity watching and wellbeing the board. We present the improvement of UAhealth - our fused compact prosperity checking structure for wellbeing the administrators, planned to screen physical activity, weight, and heart activity. mUAHealth screens Internet accessibility to choose when to submit prosperity related information to the remote clinical server. Data assembled by sensors at motivation behind consideration or labs ought to be anonymized and gathered for organize wide prosperity care and backing. Such data, especially assembled over peoples, can provoke surmising about endorsed strategies and cost speculation assets in giving prosperity organizations[8]. This is a promising field with exponentially extending number of sensors and openings in the business place that can on a very basic level change social protection system and make it continuously gainful.

8. J. Maitland, S. Sherwood, L. Barkhuus, I. Anderson, M. Anterom, B. Dull shaded, M. Chalmers, and H. Muller.(2017)

Extending the Awareness of Daily Activity Levels with Pervasive Computing,

The potential contribution to economic growth of an unimproved product development, such as the mobile phone. presenting a prototype application that tracks nearby passers-by's phone usage and analyses variations in signal strength to predict their location. Shakra is a simple tool for tracking physical activity and overall health development. It varies from other current studies and goods on the market because of its beneficial perspectives and lack of sensors other than wireless. During its review period, Shakra received an overwhelming amount of positive feedback[9]. However, accuracy, analysis, security, and care issues must be addressed before it may be utilised again.

9. FiratAlagooz, Andree Calero Valdez(2010)

From User Focus to Culture and Hedonism

The Crucible of Mobile Health Care and Wellness Applications,. Essential pieces of electronic restorative administrations applications won't simply be their ubiquitous openness yet also their ability to be facilitated into social components with respect to social complexities and individual tendencies. They ought to be usable by a contrasting customer gathering, populated by customers reaching out over an age scope of pretty much a century. These customers all offer a regular aching for brilliant, classy and usable interfaces. Organizing against avaricious necessities can change the customers' perception from pledge to need. Prosperity applications that show increasingly energetic customers a progressively gainful and continuously compact lifestyle will unavoidably change how an overall population sees itself and what it regards, not by impulse anyway by interest. A far reaching approach to manage progression of e-prosperity and wellbeing applications is required to make down to earth answers for the overall challenges of the exceptional century.

10. AinoAhtinen ,ArtoLehtiniemi, JonnaHakkila

Customer Perceptions on Interacting with Mobile Fitness Devices

Depict customer perceptions addressing distinctive differing target social occasions on picked measures. . Prosperity is considered as an extraordinarily sensitive zone and starting at now people trust more to experienced specialists than contraptions in restorative administrations examination. The results show that customer bundles with different destinations need different features for the wellbeing and social protection contraption. Teenagers would favor not to evaluate prosperity related things, yet the people who are overweighted have all the earmarks of being enthusiastic about following up a couple of wellbeing related measures and their progression.

11. Charlotte Tucker (2011)

prosperity related applications creating in number, conspicuousness

The applications overall fail to recommend that people consider pharmacotherapy and didn't insinuate people to stop lines or use social assistance. The most downloaded smoking discontinuance application was an enchanting application, regardless of how entrancing isn't exhibited effective for smoking suspension, Abrams said. Guaranteeing the applications they make are important and science-based is one of the most huge things an affiliation can do, said Jermaine McMillan, adventure head of MD Anderson Cancer Center .

Hypothesis

1. Ho: Youth are not aware with brands of health apps
H1: Youth are aware with brands of health apps
2. Ho: People are not using health apps to complete daily targets
H1: People are using health apps to complete daily targets
3. Ho: People not recommend others for health guidance using these apps
H1: People recommend others for health guidance using these apps
4. Ho: People are not distract from work because of health apps
H1: People are distract from work because of health apps
5. Ho: Youth are not Spending a lot of time on health apps
H1: Youth are Spending a lot of time on health apps
6. Ho: People are not using health apps only for looking different
H1: People are using health apps only for looking different
7. Ho: Heath apps are not helpful for youth to go gym

- H1: Health apps are helpful for youth to go gym.
8. Ho: Health apps are not helpful for youth to be flexible
H1: Health apps are helpful for youth to be flexible
9. Ho: It does not help to maintain daily records
H1: It help to maintain daily records
10. Ho: Health apps does not help youth to lose weight
H1: Health apps help youth to lose weight
11. Ho: Health apps does not provide diet plan
H1: Health apps provide diet plan
12. Ho: It does not help to walk up early
H1: It help to walk up early
13. Ho: Apps does not track calories
H1: Apps does track calories
14. Ho: Apps does not track weight
H1: Apps does track weight
15. Ho: Apps does not track steps
H1: Apps does track steps

Objectives

- To study the preference for health apps among youth.
- To check the usage of these applications in what age group
- To study the different variables of Liking and Disliking.
- To check the benefits being provided by the Health Applications to the users.

RESEARCH METHODOLOGY

This research paper was completely based on primary research as responses were collected from almost 113 people which was based on convenient and random sampling. People from all the age groups were targeted to know that what kind of health applications do they use to improve their diet & health, and how does it impact them. Also, for the analysis of the data SPSS version 25 was used. Linear regression was used.

Case Processing Summary

		N	%
Cases	Valid	113	100.0
	Excluded ^a	0	.0
	Total	113	100.0

Reliability Statistics

Cronbach's Alpha	N of Items
.782	17

Sample Design:

Sample Size: 113 Youths (An Empirical Study Of Growing Popularity Among Youth For Health Apps)

Sampling Method:- The sampling method is Convenience Sampling.

Sample Locale: The data is to be collected from the Youth's of Gwalior, Jhansi, Mathura, Agra.

Sample Selection: The sample selection is the process by which the researchers get the required data for concluding their research. In this research, the sample from the targeted population get collected from the various schools and colleges.

Data Collection & Data Sources

Data Collection: Questionnaire .

Data Sources: Data collection methods used for the study are primary and secondary.

Tool to be Used for Data Collection

Tools for Data Analysis:

The data prepared till now is to be reviewed to interpret the results to satisfy the objective of this research. Different techniques are used to interpret the result like Reliability analysis and Regression analysis through SPSS.

Data Analysis and Interpretation

Demographic Profile of Respondent

Demographic Characteristics	Demographic variables	No. of respondents	Percentage of respondents
Gender	Male	50	44.2
	Female	63	55.8
Age	15- 18	18	15.9
	18-21	26	23
	21-24	69	61.1

Correlation

Data analysis was done on the collected data. Two statistical tools were used- correlation and regression to find out the effect of the factors on each other according to the conceptual model. Here all of our hypothesis were used. We have 15 questions correlation with each other, where age is dependent variable. So correlation of all these are below:

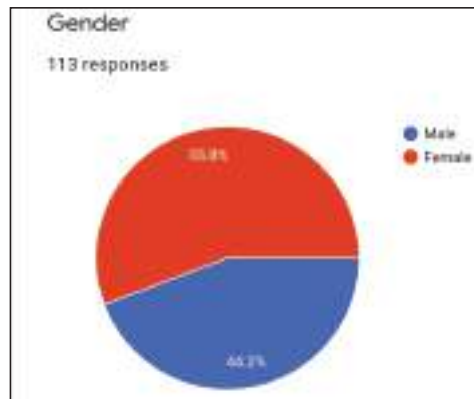
Correlations

	Gender	Age	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
Gender	Pearson Correlation	.250**	-.232*	-.091	-.008	.051	-.145	-.024	-.104	-.053	-.159	-.027	.009	.018	.010	-.158	.041
	Sig. (2-tailed)	.008	.013	.339	.931	.590	.124	.800	.271	.580	.093	.777	.924	.854	.915	.095	.669
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Age	Pearson Correlation	.250**	1	-.109	.045	.242**	-.083	-.083	-.101	-.268**	-.102	-.107	-.233*	-.045	-.107	-.229*	-.222*
	Sig. (2-tailed)	.008	.209	.251	.632	.010	.002	.382	.287	.004	.285	.257	.013	.637	.257	.015	.018
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Q1	Pearson Correlation	-.232*	1	.425**	.228*	-.061	.333**	.071	.259**	.207*	.289**	.098	.110	.031	.302**	.282**	.096
	Sig. (2-tailed)	.013	.209	.000	.015	.520	.000	.453	.006	.028	.002	.301	.244	.745	.001	.003	.310
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Q2	Pearson Correlation	-.091	.425**	1	.322**	.023	.091	.092	.103	.336**	.178	.309**	.204*	.059	.227*	.170	.179
	Sig. (2-tailed)	.339	.045	.000	.001	.808	.338	.334	.279	.000	.059	.001	.031	.534	.016	.071	.058
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Q3	Pearson Correlation	-.008	.228*	.322**	1	.212*	.066	.066	.170	.241*	.437**	.364**	.367**	.315**	.336**	.304**	.265**
	Sig. (2-tailed)	.931	.045	.001	.001	.024	.485	.486	.072	.010	.000	.000	.000	.001	.000	.001	.005
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Q4	Pearson Correlation	.051	-.061	.023	.212*	1	-.191*	-.178	.057	.000	.100	.124	.118	.087	.071	.079	.100
	Sig. (2-tailed)	.590	.520	.808	.024	.042	.060	.060	.551	.998	.292	.190	.214	.360	.452	.406	.293
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Q5	Pearson Correlation	-.145	.333**	.091	.066	-.191*	1	.567**	.294**	.303**	.081	.138	.086	.153	.132	.228*	.256**
	Sig. (2-tailed)	.124	.000	.338	.485	.042	.000	.001	.002	.001	.394	.145	.366	.106	.163	.015	.006
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113

Q6	Pearson Correlation	-.024	-.083	.071	.092	.066	-.178	.567**	1	.292**	.364**	.086	.276**	.192*	.231*	.114	.133	.295**
	Sig. (2-tailed)	.800	.382	.453	.334	.486	.060	.000		.002	.000	.364	.003	.042	.014	.230	.159	.002
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Q7	Pearson Correlation	-.104	-.101	.259**	.103	.170	.057	.294**	.292**	1	.305**	.296**	.439**	.220*	.288**	.375**	.273**	.418**
	Sig. (2-tailed)	.271	.287	.006	.279	.072	.551	.002	.002		.001	.001	.000	.019	.002	.000	.003	.000
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Q8	Pearson Correlation	-.053	-.268**	.207*	.336**	.241*	.000	.303**	.364**	.305**	1	.373**	.443**	.465**	.339**	.322**	.470**	.289**
	Sig. (2-tailed)	.580	.004	.028	.000	.010	.998	.001	.000	.001		.000	.000	.000	.000	.001	.000	.002
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Q9	Pearson Correlation	-.159	-.102	.289**	.178	.437**	.100	.081	.086	.296**	.373**	1	.306**	.419**	.340**	.320**	.489**	.412**
	Sig. (2-tailed)	.093	.285	.002	.059	.000	.292	.394	.364	.001	.000		.001	.000	.000	.001	.000	.000
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Q10	Pearson Correlation	-.027	-.107	.098	.309**	.364**	.124	.138	.276**	.439**	.443**	.306**	1	.392**	.345**	.461**	.303**	.391**
	Sig. (2-tailed)	.777	.257	.301	.001	.000	.190	.145	.003	.000	.000	.001		.000	.000	.001	.000	.000
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Q11	Pearson Correlation	.009	-.233*	.110	.204*	.367**	.118	.086	.192*	.220*	.465**	.419**	.392**	1	.397**	.415**	.476**	.382**
	Sig. (2-tailed)	.924	.013	.244	.031	.000	.214	.366	.042	.019	.000	.000	.000		.000	.000	.000	.000
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Q12	Pearson Correlation	.018	-.045	.031	.059	.315**	.087	.153	.231*	.288**	.339**	.340**	.345**	.397**	1	.282**	.264**	.347**
	Sig. (2-tailed)	.854	.637	.745	.534	.001	.360	.106	.014	.002	.000	.000	.000	.000		.002	.005	.000
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113

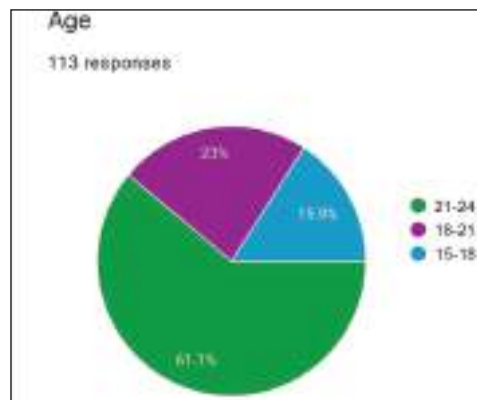
Q13	Pearson Correlation	.010	-.107	.302**	.227*	.336**	.071	.132	.114	.375**	.322**	.320**	.461**	.415**	.282**	1	.468**	.343**
	Sig. (2-tailed)	.915	.257	.001	.016	.000	.452	.163	.230	.000	.001	.001	.000	.000	.002		.000	.000
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Q14	Pearson Correlation	-.158	-.229*	.282**	.170	.304**	.079	.228*	.133	.273**	.470**	.489**	.303**	.476**	.264**	.468**	1	.168
	Sig. (2-tailed)	.095	.015	.003	.071	.001	.406	.015	.159	.003	.000	.000	.001	.000	.005	.000		.075
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Q15	Pearson Correlation	.041	-.222*	.096	.179	.265**	.100	.256**	.295**	.418**	.289**	.412**	.391**	.382**	.347**	.343**	.168	1
	Sig. (2-tailed)	.669	.018	.310	.058	.005	.293	.006	.002	.000	.002	.000	.000	.000	.000	.000	.075	
	N	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
**. Correlation is significant at the 0.01 level (2-tailed).																		
*. Correlation is significant at the 0.05 level (2-tailed).																		

Gender Profile of Respondent



It is found that 44.2% youths are male and 55.8% are female.

Age Profile of Respondents



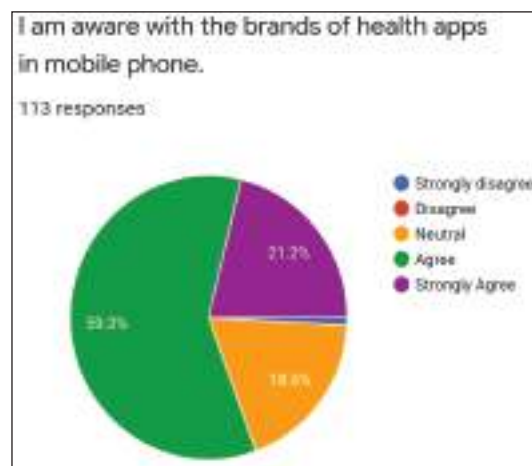
It is found that 61.1% youths are between the age of 21-24, 23% youths are between the age of 18-21 & 15.9% youths are between 15-18.

Analysis for objective: To measure the impact of factors on different age group of youths.

For 1st Factor (Awareness)

Ho: Youth are not aware with brands of health apps

H1: Youth are aware with brands of health apps



Model Summary						
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate		
1	.119 ^a	.014	.005	.693		
a. Predictors: (Constant), Age						
ANOVA ^a						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	.766	1	.766	1.597	.209 ^b
	Residual	53.234	111	.480		
	Total	54.000	112			
a. Dependent Variable: Awareness						
b. Predictors: (Constant), Age						

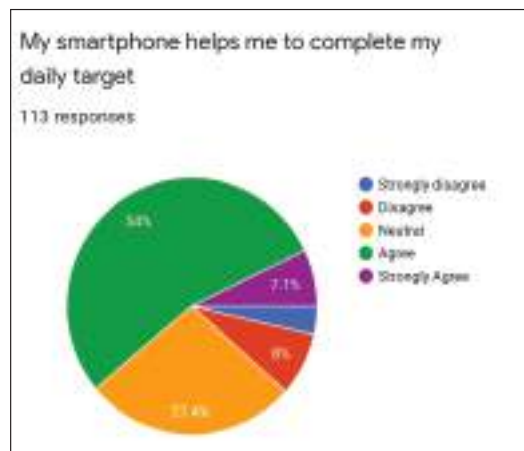
Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.268	.222		19.226	.000
	Age	-.109	.087	-.119	-1.264	.209
a. Dependent Variable: Awareness						

In this, R² value is coming as 1.40% which an indication of strong predictor model. This means 1.40% of variance is explained by Attributes. Standard error is relatively high. That F-value is significant which exhibits overall significance of regression model. Exhibits t-value for testing the slope of the regression model.

For 2nd Factor (Daily Targets)

H0: People are not using health apps to complete daily targets

H1: People are using health apps to complete daily targets



Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.109 ^a	.012	.003	.876
a. Predictors: (Constant), Age				

ANOVA ^a						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1.020	1	1.020	1.330	.251 ^b
	Residual	85.121	111	.767		
	Total	86.142	112			
a. Dependent Variable: Daily Targets						
b. Predictors: (Constant), Age						

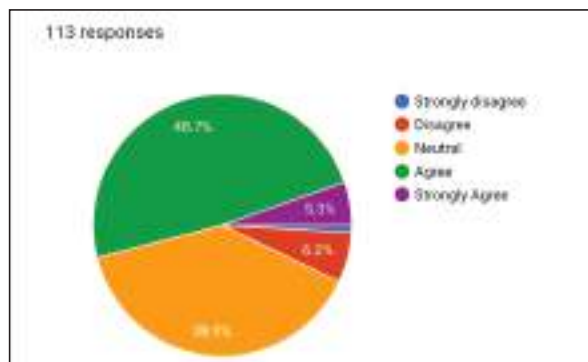
Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.841	.281		13.681	.000
	Age	-.126	.109	-.109	-1.153	.251
a. Dependent Variable: Daily Targets						

In this, R² value is coming as 1.20% which is an indication of a strong predictor model. This means 1.20% of variance is explained by Attributes. Standard error is relatively high. That F-value is significant which exhibits overall significance of regression model. Exhibits t-value for testing the slope of the regression model.

For 3rd Factor (Health Guidance)

H0: People not recommend others for health guidance using these apps

H1: People recommend others for health guidance using these apps



Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.045 ^a	.002	-.007	.736
a. Predictors: (Constant), Age				

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.125	1	.125	.230	.632 ^b
	Residual	60.106	111	.541		
	Total	60.230	112			
a. Dependent Variable: Health Guidance						
b. Predictors: (Constant), Age						

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.405	.236		14.435	.000
	Age	.044	.092	.045	.480	.632

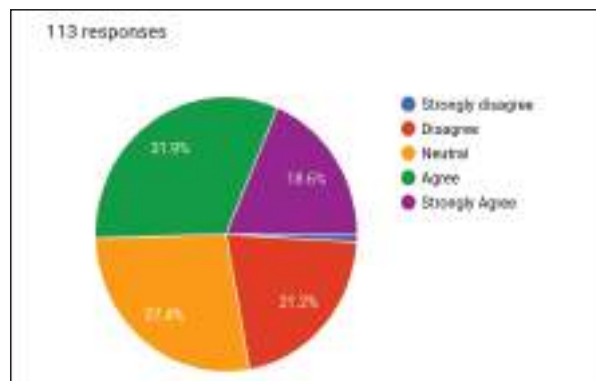
a. Dependent Variable: Health Guidance

In this, R² value is coming as 0.20% which an indication of strong predictor model. This means 0.20% of variance is explained by Attributes. Standard error is relatively high. That F-value is significant which exhibits overall significance of regression model. Exhibits t-value for testing the slope of the regression model.

For 4th Factor (Professional Work)

H0: People are not distract from work because of health apps

H1: People are distract from work because of health apps



Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.242 ^a	.058	.050	1.026

a. Predictors: (Constant), Age

ANOVA ^a						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	7.245	1	7.245	6.884	.010 ^b
	Residual	116.825	111	1.052		
	Total	124.071	112			

a. Dependent Variable: Professional Work

b. Predictors: (Constant), Age

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.635	.329		8.013	.000
	Age	.337	.128	.242	2.624	.010

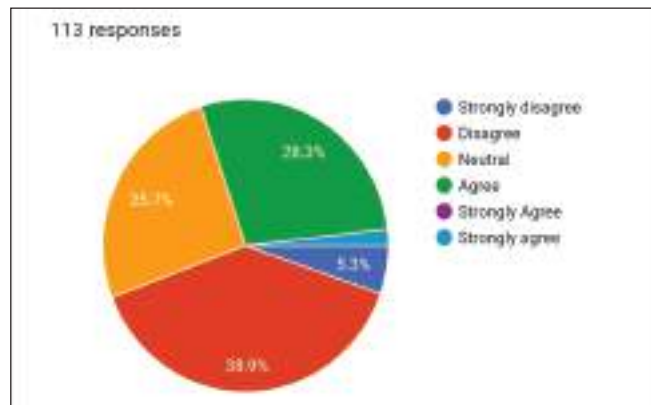
a. Dependent Variable: Professional Work

In this, R^2 value is coming as 5.80% which an indication of strong predictor model. This means 5.80% of variance is explained by Attributes. Standard error is relatively high. That F -value is significant which exhibits overall significance of regression model. Exhibits t -value for testing the slope of the regression model.

For 5th Factor (Habit Using Apps)

H0: Youth are not Spending a lot of time on health apps

H1: Youth are Spending a lot of time on health apps



Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.293 ^a	.086	.078	.927

a. Predictors: (Constant), Age

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.983	1	8.983	10.443	.002 ^b
	Residual	95.478	111	.860		
	Total	104.460	112			

a. Dependent Variable: Habit

b. Predictors: (Constant), Age

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.741	.297		12.584	.000
	Age	-.375	.116	-.293	-3.232	.002

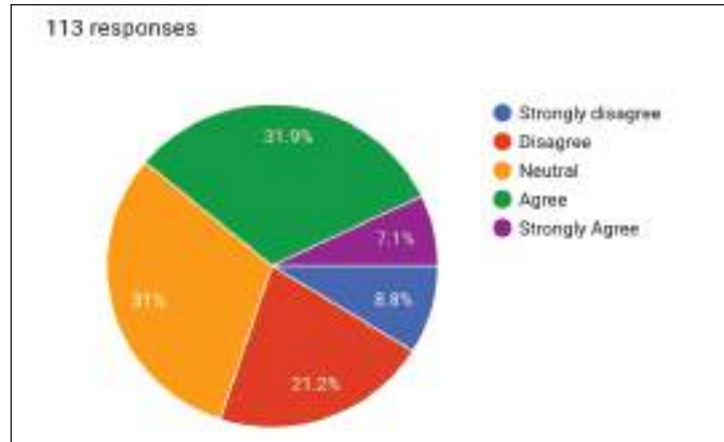
a. Dependent Variable: Habit

In this, R^2 value is coming as 8.60% which an indication of strong predictor model. This means 8.60% of variance is explained by Attributes. Standard error is relatively high. That F -value is significant which exhibits overall significance of regression model. Exhibits t -value for testing the slope of the regression model.

For 6th Factor (Look Different)

Ho - People are not using health apps only for looking different

H1 - People are using health apps only for looking different



Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.083 ^a	.007	-.002	1.084

a. Predictors: (Constant), Age

ANOVA ^a						
	Model	Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	.905	1	.905	.770	.382 ^b
	Residual	130.528	111	1.176		
	Total	131.434	112			

a. Dependent Variable: Look Different

b. Predictors: (Constant), Age

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.362	.348		9.672	.000
	Age	-.119	.136	-.083	-.877	.382

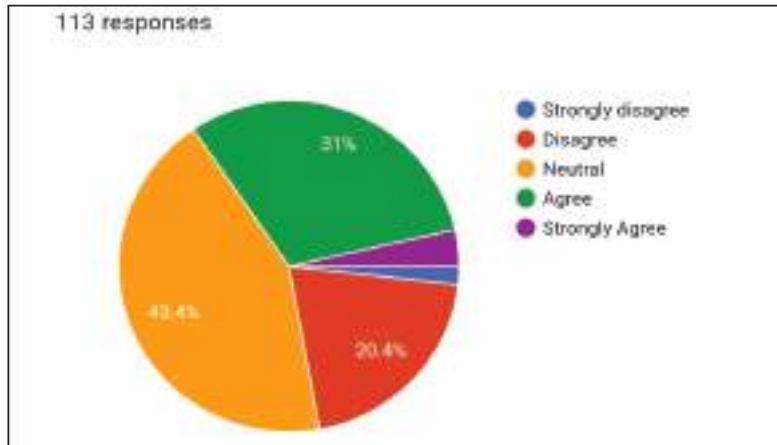
a. Dependent Variable: Look Different

In this, R² value is coming as 0.70% which an indication of strong predictor model. This means 0.70% of variance is explained by Attributes. Standard error is relatively high. That F-value is significant which exhibits overall significance of regression model. Exhibits t-value for testing the slope of the regression model.

For 7th Factor (Gym)

Ho: Heath apps are not helpful for youth to go gym

H1: Health apps are helpful for youth to go gym.



Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.101 ^a	.010	.001	.843

a. Predictors: (Constant), Age

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.815	1	.815	1.146	.287 ^b
	Residual	78.920	111	.711		
	Total	79.735	112			

a. Dependent Variable: Gym

b. Predictors: (Constant), Age

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
(Constant)	3.418	.270		12.646	.000	
Age	-.113	.105	-.101	-1.071	.287	

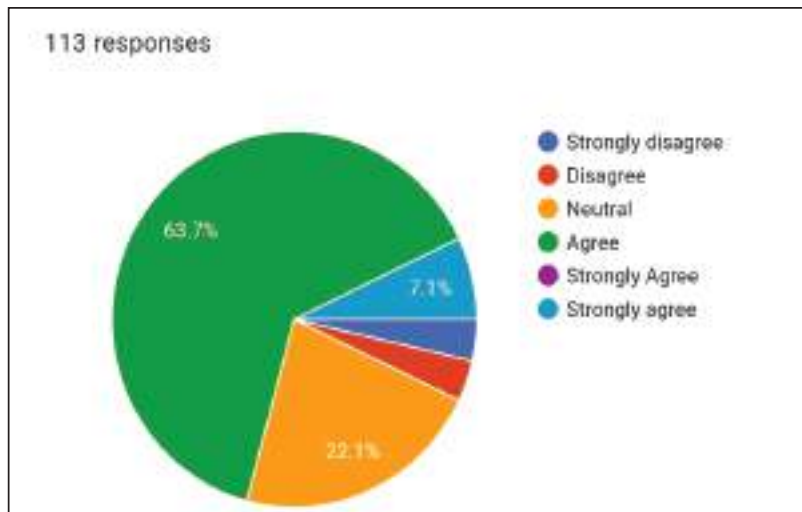
a. Dependent Variable: Gym

In this, R² value is coming as 1.00% which an indication of strong predictor model. This means 1.00% of variance is explained by Attributes. Standard error is relatively high. That F-value is significant which exhibits overall significance of regression model. Exhibits t-value for testing the slope of the regression model.

For 8th Factor (Flexible)

Ho: Health apps are not helpful for youth to be flexible

H1: Health apps are helpful for youth to be flexible



Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.268 ^a	.072	.063	.781

a. Predictors: (Constant), Age

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.235	1	5.235	8.589	.004 ^b
	Residual	67.650	111	.609		
	Total	72.885	112			

a. Dependent Variable: Flexible

b. Predictors: (Constant), Age

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.374	.250		17.476	.000
	Age	-.286	.098	-.268	-2.931	.004

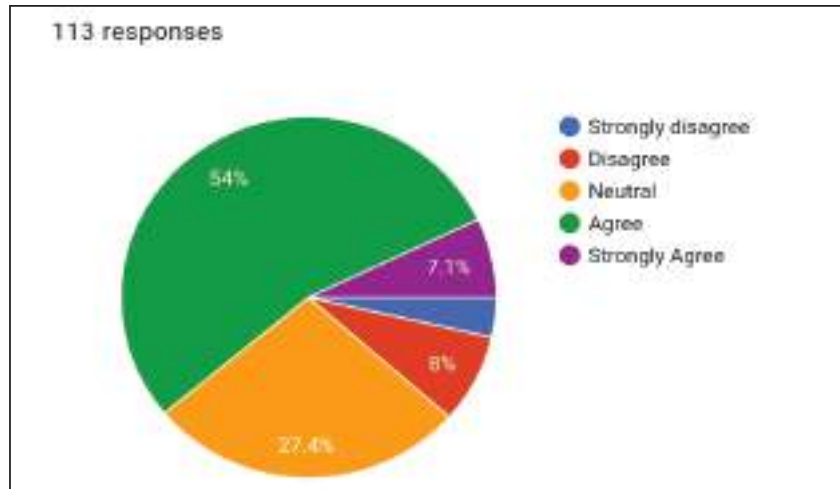
a. Dependent Variable: Flexible

In this, R^2 value is coming as 7.20% which an indication of strong predictor model. This means 7.20% of variance is explained by Attributes. Standard error is relatively high. That F -value is significant which exhibits overall significance of regression model. Exhibits t -value for testing the slope of the regression model.

For 9th Factor (Maintain Records)

Ho: It does not help to maintain daily records

H1: It help to maintain daily records



Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.102 ^a	.010	.001	.845

a. Predictors: (Constant), Age

ANOVA ^a						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	.825	1	.825	1.156	.285 ^b
	Residual	79.193	111	.713		
	Total	80.018	112			

a. Dependent Variable: Maintain Records

b. Predictors: (Constant), Age

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.048	.271		14.951	.000
	Age	-.114	.106	-.102	-1.075	.285

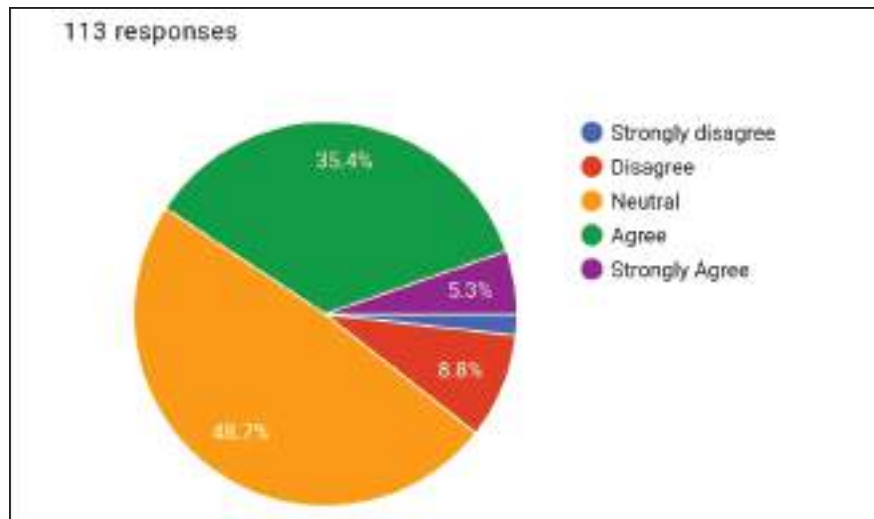
a. Dependent Variable: Maintain Records

In this, R² value is coming as 1.00% which an indication of strong predictor model. This means 1.00% of variance is explained by Attributes. Standard error is relatively high. That F-value is significant which exhibits overall significance of regression model. Exhibits t-value for testing the slope of the regression model.

For 10th factor (Loose Weight)

Ho: Health apps does not help youth to lose weight

H1: Health apps help youth to lose weight



Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.107 ^a	.012	.003	.785

a. Predictors: (Constant), Age

ANOVA ^a						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	.799	1	.799	1.296	.257 ^b
	Residual	68.422	111	.616		
	Total	69.221	112			

a. Dependent Variable: Loose Weight

b. Predictors: (Constant), Age

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.610	.252		14.344	.000
	Age	-.112	.098	-.107	-1.139	.257

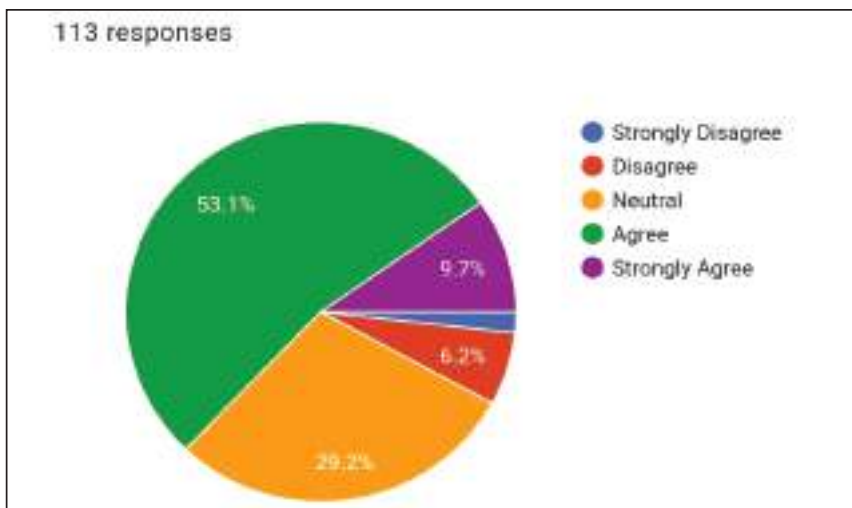
a. Dependent Variable: Loose Weight

Exhibits for Respondents' Final Purchase Attributes. This table displays R and R² values. With a R value of 0.107, the "R" column shows that there is a significant correlation between age and weight loss apps for young people. Because the R² value is 1.20, the model performs well as a predictor in this case. This means that attributes explain 1.20 percent of the variance. The standard deviation is considerable. This F-value is significant, demonstrating the regression model's general significance. The t-value is used to evaluate the slope of the regression model.

For 11th Factor (Diet Plan)

Ho: Health apps does not provide diet plan

H1: Health apps provide diet plan



Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.233 ^a	.054	.046	.796

a. Predictors: (Constant), Age

ANOVA ^a						
	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.023	1	4.023	6.347	.013 ^b
	Residual	70.366	111	.634		
	Total	74.389	112			

a. Dependent Variable: Diet Plan
b. Predictors: (Constant), Age

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.243	.255		16.624	.000
	Age	-.251	.100	-.233	-2.519	.013

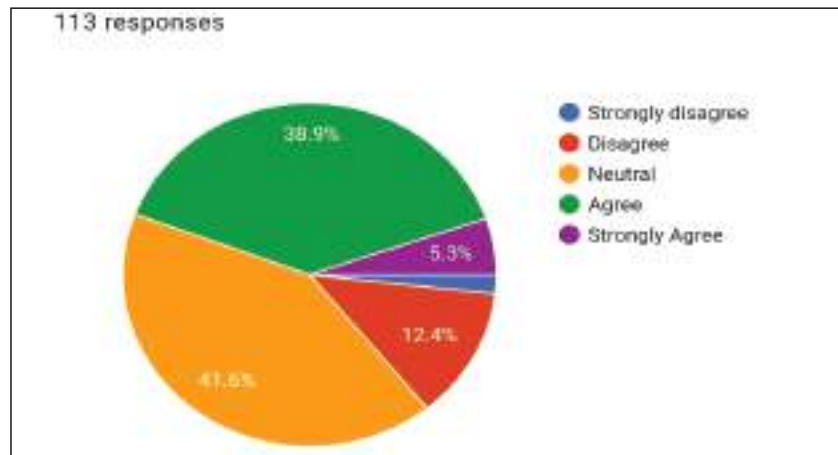
a. Dependent Variable: Diet Plan

Exhibits for Respondents’ Final Purchase Attributes. This table displays R and R2 values. The R value of 0.233 in the “R” column indicates that there is a significant relationship between ageing and health. Apps with a high R value provide diet plans based on a user’s health. In this case, the R2 value is 5.40%, indicating that the model performs well as a predictor. This means that attributes explain 5.40% of the variance. The standard deviation is considerable. This F-value is significant, demonstrating the regression model’s general significance. The t-value is used to evaluate the slope of the regression model.

For 12th Factor (Wake Up Early)

Ho: It does not help to walk up early

H1: It help to walk up early



Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.045 ^a	.002	-.007	.833

a. Predictors: (Constant), Age

ANOVA ^a						
	Model	Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	.155	1	.155	.223	.637 ^b
	Residual	77.066	111	.694		
	Total	77.221	112			

a. Dependent Variable: Wake Up Early
b. Predictors: (Constant), Age

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.457	.267		12.942	.000
	Age	-.049	.104	-.045	-.473	.637

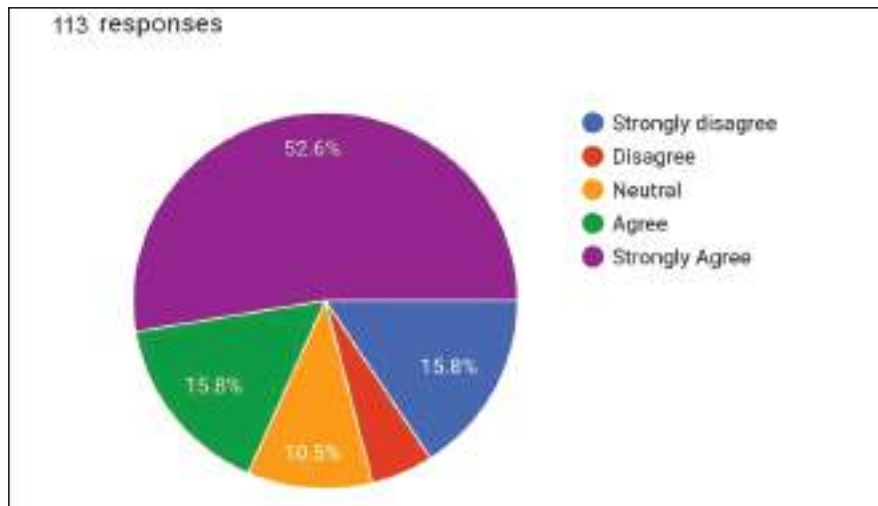
a. Dependent Variable: Wake Up Early

Exhibits for Respondents' Final Purchase Attributes. This table displays R and R² values. The R value of 0.045 in the "R" column indicates a straightforward correlation. This suggests that age and health apps for young people that promote early rising have a significant relationship. Because the R² value is 0.20, the model performs well as a predictor in this case. This means that attributes explain 0.2% of the variance. The standard deviation is considerable. This F-value is significant, demonstrating the regression model's general significance. The t-value is used to evaluate the slope of the regression model.

For 13th Factor (Track Calories)

Ho: Apps does not track calories

H1: Apps does track calories



Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.107 ^a	.012	.003	.767

a. Predictors: (Constant), Age

ANOVA ^a						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	.762	1	.762	1.297	.257 ^b
	Residual	65.220	111	.588		
	Total	65.982	112			

a. Dependent Variable: Track Calories
b. Predictors: (Constant), Age

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.816	.246		15.530	.000
	Age	-.109	.096	-.107	-1.139	.257

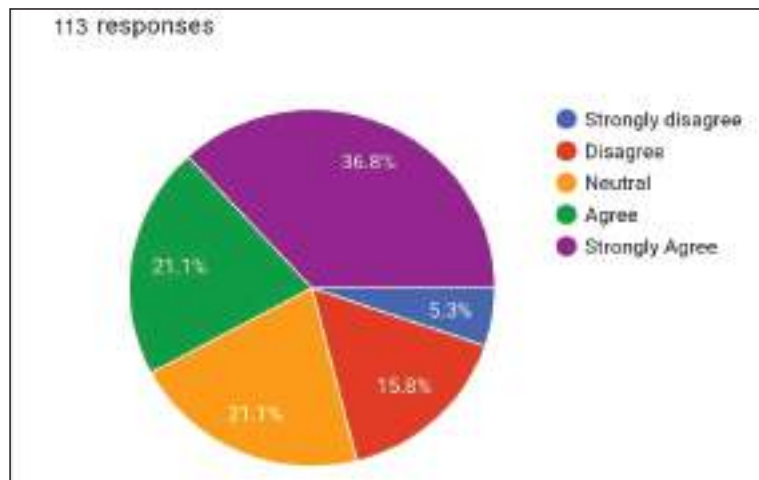
a. Dependent Variable: Track Calories

Exhibits for Respondents’ Final Purchase Attributes. This table displays R and R² values. With a R value of 0.107, the “R” column shows that there is a significant correlation between age and calorie-tracking health apps. Because the R² value is 1.20, the model performs well as a predictor in this case. This means that attributes explain 1.20 percent of the variance. The standard deviation is considerable. This F-value is significant, demonstrating the regression model’s general significance. The t-value is used to evaluate the slope of the regression model.

For 14th Factor (Track Weight)

Ho: Apps does not track weight

H1: Apps does track weight



Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.229 ^a	.052	.044	.893

a. Predictors: (Constant), Age

ANOVA ^a						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	4.906	1	4.906	6.149	.015 ^b
	Residual	88.563	111	.798		
	Total	93.469	112			

a. Dependent Variable: Track weight

b. Predictors: (Constant), Age

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.458	.286		15.567	.000
	Age	-.277	.112	-.229	-2.480	.015

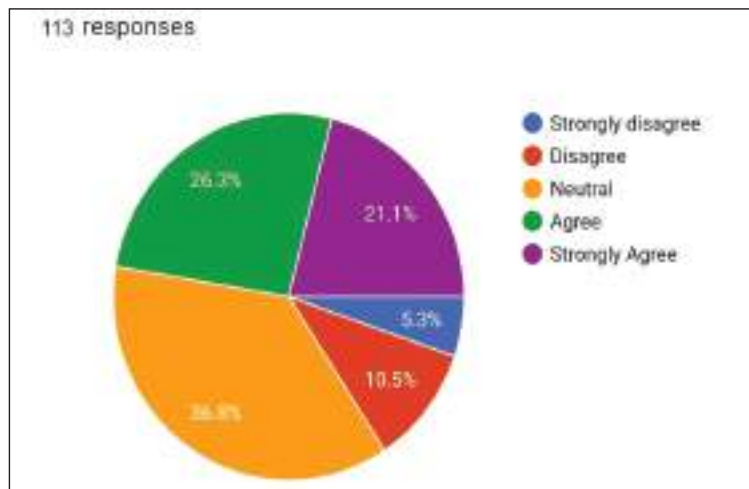
a. Dependent Variable: Track weight

Exhibits for Respondents’ Final Purchase Attributes. This table displays R and R2 values. The R value of 0.229 (in the “R” column) indicates a simple correlation. This points to a significant relationship between age and weight-tracking apps. In this case, the R2 value of 5.20 indicates that the model is a reliable predictor. This means that attributes explain 5.20 percent of the variance. The standard deviation is considerable. This F-value is significant, demonstrating the regression model’s general significance. The t-value is used to evaluate the slope of the regression model.

For 15th Factor (Track Steps)

Ho: App does not track steps

H1: Apps does track steps



Model Summary						
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate		
1	.222 ^a	.049	.041	.916		
a. Predictors: (Constant), Age						
ANOVA ^a						
	Model	Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	4.823	1	4.823	5.753	.018 ^b
	Residual	93.053	111	.838		
	Total	97.876	112			
a. Dependent Variable: Track steps						
b. Predictors: (Constant), Age						

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.115	.294		14.021	.000
	Age	-.275	.114	-.222	-2.399	.018
a. Dependent Variable: Track steps						

Exhibits for Respondents’ Final Purchase Attributes. This table displays R and R2 values. With a R value of 0.222, the “R” column shows that there is a significant correlation between age and step-tracking health apps. Because the R2 value is 4.90 percent, the model is a reliable predictor in this case. This means that attributes explain 4.90% of the variance. The standard deviation is considerable. This F-value is significant, demonstrating the regression model’s general significance. The t-value is used to evaluate the slope of the regression model.

FINDING

- 113 number of person respond this survey. Where 55.8% are female and 44.2% are male.
- Survey was conducted for youth age between 15-24. Where 61.1% are from 21-24, 23% are from 18-21 and 15.9% are from 15-18 age groups.

3. 59.3% youth are agree that they are aware about health apps. Only 0.9% are strongly disagree about it.
4. 54% are agree that health apps helps them to complete daily targets where only 3.5% are strongly disagree about this.
5. 48.7% youths agree to recommend health apps to other. Where 38.9% are neutral about this.
6. 31.9% agree that health apps distract them from doing their professional work. But it is very close to people who are neutral and disagree with this by 27.4% and 21.2% respectively.
7. 38.9% people are disagree, that they have habit to spend too much time on health apps. While 28.3% are agree with this.
8. 31.9% are agree with the statement that, health apps helps them to look different. And 31% are neutral on this.
9. 43.4% people are neutral on that, health apps help them to go gym. While 31% are agree with this.
10. 63.7% are agree, that health apps help them to be a flexible. And only 22.1% are neutral about it.
11. 48.7% are agree with, health apps help them to maintain records of daily workout. And 17.7% are also strongly agree with this.
12. 48.7% are neutral with question, that health apps help them to losse weight. Where 35.4% are agree with this.
13. 53.1% people agree with diet plan is provided by health apps. Only 6.2% are disagree with this.
14. 41.6% people are neutral on question, that health apps help them to wake up early. And 38.9% are agree with this.
15. 52.6% people are strongly agree with, health apps track their calories. And 15.8% are only strongly disagree with this.
16. 36.8% are strongly agree with, health apps track their weight. Only 5.3% people are strongly disagree with this.
17. 36.8% youths have neutral view on health apps track steps. But 26.3% are agree and 21.1% are strongly agree with this.

CONCLUSION

As in research, it is found that health apps are growing popular among youths, as it help them in various ways. The majority of app users described themselves as younger, more educated, and in good health. Despite differences by gender, age, and educational attainment, a sizable proportion of respondents believe demographic factors are less likely to influence mobile device use. Using a health app was associated with healthy eating, exercise, and meeting physical activity guidelines. In most factors of healths apps youth are agree with their features and they appreciate but some are not upto the mark. But we can say that healths apps are useful to youths in various ways, like maintain records, physical work and by reduce stress .Youths are using health apps and it does not effect their professional work. They are liking different variables of apps such as track of calories , weight and steps. Youths also like this because it also provide diet plan according to their health. User finds good benefits, which is provided by health apps. Health apps are now going popular among youths because of their features.

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Analyzing Variable Influencing Purchase Decisions Concerning Herbal Products

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▶ ABSTRACT ◀

In this paper we collect the knowledge about factors that affecting the herbal product purchasing. Also we collect importance of herbal product and his old qualities in this paper we discuss about the how much herbal product help Indian economy and also we highlight the components about herbal purchasing and we have important analysis about that how herbal product purchasing cover Indian market with his lots of brands. We have literature review about herbal products and we collect lots of objective. This research possible with qualitative research method and content analysis method that helps me to make this research paper.

Keywords: *Herbal Ayurveda Product, Herbal Things, Buying Behavior, Herbal Industry, Herbal Analyze.*

INTRODUCTION

Ayurveda, which means “Knowledge of Life,” is a traditional medical practise that has been practised for over 5,000 years. In Sanskrit, Ayu literally means “life,” whereas Veda literally means “knowledge or science.” As a result, the phrase “Science of Life” is widely used to characterise Ayurveda. Rig Veda, Sama Veda, Yajur Veda, and Atharvaveda are the four primary Vedas. Only Brahmins knew how to cure at first, therefore they were the only ones referred to be physicians. Things were different this time, and members of other groups learned how to recuperate. And the term vaidya was adopted to describe these people. Ayurveda is a system of principles that uses the vital elements of nature to keep an individual’s mind, body, and spirit in balance with nature. This benefits their health. Ayurveda is incredibly important because it studies health and disease holistically and connects each individual’s microcosm to the macrocosm of the cosmos. It studies the interactions of energy and matter.

The Ayurvedic and herbal medicine approach to treatment treats the whole person, not just the damaged area. The way a customer views a product or service is known as their “customer perception.” It could also include client satisfaction and what customers expect from Ayurvedic herbal items. The World Health Organisation has recognised Ayurveda as a comprehensive natural medicine system.

Herbal treatments have been used since the dawn of humanity. Both men and women have historically prioritised appearance and health. As a result, people use herbal beauty and health products to look appealing, young, and healthy. People all across the world are familiar with Indian plants and their purposes. Herbal and Ayurvedic products are becoming increasingly popular. There are many different sorts of women in the world, and the herbal cosmetics business in India is thriving, thanks to brands such as Himalaya Herbal, Khadi Herbal, Lotus Herbal, and others. The Indian cosmetics market is divided into several segments, including dental care, skin care, hair care, fragrance, and colour cosmetics. Garlic capsules, amla capsules, aloe vera capsules, turmeric capsules, herbal eye drops, and capsules and oils for hair development are among the natural treatments used by people. Herbal cosmetics, pharmaceuticals, therapies, fashion, and grooming are all popular these days. People nowadays choose to use herbal and Ayurvedic products over synthetic ones. This is because the world has changed and people are becoming more aware of the health benefits of herbal and Ayurvedic products.

Herbal Cosmetic Industry

The market for herbal personal care products and cosmetics is rapidly expanding. The expansion of the herbal cosmetics market in India indicates a growing desire for natural and herbal beauty products. People are shifting away from chemical-based products and towards those made from plants. Natural and organic personal care products are becoming more popular as people become more aware of how beneficial they are to their skin and general health. People are now more aware of the risks linked with chemical products than they were 10 to 15 years ago. Because of the growing demand for natural products, various health-focused companies, such as Dabur, Himalaya, Patanjali, VLCC, and others, have begun making and selling natural cosmetics.

Ayur is a well-known brand in the Indian cosmetics business due to the high quality of its products and the use of natural ingredients. The group has grown from a humble beginning in 1996 with 100 million rupees in revenue to a revenue of 2,600 million rupees in 2016.

Himalaya is a pharmaceutical company with an eight-decade history. Before developing herbal remedies and herbal personal care products, it performs extensive clinical research and testing. People are also interested in natural hair care products at the time. Ayur, Dabur, and Vatika are the key competitors in these markets. Patanjali’s herbal products are currently popular throughout India. Herbal cosmetics will continue to be in high demand. This is an excellent location for starting a new business. Effective marketing techniques, a regular supply of new things, a robust distribution network, consistently improving product quality, and the ability to offer a diverse selection of high-quality products are all required for success. These are some of the most essential factors impacting market growth. Understanding the diverse groups of herbal product purchasers’ feelings, opinions, likes, and desires is critical for economic success in India.

Beauty care products are intended to be utilized on the face and eye zone. Which are normally products are recognized by the territory of the body expected for application. Groundwork comes in equations which are suit to be singular skin conditions. Ayurvedic prescriptions are the arrangement of mending that started in antiquated India. In Sanskrit, ayur signifies “life or living” and veda signifies “learning”, so Ayurveda has been characterized as the “information of living” or the “art of life span.” Herbal Cosmetics is characterized as beauty products, which are take desirable physiological activities, for example, the skin healing, appearance, smoothening, improving and properties with the help of natural ingredients. Natural cosmetic define as a product be found **natural** substances of mineral, natural or creature birthplace which are solely acquired through microbiological, physical or enzymatic strategies, with specific exemptions for scents and preservatives. A number of the enormous name drugstore and top of the line restorative organizations are sans savagery, however their items are typically included for the most part of manufactured fixings.

Herbal Cosmetic Products In India

List is the various top brands of herbal cosmetic products which are available in India. Himalaya Herbals is one of the most well-known names in the business for natural professional hands and toenail care products in India. Since 1930, the company has taken great care of our appearance by offering a comprehensive selection of 100% safe and natural goods. This method is well-known for features such as the lengthy period required by experts to investigate it, uncommon mountain herbs, the greatest ayurvedic structures, and the most significant pharmaceutical advancements. Lotus Herbal is one of India's most well-known pharmaceutical companies. Lotus Herbals sells over 250 different beauty and cosmetic care products. It is completely genuine, albeit a little difficult to achieve. Furthermore, it may be difficult to discover herbs that are both therapeutic and beneficial. Lotus is ISO 9001 certified and takes a systematic approach to human resource management. As a result, we can grant long-term contracts as soon as feasible, harnessing the potential of our excellent company.

Lotus Herbals Products

- **Skin Care:** go up against washes, chemicals, toners, correctors, salves, protectors, nourishes, exfoliators, enhancers, lip care and brightening territory.
- **Makeup:** go up against, eyes, lips, nails, Eco remain and other,
- **Hair Care:** Oils, shampoos and tonics.
- **Body Care:** are moisturizers and Ayurveda filtering bars.
- **Safe Sun Care:** some time recently sun, after sun, non-oily, against developing with tint, for men and for kids.

Ayur Herbals

Ayur is an Indian herbal cosmetic company. It has been in existence since 1986. Ayur is known for offering good quality of products and at the affordable prices. Here are some ayur beauty products that are widely used and loved by consumers. Ayur Herbals offers a huge scope of the normal excellence and makeup items to Indian and in addition global clients Customers are well know about the ayur herbal products in current scenario.

Ayur Herbals Products

- **Face Care:** gels, wash, moisturizers, moisturizers, creams, scours, cloak, packs, cleansing drain, astringent, toners and lip demulcent.
- **Body Care:** waxes, rosewater, cleansers, sensibility blur and bosom firming items.
- **Sun Care:** sunscreen cream and after sun devour gel.
- **Hair Care:** hair wash, oils, shampoos, conditioners, styling gels, kali mehndi and henna powder.

VLCC (Very Large Curd Carrier)

VLCC is biggest brand in current scenario and it founded in 1986 by Mrs. Vandana Luthra. VLCC is providing various problem solutions like: weight loss, skin care, hair care, body care, therapeutic and beauty treatments.

VLCC Products

- **Skin Care:** Chemicals, washes, cleans, toners, astringent, creams, packs, cleansers, skin brightening things, against defilement things, colors, eye care and lip mind.
- **Sun Defense Extend:** Sun screens and after sun mind.
- **Specialties:** facial units, things for body molding and things for prepping.
- **Hair Care:** oils, shampoos, henna, conditioners and veils.
- **Body Care:** salves, body treatment and pedicle.

Advantages of Herbal Cosmetics

- Natural ingredients products
- Safely for using
- Compatible with all skin writes
- Fit for customer budget
- Wide rang are available in market for selecting the herbal products
- Not tested on animals
- Easily to available in markets

Need For Study

- People are more health conscious now a day. They are preferring products to which have a perfect blend of quality, features and right price. Same is happening/ applied in case of cosmetic products too.
- This study will try to find out the preferences of customers in terms of products used by their (cosmetics), rational/reason for using na specific category of products (herbal), the reasons to avoid such products. Ultimately this will provide a hint for the market potential of this cosmetic `products.

LITERATURE REVIEW

Domestic goods are utilised more frequently in personal care, according to V. Kapoor's [1] study, and there is a large demand for domestic cosmetics. The personal care business is currently focusing more on natural-based cosmetics since it is a fast increasing sector that will grow greatly in the next years. Bioactive substances in cosmetics modify the organic components of the skin while also providing critical nutrients to the skin or hair. India's present contribution to the global market is insignificant. This scenario may change if researchers, technologists, the cosmetics industry, and the government coordinated on research and development and actively worked with the cosmetics sector. Yasmin According to a 2008 Singapore Wala study, young Indian women are becoming more aware of the need of always looking their best. Both the skin care and cosmetics businesses have grown steadily over the last five years[2]. According to a Euro Monitor analysis on the Indian cosmetics and hygiene industry, the skin care market is valued \$346,9 million, while the colour cosmetics sector is worth \$113,4 million. Himalaya Herbals, according to Simon Pitman's (2011)[3] study, is a brand of safe, organic, and effective goods made from carefully chosen natural herbs. These solutions combine years of scientific study with the most efficient herbal formulations to aid in the restoration of your skin's health and brightness. The 2012 study by Prof. SiddharthaShriramShimpi and Dr. D. K. Sinha shows that, while male restorative products are still a niche market in India, the case for them is improving and increasing. Men are more concerned with their looks and self-care when it comes to fitness and health. Finding out what guys need and how they think and prepare might lead to new advertising chances in this underdeveloped market[4]. While advertising for men's beauty care products has a lot of promise, it requires a different strategy than advertising for the rising female market. This is because men and women act and perform in very different ways. This survey highlights the most important product quality components as seen by Punean guys who buy cosmetics. The texture of the product, its benefits, how well it compliments your skin type, and how long it lasts, according to the expert, are the most important of the product's examined characteristics. According to the findings of a 2012 study done by Vikrant Arya, Raneev Thakur, Suresh Kumar, and Sanjeev Kumar, the residents of Joginder Nagar are more interested in over-the-counter (OTC) Ayurvedic therapies than in items or drugs recommended by doctors.[5] As a result, if we are to compete on the global market and keep consumers pleased, we must effectively spread correct information about Ayurvedic and indigenous treatments. The findings for Ayurveda in India differ from what is actually happening since individuals in Joginder Nagar did not behave as planned. A multitude of variables impact women's cosmetic consumption patterns and purchase decisions, according to Abdullah Bin Junaid, Reshma Nasreen, and Faheem Ahmed (2013)[6]. Because Delhi is India's largest state and the National

Main Region (NCR) is made up of growing cities, these two locations were chosen for data collecting. The data exposes how women apply makeup as well as how the cosmetics business functions. We observed that when a woman's income climbs, so does her expenditure on cosmetics. Furthermore, we noticed that people are becoming more conscious of cosmetics. In other words, people choose items that benefit them. As more herbal cosmetic firms debut, the herbal cosmetics industry will have a significant possibility to dominate the cosmetics market. The majority of the subjects in a 2015 study done by M. Banu Rekha and K. Gokila have knowledge of plant composition. People no longer regard cosmetics as an unnecessary indulgence. Most people have begun to revert to natural cosmetics because they feel that synthetic cosmetics include more components that might produce a range of bad consequences. When the cosmetics firm noticed that consumers wanted herbal-based cosmetics, they began creating them. Many respondents suggested that manufacturers limit the quantity of chemical blends used in herbal cosmetics in order to entice more people to use them. As a consequence of the analyst's evaluation, the responder employs handcrafted items created from natural components that do not cause symptoms, are healthy, and do not comprise pharmaceuticals, according to Md. Irshad Ali and Manmohan Yadav (2015)[7]. (2011) Janagam and Kumar The majority of poll respondents claimed that because handcrafted things were manufactured from natural ingredients, there were no harmful side effects. The bulk of handcrafted things are acquired once a month and used on a daily basis. The second goal was chosen because to the popularity of regional brands, notably Vindhya Herbal. Vindhya's handcrafted goods are purchased by people who are middle-class, well-educated, and above the age of 36. Respondents said Dabur (90%) and Himalaya (70%) were the market leaders in terms of similarity. Regardless of your point of view, those who have experienced Vindhya Herbal goods prefer them. Pujari Neelkanth M*, Sachan Anupam K, and Gupta Deepika performed a study in 2015 to see how customers felt about botanical goods. This study was conducted in order to develop medicinal treatments for the marketing of botanical commodities[8]. The majority of people in India use herbal treatments and work for pharmaceutical companies. People are more willing to purchase drugs that function faster since their lives are so chaotic. They are well-versed in the use of herbal and natural treatments. RMPs frequently provide Allopathic drugs. According to the researchers of this study, while having fewer undesirable side effects, plant-based products are more expensive. Herbal medicines, on the other hand, are easier to find and more effective in the long run. Rajani P[9]. conducted a 2016 study on customer views of ayurvedic medicines, focusing on Megha's Herb Care Ayurvedic Pharmacy. This pharmacy has received the Good Manufacturing Practises (GMP) accreditation mark. Those who have tried the pharmacy's items have given them positive feedback. The pharmacy has strong ties with its customers because of the high quality of the things it sells. Everyone who bought items from the company was pleased with them and urged others to do the same. According to Mrs. Gurmeet Kaur's 2016 research, respondents of all ages and socioeconomic position utilise personal care products. The expert investigated how delighted customers were with various plant-based cosmetics. The current study's data was gathered from 100 women who used herbal cosmetics and completed a questionnaire. According to the results of the poll, the majority of people are pleased with the price and quality of herbal cosmetics, as well as how they were used, how frequently they were purchased, and when they were first used. Individuals are more concerned with the quality of cosmetics than with their price, according to research. As demonstrated by their readiness to buy herbal cosmetics, the majority of respondents are quite happy with them. Chandiraleka E. and Dr. Hamalakshami R. revealed in 2016 that all Patanjali and natural food outlets sell Ayurvedic and herbal drugs. Customers like Ayurvedic items, and they're good for the economy. They are easy to get and have no harmful consequences. Because of its rich bio-decent variety and long history of Indian therapeutic frameworks, India would be known across the world as a place where eco-friendly therapeutic frameworks that deal with environment may be found. It is expected that all clients are aware of the product, like how it works, and understand its pricing. According to S. Anupriya's 2017 article, Ayurvedic and herbal remedies are accessible at all Patanjali and natural food stores. Ayurvedic goods are popular with customers and are economical. They are easy to find and have no emotional consequence. Because of its great bio-diversity and long history of Indian therapeutic frameworks, India would become known across the world as a country where eco-friendly therapeutic frameworks that deal with environment are used. Everyone who

buys the items should be aware of it and satisfied with both the price and the quality. Prof. G.R. Joshi observed in 2017 that the majority of the people he spoke with were aware of herbal products. Herbal drugs are no longer considered helpful by the majority of people. Most people are moving to ayurvedic cosmetics because they feel that plant products include chemicals that might hurt them in a variety of ways. When herbal firms realised that consumers were interested in them, they began making ayurvedic cosmetics. This research helped businesses understand more about what their customers desire and need so that they might enhance their goods. Dr. BhanuSree Reddy and B. Naresh's research, like their 2016 study, focuses on the elements that determine how consumers perceive botanical goods. A number of sources were used to assess the poll's accuracy and thoroughness. When immediate treatment is necessary, many people turn to modern pharmaceuticals, while the majority still choose natural therapies. Natural products are accessible on the market, but at a high price and with no harmful side effects. Customers are more likely to buy plant-based items when it is in their best interests, when their doctors recommend it, and when they see it in the media. People today assume that ingesting natural materials included in herbal goods can enhance their health, according to Dr. K. S. Kavitha and T. Anish Fathima (2017). The primary goal of this study was to discover how herbal goods fare in India. The other goal was to discover what makes herbal goods more or less appealing to customers. According to studies, the majority of users are pleased with the product's healthfulness, comfort lifespan, affordability, convenience of purchase, and lack of chemicals or drugs. It was also revealed that the majority of people are satisfied with the benefits herbal products bring for their health. This survey found, according to Dr. R. Ramachandran (2018), that customers are beginning to choose natural Ayurvedic goods over pharmaceutical ones because they feel they will last longer. Individuals now evaluate the pricing of ayurvedic items, which are less expensive than mass-produced cosmetics. Consumers prefer ayurvedic cosmetics to other forms of cosmetics, according to a poll on Patanjali ayurveda's special goods. The research was carried out in 2019 by Pranam Dhar and Suchetana Dey. This research focuses on the ongoing study of ayurvedic botanicals and how people are becoming more interested in purchasing ayurvedic items as a consequence of the increased use of ayurveda outside of Indian towns and the use of technology to further it. In addition, the study looks at how changing client preferences for ayurvedic drugs in Kolkata.

OBJECTIVES

- To analyze and identify the buying behavior of customers (herbal cosmetic product category)
- To know the critical factors playing crucial role.
- To analyze the customer satisfaction level with herbal cosmetic product

RESEARCH METHODOLOGY

The Research Design Used For the Study

Research design is a "blueprint" for gathering the necessary data and figures in the most entertaining method possible. This study employed investigative research. Our major objective in our search is to learn more. The goal of exploratory research is to describe topics that have never been studied previously. Its goal is to establish needs, offer usable definitions, and build on the previous research plan. It selects the optimal research subject, data gathering technique, and research framework. Exploratory research is conducted to ensure that participants understand the researcher's objectives and to collect data that may be used to measure the data.

Area of the Study

The area of the study is in Gwalior City and data collected by various age groups in Gwalior reason.

Sampling Technique

The sampling techniques used in this project are **convenient and snowball** sampling technique. it used for easily identify the customer perception and attitude towards herbal products.

Sample Size

The sample size comprises of different types of users at different age groups level, who are using Herbal products. The sample of **196 respondents** are taken into account for the study.

Method of Data Collection

The study based on primary data and secondary data. We have use the survey method for collecting the data and finding the best result.

Primary Data

Primary data and information on a first hand basis. It's taken with the help of personal observation.

Primary Data Collected By

- Questionnaire
- Discussion with my mentor

Secondary Data

Secondary Data is collected by

- Research paper
- The internet
- Newspapers
- Web sites

TOOLS

T-test

The T-test is an example of an inferential measurement. The simple T-test may be used to determine whether the difference between the means of two groups is statistically significant. It is applicable to any inferential statistic. It is assumed that the dependent variable has a normal distribution.

Mean

The arithmetic mean is another term for the mean. The mean is the sum of all integers. To get the average, add all the numbers in a set and divide by the total number of numbers.

Formula of Mean

Population Mean

$$\mu = \frac{\sum X}{n}$$

Simple Mean

$$\bar{X} = \frac{\sum X}{n}$$

Standard Deviation

Standards deviation is represent the root average squared deviations of scores from the mean.

Formula of Standard Deviation

$$S = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

ANALYSIS AND INTERPRETATION

Table No. 1

S.no.	Variables	Character	No. of Respondents	Percentage
1	Gender	Male	105	53.57
		Female	91	46.42
		Total	196	
2	Age Group	18-30 Year	132	67.36
		31-40 Year	27	13.77
		41-50 Year	09	04.59
		51-Above Year	28	14.28
		Total	196	100
3	Employment Status	Students	122	62.24
		Businessman	10	05.10
		Serviceman	51	26.02
		Others	13	06.63
		Total	196	
4	Annual Income	0-2.5 Lac	104	53.06
		2.5-5 Lac	59	30.10
		5-10 Lac	25	12.75
		10 Lac Above	08	04.08
		Total	196	100

PERSONAL FACTORS

Interpretation

The table above plainly demonstrates that 53.57 percent of the 196 responses are men and 46.42 percent are women.

The population was divided as follows: 67.36 percent were under the age of 18, 13.7 percent were between the ages of 18 and 30, 0.45 percent were between the ages of 41 and 50, and 14.28% were above the age of 51.

This data shows that 53.06% of respondents earn less than 2.5 lacs per year, 30.10% make between 2.5 and 5 lacs per year, 12.75% earn between 5 lacs and 10 lacs per year, and 4.8% earn more than 10 lacs per year.

Table No 2: Types of Herbal Products used Mostly

S.no.	Types of Products	No of Respondents	Percentage
1	Herbal Cream	50	25.51
2	Herbal Hair Oil	24	12.24
3	Herbal Shampoo	49	25
4	All Of These	73	37.25
	Total	196	100

Interpretation

This table portrays that, out of 196 respondents, 25.51% respondent are using the herbal cream, 12.24% respondent are using Hair oil, 25% Respondent are using herbal shampoo and 37.25% are using all of these.

Table No 3: Herbal Company's Products are Using

S.no.	Company's Products	No of Respiendent	Percentage
1	Himalaya Herbals	50	25.51
2	Patanjali	75	38.27
3	Ayur Herbals	10	5.10
4	Baidyanath	35	17.86
5	Vicco Laboratories	10	5.10
6	Dabur	16	8.16
	Total	196	100

Interpretation

This table portrays that, out of 196 respondents, 25.51% of the respondents are prefer to herbal product for Himalaya herbal, 38.27% of the respondents for Patanjali, 05.10% of the respondents for Ayur herbals, 17.86% of the respondents of Baidyanath, 5.10% of respondents for Vicco laboratories and 8.16% of the respondents of herbal product for the Dabur.

Table No 4: Frequently Purchase of Herbal Prodcuts

S.no.	Frequency	No. of Respondents	Percentage
1	Oftenly	48	24.49
2	Sometimes	62	31.64
3	Always	86	43.87
	Total	196	100

Interpretation

This table portrays that, out of 196 respondents, 24.49% of the respondents are prefer to herbal product for the purchase of often, 31.64% of the respondents for the sometimes and 43.87% of the respondents for using the herbal products always.

Table No 5: Awareness of Herbal Prodcuts

S.no.	Awareness	No. of Respondents	Percentage
1	Newspaper	30	15.31
2	Online	37	18.88
3	Friends/Relatives Recommendation	40	20.41
4	Road Show	0	0
5	Personal Selling	10	5.10
6	Tv Advertising	69	35.20
7	Magzines	10	5.10
	Total	196	100

Interpretation

The above table shows that, 15.31% of the respondents are aware about herbal cosmetic products through newspaper, 20.41% of the respondents are aware through their friends/relatives, 18.88% of respondents are aware through the online, 5.10% of the respondents are aware through the personal selling, 35.20%the respondents are aware through TV advertising, 5.10% of the respondents are aware through the magazines.

Table No. 6: Trust Worthiness of the Herbal Products

S.no.	Trust Worthiness	No of Respondents	Percentage
1	Product Origin	76	38.78
2	Awards Received	25	12.76
3	Laboratory Recommendation	36	18.36
4	Editorial Recommendation	15	7.65
5	Experience Recommendation	44	22.45
	Total	196	100

Interpretation

This table portrays that, out of 196 respondents, 38.78% of the respondents are prefer to herbal product for the purpose of products origin, 12.76% of the respondents for awards received, 18.36% of the respondents for laboratory recommendation, 7.65% of the respondents for editorial recommendation and 22.45% of the respondents shift to herbal product for the purpose experience recommendation.

Table No. 7: Places of Purchase

S.no.	Format	No of Respondents	Percentage
1	Departmental Store	75	38.26
2	Supermarket	35	17.85
3	Convenient Store	42	21.44
4	Kirana Store	44	22.45
	Total	196	100

Interpretation

This table portrays that, out of 196 respondents 38.26% of the respondents are purchase from departmental store, 17.85% of the respondents are purchase from online super market, 21.44% of the respondents are purchase from convenient store and 22.45% of the respondents are purchase from kirana store.

Table No. 8: Use To Describe the Herbal Products

S.no.	Reasons	No of Respondents	Percentage
1	Reliable	67	34.18
2	High Quality	43	21.94
3	Unique	19	9.70
4	Useful	67	34.18
	Total	196	100

Interpretation

This table portrays that, out of 196 respondents, 34.18% of the respondents are prefer herbal product for the purpose of reliability, 21.94% of the respondents for high quality, 9.70% of the respondents for uniqueness and 34.18% of the respondents shift to herbal product for the purpose usefulness.

FREQUENCY TABLE**1. Herbal Products are Useful?**

A Usefulness					
		Frequency	Percent	Valid Percent	Cumulative Percent
08 Valid	Strongly Disagree	8	04.08	04.08	4.08
	Disagree	12	6.13	6.13	10.21
	Neutral	38	19.39	19.39	29.60
	Agree	98	50	50	79.60
	Strongly Agree	40	20.40	20.40	100.0
Total		196	100.0	100.0	

Interpretation

The mean value of the above statement 4.16. Most of the respondent purchase the herbal products on the basis of usefulness and standard deviation is .687. It shows the value of standard deviation is less than the 0 means that the variable is more close to the average and most of the respondent are given a positive result towards the usefulness of herbal products and most of the respondents purchase the herbal products because they are useful .If the standard deviation is more than 1 that indicate the variables are more spread out from the average so, we can say that herbal products are very useful and good for health as well.

2. Herbal Products are Safe because they are made of Natural Ingredients?

A_Safe					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	2.1	2.1	2.1
	Neutral	11	11.3	11.3	13.4
	Agree	52	53.6	53.6	67.0
	Strongly agree	32	33.0	33.0	100.0
	Total		97	100.0	100.0

Interpretation

The mean value of the above statement 4.18. Most of the respondent purchase the herbal products because they are safe and made from natural ingredients and standard deviation is .707 it shows the value of standard deviation is less than the 0 means that the variable is more close to the average and most of the respondent are give a positive result towards the herbal products and most of respondent purchase the product on the basis that the herbal products are safe and made from natural ingredients. If the standard deviation is more than 1 that indicates the variables are more spread out from the average so, we can say that herbal products are safe and today people are concern about their health so they purchase herbal products.

3. Herbal Products are Pure?

A_Pure					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disagree	10	5.10	5.10	5.10
	neutral	37	18.88	18.88	23.98
	Agree	94	47.96	47.96	71.94
	Strongly agree	55	28.06	28.06	100
	Total		196	100.0	100.0

Interpretation

The mean value of the above statement 3.90. most of the respondents purchase herbal products because they are pure and standard deviation is .707 it shows the value of standard deviation is less than the 0 means that the

variable is more close to the average and most of the respondent are given a positive result towards the herbal products and most of respondent purchase the product because they are pure. We all know that herbal products are made from natural ingredients and are pure. People believe that natural ingredients are safe for their skin and health.

4. Herbal Products are Cheaper than Other FMCG Products and Pocket Friendly?

A_Cheaper than FMCG					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	1.0	1.0	1.0
	Disagree	14	14.4	14.4	15.5
	Neutral	30	30.9	30.9	46.4
	Agree	41	42.3	42.3	88.7
	Strongly agree	11	11.3	11.3	100.0
	Total	97	100.0	100.0	

Interpretation

The mean value of the above statement 3.48. most of the respondents purchase the herbal products because they are comparatively cheap then other FMCG products and they are pocket friendly too and standard deviation is .914 most of the respondents believe that herbal products and are very useful for health and skin.

5. Herbal Products are Better than Others?

A_Better Prod than Others					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.0	1.0	1.0
	Neutral	17	17.5	17.5	18.6
	Agree	54	55.7	55.7	74.2
	Strongly agree	25	25.8	25.8	100.0
	Total	97	100.0	100.0	

Interpretation

The mean value of the above statement 4.06. Most of the respondents purchase the herbal products because they are better than others and standard deviation is .689 most of the respondents said that herbal products are better than other products because they are made from natural ingredients and pure. They believe that herbal products are safe and good for skin and health. If the standard deviation is more than 1 that indicate the variables are more spread out from the average so, we can say that herbal products are better than others.

6. Herbal Products are Easy to use?

A_Easy to use					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	1.0	1.0	1.0
	Disagree	3	3.1	3.1	4.1
	Neutral	13	13.4	13.4	17.5
	Agree	54	55.7	55.7	73.2
	Strongly Agree	26	26.8	26.8	100.0
	Total	97	100.0	100.0	

Interpretation

The mean value of the above statement 4.04. Most of the respondents purchase the herbal products because they are easy to use and standard deviation is .789. It shows the value of standard deviation is less than the 0 means that the variable is more close to the average and most of the respondent said they can use the herbal products easily .If the standard deviation is more than 1 that indicate the variables are more spread out from the average so, we can say that herbal products can be used by the people easily and are good for skin and health, people prefer herbal products because they are made from natural ingredients.

7. Experience of using Herbal Products is Good?

A_Good Experience					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.0	1.0	1.0
	Neutral	14	14.4	14.4	15.5
	Agree	60	61.9	61.9	77.3
	Strongly Agree	22	22.7	22.7	100.0
	Total	97	100.0	100.0	

Interpretation

The mean value of the above statement 4.06. Most of the respondent purchase the herbal products because the experience of using herbal product is good and standard deviation is .642. It shows the value of standard deviation is less than the 0 means that the variable is more close to the average and most of the respondent said experience of using herbal products is good .If the standard deviation is more than 1 that indicate the variables are more spread out from the average so, we can say that when people using herbal products they have a good experience of herbal product and are good for skin and health. Herbal product is useful for the people.

8. Herbal Products can be used to Help Maintain & Promote Health?

A_Promotehealth					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.0	1.0	1.0
	Neutral	11	11.3	11.3	12.4
	Agree	62	63.9	63.9	76.3
	Strongly Agree	23	23.7	23.7	100.0
	Total	97	100.0	100.0	

Interpretation

The mean value of the above statement 4.10. Most of the respondent purchases the herbal products because they used to help the people to maintain and promote their health and standard deviation is .621. It shows the value of standard deviation is less than the 0 means that the variable is more close to the average and most of the respondents said that herbal products are good and help them to maintain their health .If the standard deviation is more than 1 that indicate the variables are more spread out from the average so, we can say that herbal products is useful in promoting health and it also help them to maintain their health, herbal products are made from natural ingredients and having good results on skin.

9. Lots of the Claims made by the Manufacturers of Herbal are not Correct?

A Corrt Claims					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	4	4.1	4.1	4.1
	Disagree	14	14.4	14.4	18.6
	Neutral	31	32.0	32.0	50.5
	Agree	42	43.3	43.3	93.8
	Strongly Agree	6	6.2	6.2	100.0
	Total	97	100.0	100.0	

Interpretation

The mean value of the above statement 3.33 it indicates that respondents said that many claims are correct but some claims are not correct and standard deviation is .943. It shows the value of standard deviation is less than the 0 means that the variable is more close to the average and most of the respondents said the claims are correct .If the standard deviation is more than 1 that indicate the variables are more spread out from the average so, we can say that some respondents said that some claims are correct and some claims are not correct.

10. Government Should Regulate the Claims made by the Manufacturers of Herbal Products?

A Regulate Claims by Govt					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	1.0	1.0	1.0
	Disagree	7	7.2	7.2	8.2
	Neutral	30	30.9	30.9	39.2
	Agree	43	44.3	44.3	83.5
	Strongly Agree	16	16.5	16.5	100.0
	Total	97	100.0	100.0	

Interpretation

The mean value of the above statement 3.68. Most of the respondents said that the claims made by the manufacturers of herbal product should be regulate by the government and standard deviation is .873. It shows the value of standard deviation is less than the 0 means that the variable is more close to the average and most of the respondents said that the claims should be made by the government but some said they have a neutral opinion .If the standard deviation is more than 1 that indicate the variables are more spread out from the average so, we can say that the claims which are made by the herbal manufacture should be regulate by the government but some said that these claims are not regulate by the government.

11. Which Factor Influence you to Purchase the Herbal Products{Low Price}?

A Low Price					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	26	26.8	26.8	26.8
	Disagree	23	23.7	23.7	50.5
	Neutral	20	20.6	20.6	71.1
	Agree	22	22.7	22.7	93.8
	Strongly Agree	6	6.2	6.2	100.0
	Total	97	100.0	100.0	

Interpretation

The mean value of the above statement 2.58. Most of the respondents said that low price is not the factor which influence the respondents to purchase the herbal products and standard deviation is 1.273. It shows that the people are not using the herbal product because of low price, according to them some herbal products cost is so high and which everyone can't afford, so we can say that low price is not the factor which influence people to purchase.

12. Which Factor Influence you to Purchase the Herbal Products {Attractive Packaging}?

A Attractive Packaging					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	10	10.3	10.3	10.3
	Disagree	29	29.9	29.9	40.2
	Neutral	29	29.9	29.9	70.1
	Agree	22	22.7	22.7	92.8
	Strongly Agree	7	7.2	7.2	100.0
	Total	97	100.0	100.0	

Interpretation

The mean value of the above statement 2.87. Most of the respondents said that attractive packaging is not the factor which influence the respondents to purchase the herbal products and standard deviation is 1.105. It shows that the people are not using the herbal product because of attractive packaging. Packaging of herbal products is normal, it is not the reason of purchasing herbal product.

13. Which Factor Influence you to Purchase the Herbal Products {Quality}?

A Quality					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	4	4.1	4.1	4.1
	Disagree	7	7.2	7.2	11.3
	Neutral	17	17.5	17.5	28.9
	Agree	23	23.7	23.7	52.6
	Strongly Agree	46	47.4	47.4	100.0
	Total	97	100.0	100.0	

Interpretation

The mean value of the above statement 4.03. Most of the respondents said that quality is the factors which influence the respondents to purchase the herbal products and standard deviation is 1.150. It shows that the people are using herbal product because of its good quality. Quality of herbal products is good, people purchase the herbal product because the quality of herbal product is good.

14. Which Factor Influence you to Purchase the Herbal Products {Long Freshness}?

A Long Freshness					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	14	14.4	14.4	14.4
	Disagree	21	21.6	21.6	36.1
	Neutral	16	16.5	16.5	52.6
	Agree	35	36.1	36.1	88.7
	Strongly Agree	11	11.3	11.3	100.0
	Total	97	100.0	100.0	

Interpretation

The mean value of the above statement 3.08. Most of the respondents said that long freshness is not the factor which influence them to buy the herbal products and some said that they use herbal product because of its long freshness and standard deviation is 1.272. It shows that some of the respondents are using herbal product because of long freshness but some are using because of its good quality long freshness is not the factor which influence them to buy the herbal products.

15. Which Factor Influence you to Purchase the Herbal Products {Fragrance}?

A Fragnance					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	24	24.7	24.7	24.7
	Disagree	13	13.4	13.4	38.1
	Neutral	31	32.0	32.0	70.1
	Agree	15	15.5	15.5	85.6
	Strongly Agree	14	14.4	14.4	100.0
	Total	97	100.0	100.0	

Interpretation

The mean value of the above statement 2.81. Most of the respondents said that fragrance is the not the factor which influence them to purchase the herbal products and standard deviation is 1.357. It shows that fragrance is not the factor for using it, some respondents said that fragrance is normal than others but some use it for fragrance but most of the people said that they are using the herbal product because of its good quality

Non User's Analysis

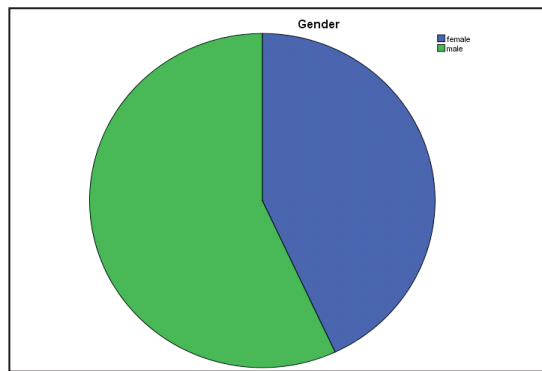
Group Statistics					
	Gender	N	Mean	Std. Deviation	Std. Error Mean
B_Expensive	Female	28	1.29	.460	.087
	Male	37	1.30	.463	.076
B_Undesirable results	Female	28	1.71	.460	.087
	Male	37	1.62	.492	.081
B_Poor quality	Female	28	1.79	.418	.079
	Male	37	1.57	.502	.083
B_Side effects	Female	28	1.43	.504	.095
	Male	37	1.54	.505	.083
B_It easily available	Female	28	1.39	.497	.094
	Male	37	1.30	.463	.076

Independent Samples Test											
		Levene's Test for Equality of Variances			t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	Lower	Upper
B_Expensive	Equal variances assumed	.040	.841	-.100	63	.921	-.012	.116		-.243	.220
	Equal variances not assumed			-.100	58.508	.921	-.012	.116		-.243	.220
B_Undesirable results	Equal variances assumed	2.487	.120	.773	63	.442	.093	.120		-.147	.332
	Equal variances not assumed			.781	60.146	.438	.093	.119		-.145	.330
B_Poor quality	Equal variances assumed	13.990	.000	1.861	63	.067	.218	.117		-.016	.452
	Equal variances not assumed			1.909	62.385	.061	.218	.114		-.010	.447
B_Side effects	Equal variances assumed	.240	.626	-.886	63	.379	-.112	.126		-.365	.141
	Equal variances not assumed			-.886	58.367	.379	-.112	.126		-.365	.141
B_It easily available	Equal variances assumed	2.233	.140	.798	63	.428	.096	.120		-.144	.335
	Equal variances not assumed			.790	56.000	.433	.096	.121		-.147	.338

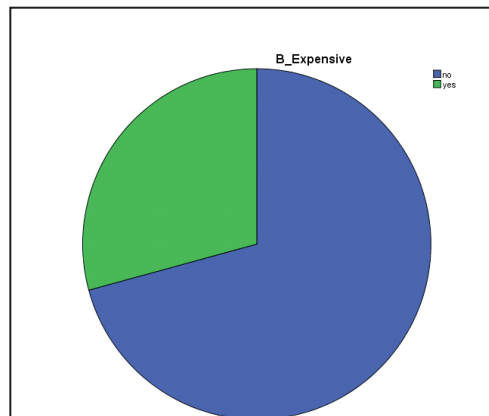
Statistics							
		Gender	B_Expensive	B_Undesirable results	B_Poor quality	B_Side effects	B_1t easily available
N	Valid	65	65	65	65	65	65
	Missing	0	0	0	0	0	0

• **Frequency Table**

Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	28	43.1	43.1	43.1
	Male	37	56.9	56.9	100.0
	Total	65	100.0	100.0	



B Expensive					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	46	70.8	70.8	70.8
	yes	19	29.2	29.2	100.0
	Total	65	100.0	100.0	



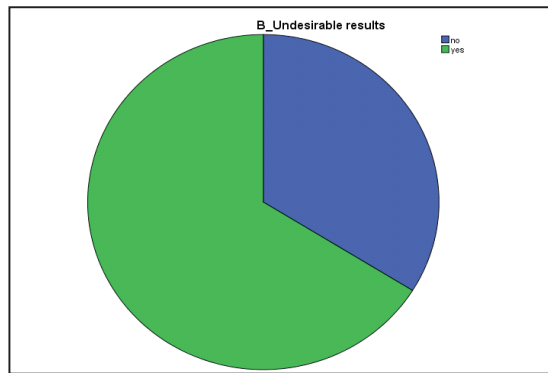
Why Would you have not using Herbal Products? {Expensive}

According to the above responses 46(70.8%) of respondents say that herbal products are not so expensive, they are not using because believe on word of mouth some people say that herbal product are npt good, so they believe on it and never use it but out of 65 respondents 19(29.2%) respondents say that herbal products are expensive.

B Undesirable results					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	22	33.8	33.8	33.8
	yes	43	66.2	66.2	100.0
	Total	65	100.0	100.0	

Would you Have not using Herbal Products? {Undesirable results}

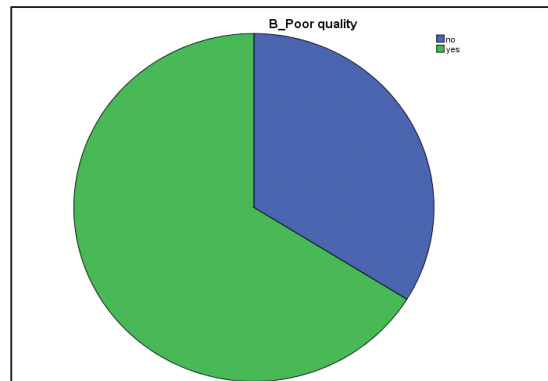
According to the above responses 22(33.8%) of respondents said that undesirable results is not the factor of not using the herbal product but 43(66.2%) respondents think that they are not giving the desirable results that’s why they don’t use herbal product. They don’t try but because of word of mouth.



B. Poor Quality					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	22	33.8	33.8	33.8
	yes	43	66.2	66.2	100.0
	Total	65	100.0	100.0	

Why would you have not using herbal products? {Poor quality}

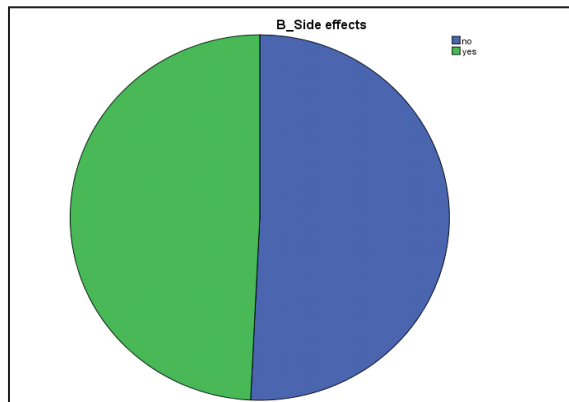
According to the above responses 22(33.8%) of respondents said that they think that poor quality is not the factor of not using the herbal product but 43(66.2%) respondents think that the quality of herbal product is not good the herbal product companies providing poor quality that’s why they don’t use herbal product.



B Side Effects					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	33	50.8	50.8	50.8
	yes	32	49.2	49.2	100.0
	Total	65	100.0	100.0	

Why Would you have not using Herbal Products? {Side effects}

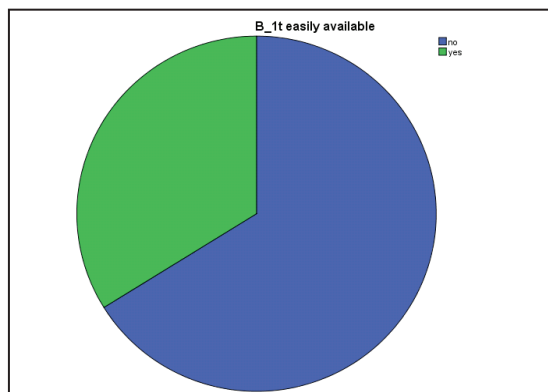
According to the above responses 33(50.8%) of respondents said that they think that there is no side effect of herbal product but 32(49.2%) respondents think that there should be the side effect of herbal product at skin, so that's why they don't use herbal product.



B_ easily available					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	43	66.2	66.2	66.2
	yes	22	33.8	33.8	100.0
	Total	65	100.0	100.0	

Why Would You have not using Herbal Products? {Easily available}

According to the above responses 43(66.2%) of respondents said that it is not hard to purchase herbal products everywhere they are easily available everywhere but 22(33.8%) respondents think that herbal products are not easily available which they want, so because of that they are not using the herbal product.

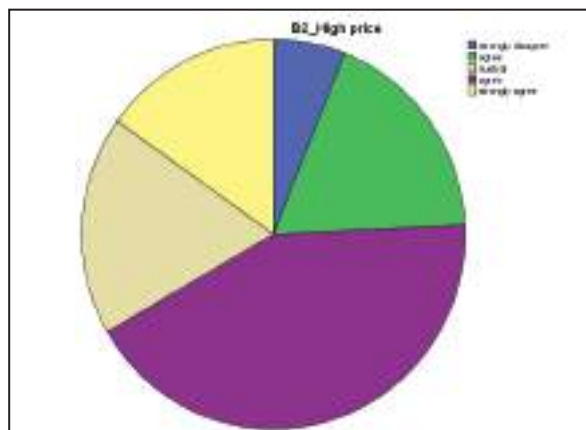


Ex-users analysis part

Statistics						
		B2_High price	B2_Low quality	B2_Not easily available	B2_Not suited me	B2_Unable to fulfill promise
N	Valid	33	33	33	33	33
	Missing	1	1	1	1	1

Frequency Table

B2_High price					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	2	5.9	6.1	6.1
	Agree	6	17.6	18.2	24.2
	Nuetral	6	17.6	18.2	42.4
	Agree	14	41.2	42.4	84.8
	Strongly Agree	5	14.7	15.2	100.0
	Total		33	97.1	100.0
Missing	System	1	2.9		
Total		34	100.0		



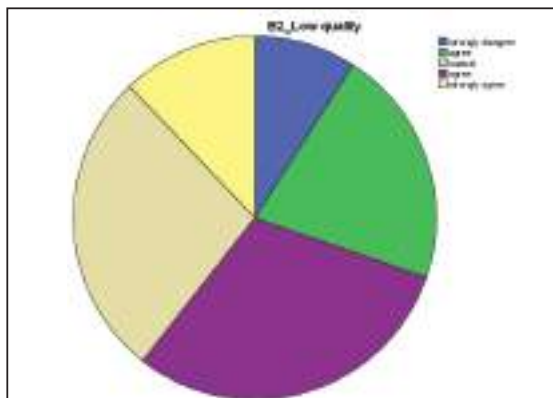
Interpretation

- High price

The mean value of the above statement 3.42. Most of the respondents discontinue using herbal products because of high price and standard deviation is 1.146. It shows that most of the respondents said that herbal products have high prices so, because of that they discontinue the herbal products.

B2_Low quality					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	3	8.8	9.1	9.1
	Agree	7	20.6	21.2	30.3
	Nuetral	9	26.5	27.3	57.6
	Agree	10	29.4	30.3	87.9
	Strongly Agree	4	11.8	12.1	100.0
	Total		33	97.1	100.0
Missing	System	1	2.9		

Total	34	100.0		
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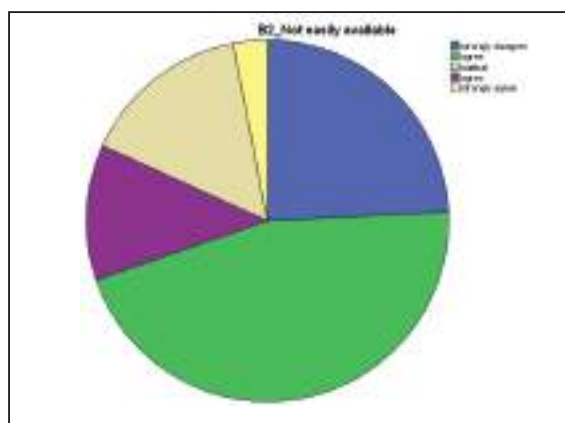


Interpretation

- **LOW QUALITY**

The mean value of the above statement 3.15. Most of the respondents discontinued the use of herbal products because of low quality and standard deviation is 1.176. It shows that most of the respondents said that herbal products have low quality in their products so, because of that they discontinued the herbal products.

B2_Not easily available					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	8	23.5	24.2	24.2
	Agree	15	44.1	45.5	69.7
	Neutral	5	14.7	15.2	84.8
	Disagree	4	11.8	12.1	97.0
	Strongly Agree	1	2.9	3.0	100.0
	Total	33	97.1	100.0	
Missing	System	1	2.9		
Total		34	100.0		

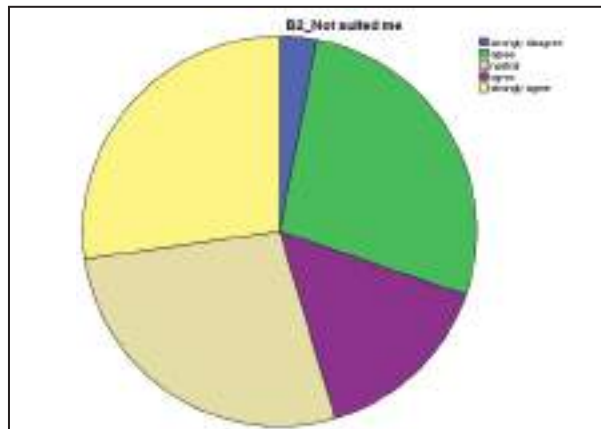


Interpretation

- **Not easily available**

The mean value of the above statement 2.24. Most of the respondents discontinued using herbal products because of they are not easily available to their near stores and standard deviation is 1.062. It shows that most of the respondents said that herbal products is not easily available, because of that they discontinued the herbal products.

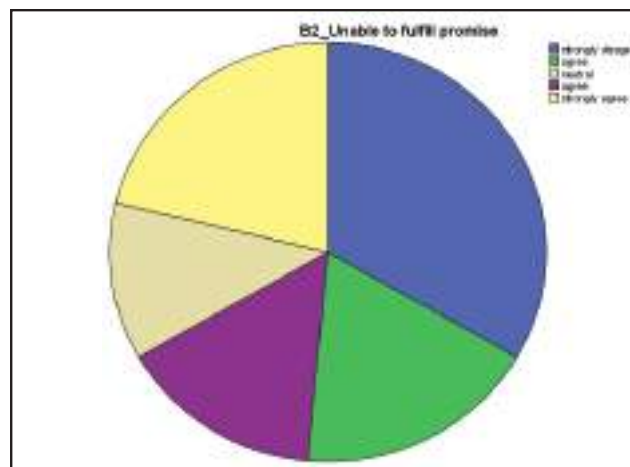
B2_Not Suited Me					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	2.9	3.0	3.0
	Agree	9	26.5	27.3	30.3
	Nuetral	9	26.5	27.3	57.6
	Agree	5	14.7	15.2	72.7
	Strongly Agree	9	26.5	27.3	100.0
	Total	33	97.1	100.0	
Missing	System	1	2.9		
Total		34	100.0		



Interpretation

• The mean value of the above statement 3.36. Most of the respondents discontinue the usage of herbal products because of that was not suited on them and they suffer from side effects, and standard deviation is 1.245. It shows that most of the respondents said that herbal products are not suits them so, because of that they discontinue the herbal products.

B2 Unable to Fulfill Promise					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	11	32.4	33.3	33.3
	Agree	6	17.6	18.2	51.5
	Nuetral	4	11.8	12.1	63.6
	Agree	5	14.7	15.2	78.8
	Strongly Agree	7	20.6	21.2	100.0
	Total	33	97.1	100.0	
Missing	System	1	2.9		
Total		34	100.0		



Interpretation

The mean value of the above statement 2.73. Most of the respondents discontinue the usage of herbal products because of products was not able to fulfill the promise was made and standard deviation is 1.587. It shows that most of the respondents said that herbal products are unable to fulfill the promises made by their respective company's, because of that they discontinue the herbal products.

CONCLUSION

This research study mainly focused on various factor, which influencing the buying behavior of customers towards the herbal products. In this research study we done the research on the basis of three segments i.e., users of herbal products, non- users of herbal products and the people who uses herbal product in past but now they discontinue. We find that most of the people uses herbal product and they using because they are very useful, safe, pure, better than other cosmetics and pocket friendly as well. We also find that those who never use herbal product because of word of mouth. Word of mouth is not influencing them so because of that they never tried. But in case of ex users they don't want to use because herbal products are not suiting them, the claims made by the companies are not fulfilled, they think that there quality is low instead of prices, and herbal products are not easily available to them.

FINDINGS

The present study represents that majority of the respondents are using herbal products. They mostly prefer the products of Patanjali & Himalaya products. They uses on the basis of experience of known/relatives.

- They uses herbal products because they are useful, safe, better than other products and they are pocket friendly as well.
- According to our study we find that some people are not using herbal products on the basis of word of mouth. They think that fragrance and long freshness is not available in herbal products. Some respondents said that they are not easily available.
- Some of the respondents said that they are using herbal products but now they discontinue it because of low quality, high prices, not suiting them and the promises made by the herbal products are not fulfilled. So, these are the factors of discontinue the usage of herbal products.

Limitation

- Time is limited, extensive study was not possible due to time constraints.
- The study is confined to Mathura Region.

- The sample size taken for the study is limited only to 196 respondents.
- The respondent's views and opinions may hold good for the time being and may vary in the future.

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The Impact of Total Quality Management Practices on Employee Satisfaction and Loyalty

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▶ ABSTRACT ◀

In order to get relevant information on employee satisfaction and loyalty for the business and employee growth, we examine TQM practices in this article. To achieve the desired outcome, we must concurrently apply software (SPSS), technology, and research methods while investigating or testing hypotheses about numerous components and variables. Additionally, studies on related ideas (employee satisfaction, loyalty, and TQM practices) have been conducted. The primary goal of this research and study is to create an empirical model that demonstrates the relationship between TQM practices, employee loyalty, and job happiness. And because this research explicitly addresses employee training, employee empowerment, teamwork, employee compensation, and management leadership, we also studied the functions of HRM. To obtain the right outcome for each of the computations in this case, we are also applying the relevant mathematical calculations. And in the end this research giving a relation model of TQM practices, employee satisfaction and employee loyalty.

Keywords: *Loyalty, Empowerment, Compensation, Training, Satisfaction, Psychology, Organization.*

INTRODUCTION

It has been observed that most of the organizations are more focused regarding implementation for the Total Quality Management (TQM) Practices as it has been proved in most of the studies that Employees of the organization are more Satisfied and Loyal where TQM practices are implemented in a good successful way and this somehow lead to the continuous betterment of the organization.

A study made by (Samson & Terziovski, 1999) showed a positive and significant relationship between the TQM implementation and the performance of the employees. With a continuous increase in the customer oriented services, government also has shifted to a service concerned organization. In order to better understand the employee satisfaction and their loyalty towards their organization we refer to the TQM practices, which aim to explain the direct and indirect relationship between employees in the presence of satisfaction and loyalty (C.C. Change, 2010).

The purpose of this research is to identify all of the ways in which TQM practices affect employee loyalty and job satisfaction in the private sector. We were able to conduct the Study by collecting responses from a variety of private company employees using a questionnaire we created. A variety of factors influence the responses, including management leadership, teamwork, employee loyalty, employee satisfaction, employee empowerment, and employee training. Each of these TQM techniques is used by numerous organizations to maintain high levels of employee loyalty and satisfaction.

Related Concepts

- Employee Loyalty.
- Employee Satisfaction.
- Total Quality Management (TQM) Practices.

OPERATIONAL CONCEPTS

Total Quality Management

TQM is a management strategy aimed at increasing employee, customer, and product satisfaction. W. Edwards Deming developed TQM. He came up with this idea to improve the quality of a variety of goods and services. The primary goal of this research is to develop an empirical model that demonstrates the relationship between TQM practises, employee loyalty, and job satisfaction. The goal of this research is to find out how effective TQM implementation in HRM affects employee satisfaction and loyalty. Employee empowerment, teamwork, employee compensation, and management leadership are the primary TQM practises that are the focus of this research.

So we can hypothesize that

H1: TQM Practices has a positive impact on employee satisfaction.

H0: TQM Practices doesn't have any Positive impact on Employee Satisfaction

Employee Satisfaction and Loyalty

Satisfaction signifies fulfillment of one's wishes, expectations or needs. Satisfaction can further be classified as affective satisfaction and cognitive satisfaction. Employee satisfaction signifies the satisfaction that an employee derives from his/her job. It refers to an attitude of employee towards job which is affected by various factors. It's generally linked to productivity and personal wellbeing. It involves doing of work that one enjoys and is rewarded for the same.

Loyalty is the important motivator for employee performance. Improvement in Employee Satisfaction and their loyalty causes higher productivity and profits. Job satisfaction results in recognition, income, promotion, and the achievement of other goals that lead to a feeling of fulfillment (Kalski, 2007). It can also be defined as contentment with the reward that he/she receives for work (Statt, 2004). People have various perspectives regarding their co-workers, supervisors, or subordinates and their pay.

So we can hypothesize that

H2: Employee satisfaction has a positive impact on employee loyalty.

H20: Employee satisfaction doesn't have any positive impact on employee loyalty.

Employee Training

Employee training and employee's productivity has a positive relation which increase employee's satisfaction. It provides opportunities to employees to enhance and skills and knowledge which will lead to efficiency and personal growth and development.

It enables employees to gain new skills, increases productivity, and provides them with access to new abilities. It also increases employee productivity at work. It results in facilitation of updation of skills, also increasing professionalism which leads to employee commitment and hence, provides satisfaction to the employees of the organization. As a result of lack of training in an organization can lead to frustration, turnover as well as job dissatisfaction.

So we can hypothesize that

H1a: Employee training has a positive impact on employee satisfaction.

Employee Empowerment

Encourage employees to deal with quality issues and provide them the authority and tools they need. Employees with more responsibilities are more involved in creating goals and making decisions, which improves their performance and job satisfaction. It also impact employee's attitude and behavior positively. Provides positive job experience and leads to higher job satisfaction. It's a strategy which helps people in decision making. It's observed that the when employees are provided participative type of environment then they feel feel empowered to take part in decision making (GaudreauMeyerson, 2012).

We can observe a positive impact of empowering employees as they would be taking best decision which would be favorable for all (Hogan and Coote, 2014). It has become very important for the organizations to make the team members getting involved in the implementation of TQM (Zadry & Yusof, 2007). It's also important to keep the employees satisfied and productive along with empowering them (Fernandez and Moldogaziev, 2013).

The management needs to encourage employees by trusting them and providing training in order to understand the importance of employee empowerment which will help them in taking the right decision.

So we can hypothesize that

H1b: Employee empowerment has a positive impact on employee satisfaction.

Teamwork

An effective team work together towards a common objective can enhance the motivation in employees and their job satisfaction said by (Griffin, Patterson, & West, 2001). Similarly, a research work on teamwork has proved that team member's satisfaction in order to their Job can be determined by multiple no. of factors like: Team Composition, group processes in the team, and the nature of the work itself (Gradstein, 1984; Campion, Medsker, & Higgs, 1993), because these factors usually operates in the combination, there is not a simple process through a teamwork could influence the job satisfaction. So, employee satisfaction could not fully assume if teamwork will be there or not.

So we can hypothesize that

H1c: Teamwork has a positive impact on employee satisfaction.

Management Leadership

In the past years various researches has took place in order to find out whether there is any relationship between Job Satisfaction and Leadership. A research a direct relationship between Management Job Satisfaction and Leadership (Hinkin & Tracey, 1994). (Church, 1995; Hallowell, Schlesinger, & Zornitsky, 1996) also mentioned in their study that Leader takes care to help and support their employees and with this employees feel more Satisfied which somehow leads to their Loyalty also and according to (Downey, Sheridan, & Slocum, 1975 Hampton,

Dubinsky, & Skinner, 1986) there is not such positive relationship between the following Job Satisfaction and Management Leadership.

So we can hypothesize that

H1d: Management leadership has a positive impact on employee satisfaction.

Employee Compensation

(Wageman, 1995; Carson, Carson, Roes, Birkenmeier, & Phillips, 1999) said in their research work that Employee Compensation systems are considered to be the one of the key factors that help in influence the Employee Satisfaction. (Brown & Mitchell, 1993; Oliver & Anderson, 1994; Livingstone, Roberts, & Chonko, 1995) also indicated a positive relationship between the Employee Compensation and the Employee Job Satisfaction. Various researches in the area of services have also proven that, in order to ensure quality, the organization should reward its employees on the basis of their behavior rather than on the basis of their overall results (Hartline & Ferrell, 1996). Therefore, employee compensation is also crucial to determine the employee satisfaction. So we can hypothesize that

H1e: Employee compensation has a positive impact on employee satisfaction

REVIEW OF LITERATURE

Extensive Review of Literature

Employee happiness relates to how a worker feels about their job, whether those sentiments are positive or negative. It is arbitrary because it is based on the employee's subjective assessment of his or her own happiness. It signifies the satisfaction that an employee derives from his/her job. It refers to an attitude of employee towards job which is affected by various factors. It's generally linked to productivity and personal wellbeing.

According to the Fletcher and Williams (1996)[1], Employee satisfaction impacts the loyalty of employees positively in an organization. According to the Martensen and Groholdt (2001), it's being observed that employee satisfaction leads to an increase in the loyalty of the employees towards organization in which they work. According to Kim et al, (2005), it's found that the satisfied employees are more loyal to the organization as compared to the dissatisfied employees. According to Herzberg's (1968)[2] motivation-hygiene theory there is a distinction between the factors that are involved creating job satisfaction from those that led to job dissatisfaction. We can classify these factors into two categories i.e. motivators like achievement, recognition, work itself, responsibility and advancement and hygiene factors like administrative policies, supervision, salary, interpersonal relations and working conditions (Petty et al, 2005)[3].

Employee loyalty is influenced by how an organization operates and interacts with its employees. According to Allen and Grisaffe (2001)[4], loyalty is a state of psychology which characterizes the relationship between an employee and the organization in which he/she works and how it impacts their decision in remaining in the organization. According to Becker et al. (1995)[5], loyalty is a desire to maintain and sustain an employee of an organization and it also involves having a strong belief in the values and goals of the organization. According to Wu and Norman, (2006)[6], loyalty of employees can be defined as identifying an individual's strength involved in an organization.

Training helps employees to enhance and sharpen their skills and knowledge in order to improve their performance more efficiently and effectively. It's considered as an important factor as it can influence the employee's behavior. It helps employees to deal with various issues related to their performance and helps in enhancing it.

According to SABir, Akhtar, Bukhari, Nasir, and Ahmed (2014)[7], training is considered as acquiring of skills, knowledge and abilities for the development of the employees of an organization. According to Meyer & Allen (1997), it's found that in order to develop the members of the organization, training is considered as an important factor as it helps employees perform their jobs more efficiently and effectively. According to Hafeez and Akhbar (2015)[8], when employees are provided training then it helps in the increasing the efficiency of

their performance. According to Bhat (2013), training is important for increasing organizational performance as it strengthens the competencies of the employees. According to Tarasco and Damato(2006)[9], training helps in building employee satisfaction. According to

Vasudevan (2014), training helps to positively impacting and influencing the commitment of employees and also improves job satisfaction among them [10].

Employees are empowered when they are given the choice and accountability to choose their own job duties. Due to global competition and high technological changes, the organizations are needed to make necessary changes in the management of their employees. It has become very important to remain competitive, productive and have sustainable advantage over other competitors. Employees should be given opportunity to empower themselves as it would lead to their commitment towards the organization.

According to Sahoo, Behera & Tripathy (2010)[11], Employee empowerment helps an organization to sustain in the competitive market and face the various challenges confidently. According to Handy (1993); Spreitzer (1996), the main purpose of the empowerment is to fill the gap between management and employees through involving them in authority, responsibility and commitment toward the organization. According to Karim & Rehman, (2012), Employee empowerment is a fundamental practice that manager needs to be utilize to improve performance of the employees. According to Wellins(1991), an organization which follows employee empowerment practices would be able to survive in the market competition for longer duration of time.

According to Kalisch, Weaver and Salas(2009), teamwork involves 3 important components i.e. involvement of more than 2 employees to achieve the same goal, having clearly defined roles of all the members of the team and working together by collaborating in order to achieve the goal. According to Jiang (2010)[12], teamwork helps to create a positive and friendly environment which reduces the anxiety among the employees as well as it helps them to perform their jobs more efficiently and effectively in the organization. According to Khoung and Tien(2013), teamwork impacts an organization in having a positive result as job satisfaction among that employees. According to Salas, Sims, & Burke(2005)[13], the study shows that the absence of teamwork will impact an organization negatively by leading to undesirable results like less productivity and lower capability of finishing the work in the given stipulated time period. According to Benrazavi & Silong (2013)[14], the job which used to be performed by an individual independently would now be performed by a team in which each individual will be having different perspective towards the work. According to Griffin, Patterson and West(2001), teamwork helps in increasing the employee motivation and self- efficacy which can result in job satisfaction among them.

According to Elenkov & Manev (2005), socio-cultural context has a direct impact on the leadership factors and there is a relationship between the leadership, socio- cultural context and strategic innovation. According to full-range leadership theory (FRLT; Avolio, 1999; Bass, 1985, 1998), leadership can be categorized into 3 categories i.e. transformational leadership, developmental leadership and corrective leadership. Transformational leadership consists of 4 lower factors, developmental leadership consists of 2 components. According to Manz and Sims (1986, 1987), the fundamental purpose was to identify the independent features of leadership behavior required for self-managing teams to function well. According to , It was found that leadership factors that are related to behavior, trust, respect for junior employees has positive impact on knowledge acquisition attributes whereas the factors related to task orientation and autocratic behaviour as negative impact.

Compensation includes all payments made to employees, whether direct or indirect, such as salary, bonuses, stock options, and benefits. Employees receive monetary compensation, paid time off, and other benefits in exchange for their efforts.

According to Cascio (2003), the compensation can be divided into two parts i.e. direct and indirect form of compensation in order to encourage the employees to achieve the organizational goal. According to Gerhart, B., Minkoff, H. B. & Olsen,

R. N. (1995) , Compensation is plays a crucial role for both the employer as well as employee as it's a cost for the former and an income for the latter. It shows the trade-offs required while designing the compensation

policies depending on different practices taking place in the different organizations. It shows that trade-offs nature should depend on corporate as well as business strategies. Also the best compensation practice depends on the human resource activities matching to the business strategy. According to Thomas Patton(1977), the compensation should be adequate, equitable, balanced, cost effective, secure, providing incentive as well as acceptable by the employees. According to Lambert et al. (2001), compensation has significant influence on job satisfaction. According to Nawab & Bhatti (2011), it's observed that the employees take employment where they receive financial as well as non-financial compensation benefits .Also, financial compensation positively impacts the commitment of the employees in the organization.

OBJECTIVES OF RESEARCH

- To layout the Effect of TQM practices on Employee Satisfaction and Employee Loyalty.
- To open new vistas for further researches.

RESEARCH METHODOLOGY

Sampling Design

Sample size: Sample size was 150 respondents.

Sampling Method: Non-probability purposive sampling method was used for sampling.

Sampling Locale: Responses of the purpose of Sampling was taken from the various Employees of Farelabs Pvt Ltd.

Sample Selection: Individual respondents working in Farelabs Pvt Ltd.

Data Collection and Data Sources

Responses were collected from the employees of Farelabs Pvt Ltd. with the help of a self-generated Questionnaire.

Tools used for Data Collection

A self-generated Questionnaire was used for the purpose of collecting Data.

Tools for Data Analysis

1. Reliability Analysis
2. T-test
3. Regression Analysis

Reliability Test

With the help of SPSS Software Cronbach's Alpha method has been used in order to check the reliability of the questions that were used to take the responses of the respondents. Below mentioned is the table that is the outcome of the test.

Table 1: Reliability Statistics

Variable	Cronbach's Alpha	No. of Items
Employee Loyalty	0.878	4
Employee Satisfaction	0.804	4
Employee Empowerment	0.902	3
Employee Training	0.829	3
Teamwork	0.859	3
Employee Compensation	0.902	3
Management Leadership	0.784	6

When a dependability rating greater than 0.77 is needed, you can see that all of the results are considerably above average. This implies that all questionnaire questions are reliable.

REGRESSION ANALYSIS

Objective 1

In order to layout the Effect of TQM practices on Employee Satisfaction and Employee Loyalty we had assumed a Hypothesis Statement which is as follows:

H1: TQM Practices has a positive impact on employee satisfaction.

We had divided our Hypothesis statement into five parts based on the five different Total Quality Management Practices so that we can apply the Regression Analysis into five different parts and can get the results accordingly, so our Hypothesis Statements are as follows:

Table 2: Model Summary

Model	R	R square	Adjusted R square	Std. Error of the Estimate	Durbin Watson
Employee Compensation	.504	.254	.251	.83300	1.637
Employee Training	.628	.394	.392	.75058	1.586
Employee Empowerment	.504	.254	.251	.83000	1.637
Teamwork	.667	.445	.443	.71866	1.949
Management Leadership	.555	.308	.305	.80252	1.771

Dependent Variable: Employee Satisfaction

The above table of the Model Summary is the outcome of the Regression Analysis test which was being applied with the help of the SPSS software. This table presents the value of R which shows the direction of the relationship (Positive or Negative) and it has been observed from the above table that all the R values are 0.504, 0.628, 0.504, 0.667, 0.555 and all lies between the range of -1 to 1 which shows a positive relationship. So here the values of R square which were found to be .254, .394, .254, .445, .308 indicates the following results:

- Employee compensation is a variable that can be independently used. dependent element. The variation in employee loyalty is 254%.
- Employee training as a separate cost variable dependent element. There is a 394 percent gap in employee loyalty.
- Empowerment of Employees was used as an independent variable dependent element. The variation in employee loyalty is 254%.
- Teamwork is an unrelated variable dependent element .Employee Loyalty makes a difference of 445%.
- The independent variable used was management leadership dependent element. Difference in employee loyalty of 308%.

Table 3: Anova

Model	Sum of Square	Df	Mean Square	F	Sig.
EMPLOYEE COMPENSATION					
Regression	58.567	1	58.657	84.533	.000
Residual	172.084	248	.694		
Total	230.741	249			

EMPLOYEE TRAINING					
Regression	91.023	1	91.023	161.567	.000
Residual	139.718	248	.563		
Total	230.741	249			
EMPLOYEE EMPOWERMENT					
Regression	68.547	1	68.547	82.543	.000
Residual	162.084	248	.674		
Total	230.741	249			
TEAMWORK					
Regression	102.656	1	102.656	198.764	.000
Residual	128.085	248	.516		
Total	230.741	249			
MANAGEMENT LEADERSHIP					
Regression	71.018	1	71.081	110.268	.000
Residual	159.723	248	.644		
Total	230.741	249			

Dependent Variable: Employee Satisfaction

In this scenario, the F values are 84.533, 161.567, 82.543, 198.764, and 110.268. Each of them is significant at the 0% level of significance. This demonstrates that the final model significantly improves our ability to forecast the dependent variable. We may conclude that the hypothesis is accurate because the F values are 84.533, 161.567, 82.543, 198.764, and 110.268, all of which are significant at the .000 level. As a result, the model fits well.

Table 4: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Employee Compensation	1.755	.249		7.043	
	.0524	.057	.504	9.194	0.000
Employee Training	1.388	.210		6.597	
	.641	0.50	.628	12.711	0.000
Employee Empowerment	1.755	.249		7.043	
	.524	.057	.504	9.194	0.000
Teamwork	1.382	.191w		7.284	
	.643	.046	.667	14.098	0.000
Management Leadership	1.634	.230		7.089	
	.625	0.59	0.555	10.501	0.000

Dependent Variable: Employee Satisfaction

$$Y = a + bx + e$$

Here, Y= All the independent variables which are Employee Compensation, Employee Training, Employee Empowerment, Teamwork, Management Leadership

X = Employee Satisfaction

B = Beta value A = Constant E = Std. Error

In the table above, the coefficient for Employee Compensation, the independent variable, and Employee Satisfaction, the dependent variable, is 9.914, which is statistically significant at the .000 level.

As a result, the Null Hypothesis is false, stating that employee compensation has no beneficial effect on employee satisfaction. As a result, our H1a, which states: H1a: Good compensation makes employees happy, is acceptable.

The same is true for H1b, which states that training employees makes them happier, H1c, which states that empowering employees makes them happier, H1d, which states that collaboration makes employees happier, and H1e, which states that management leadership makes employees happier.

As a result, we may conclude that our major theory, H1, that TQM practises improve employee happiness, is also correct. As a result, we can conclude that TQM practises improve employee satisfaction.

Objective: 2

H2: Employee satisfaction has a positive impact on employee loyalty.

Table 5: Model Summary

Model	R	R square	Adjusted R square	Std. Error of the Estimate	Durbin Watson
Employee Satisfaction	.510	.260	.257	0.78203	1.518

Dependent: Employee Loyalty

The above table of the Model Summary is the outcome of the Regression Analysis test which was being applied with the help of the SPSS software. This table presents the value of R which shows the direction of the relationship (Positive or Negative) and it has been observed from the above table that all the R value is .510 and it lies between the range of -1 to 1 which shows a positive relationship.

In this situation, the square root of R has been computed. Service Quality was utilised as an independent variable 260 times. Employee Satisfaction, a dependent measure, varies by 260%.

Table 6: Anova

Model	Sum of square	Df	Mean Square	F	Sig.
1. Regression	53.312	1	53.312	87.172	.000
Residual	151.699	248	.612		
Total	204.981	249			

Table 7: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1. (Constant)	2.354	.211		11.132	.000
Employee Satisfaction	0.481	.051	.510	9.337	.000

Predictors: (Constant), Employee Satisfaction Dependent Variable: Employee Loyalty

This table of ANOVA shows the F value which is 87.172 and it is being observed that it is significant at the significance level of 0.000 therefore it improves our ability to predict the dependency variable and shows that the model is a good fit.

DEPENDENT VARIABLE: EMPLOYEE LOYALTY

Regression equation showing the relationship between Employee Loyalty and Employee Satisfaction

$$Y = a + bx + e$$

Here, Y= Employee Loyalty, X= Employee Satisfaction, B= Beta value of X, A= Constant and E = Standard Error
The coefficient for employee satisfaction as the independent variable and employee loyalty as the dependent variable is 9.337, which is significant at the.000 level, according to the coefficient table above. The Null Hypothesis, which asserts that there is no relationship between employee happiness and employee loyalty, implies that our hypothesis, i.e.

H2: Employee satisfaction has a positive impact on employee loyalty is accepted

CONCLUSION

According to the findings of this study, private employees' satisfaction and loyalty can be raised by effectively implementing Total Quality Management practices. Collaboration, remuneration, employee empowerment, and executive leadership are all highly significant markers of employee happiness, according to the study. The study discovered a correlation between employee loyalty and satisfaction, thus the happier a person is with their employment, and the more dedicated they are to the organization. To foster employee loyalty, it is therefore recommended that all types of private enterprises implement diverse TQM practices.

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A Study on, Employees Work, Motivation and it's Effect on their Performance

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▶ ABSTRACT ◀

Transforming sure that employee work is more fulfilling and balancing employee motivation with organizational objectives is one of management's most crucial responsibilities. The range of occupations available now makes this a dynamic challenge. Numerous factors, such as the influence of various cultural roots, affect what people value and enjoy. This research report looks at employee motivation and how it affects productivity. The study looks at a few popular ideas of motivation that might be applied in a workplace to boost worker productivity. The study demonstrated that different employees have different ideas about what motivates them. Different types of motivational theories have been discussed in literature, along with their applications and ramifications. Three inquiries were looked at: Describe motive. What sort of incentive can be utilized to improve employee performance? The study's findings indicate that employee performance can either rise or decrease depending on an incentive. The employee's performance improves if the chosen method of motivation fulfils their needs. The profit, however, declines if the employee's needs are not met via the chosen method of motivation. As such, it motivates businesses to recognize each employee's intrinsic motivation to perform effectively.

Keywords: Best Performance, Motivation Helps, Effective Motivation, Motivation Factors, Different ways to Motivate, Need of Motivation, Motivation Approaches, Maslow's Hierarchy of Needs, McClelland's Needs Theory, Fredrick and Herzberg's Two Factor Theories.

INTRODUCTION

Every organization follows some motivation factors and theories to make them realize to give their best performance. In the term of the management scenario, most effective motivation work is based on the need of the individual. Different types of employees are having different needs to get fulfilled. Some employees are interested basic needs but some are more interested psychological needs. These are fulfilled through experiences.

Motivation is factors which stresses by different level in organization, like senior to junior level. Everyone is working in the organization but the important role is played by managers who have responsibilities to motivate employees. Manger must ask to employees that what factor motivate them and according to those factor manager should carry forward motivation process.

After that motivation is defined about those employees who are doing their jobs better and achieving their target and receiving reward (Gardner and Lambert, [1] Motivation is also stressed as a factor which helps to change the direction or ways, in which employees are working and behaving. So it is also a changing factor. (Streets and porter, [2] If organization wants the good environment and any positive aspects then it is best way to help in the organization. Motivation is also required where business need the best performance of employees (Allescheid and cellar, [3] According to the (Anne, 1994), motivation helps in the process of control; sustain specific behavior of any employees. It also helps to explore the different need and requirement of employees. By which we can observe that every employees need different ways of motivation ([4]

Motivation also works as inspiration, which is fruitful to encourage the performance efficiency of the employees. it forces employees to do their work with loyalty towards goals and objectives. Motivated employees also do their work on time. They believe to follow deadline (Hislop [5]. Motivated employees are need of business and company . They makes organisational environment healthy and positive. People love to work at workplace. It also helps organization to survive in the market so they are more productive and efficient (youngsun, Barbara, and Christy [6] After the knowing the performance efficiency of employees, they are hired for right person at right place. They are also hired on the basis of their skills abilities (Youngsun, Barbara and Christy 2002). So, ultimately without motivation, employees cannot give better performance efficiency . With the purpose to achieve the goals , objectives on the times , motivation process must held in the every organization.

Related Concepts

There are several concepts of employee motivation which need to be known as:

- **Employee Participation:** Where employees get involved “in the management decision making process instead of working in orders.
- **Employee Achievement:** It is when an employee completes his her work on or before time by using skills, effort and persistence.
- **Employee Appreciation:** When management recognize, praise and thank their employee for the work they had done to achieve the organizational goals.
- **Employee Commitment:** It is the bond employees experience with their organization.
- **Employee Performance:** It means when employees fulfill their jobs and responsibilities efficiently and effectively.
- **Employee Satisfaction:** It means to know the happiness of employees within the organization.
- **Job involvement:** When an employee indulges himself with the task assigned by the top management in know as Job involvement.

Operational Definition of the Concepts

1. Employee Participation

It is well-defined that it is a process of employee’s involvement in the organization’s policies of which they are being affected. Employee’s participation in the decision making helps the employee to feel that they are also the part of organization and they give their best.

2. Employee Involvement

It can be range of procedures intended to engage the help, understanding and optimal involvement of all the personnel in an organizational decision. Employee involvement can be seen in a company inf

terms of Presentation, usefulness, efficiency, satisfaction and elasticity. Though, it can be seen that the consequences from this are furthestmost expected to be enjoyed in the extensive for benefit of the company and its workforces.

3. **Employee Promotion**

It may be defined as an ascendant promotion of workforce in the organization to another job, which orders improved reimbursement earnings, improved position respect and higher opportunities challenges and responsibility a better working atmosphere, times of effort, & amenities etc.” Promotion from within are two different words and means, that promotion may incorporate provisions for recruitment from the outside, to man promotional vacancies, but Promotion from within policy strictly provides for, internal recruitment of personnel

4. **Employee Commitment**

Commitment is the bond employees experience with their organisation. Staffs who are dedicated towards the association, usually sense a linking through the group. The further worth of such employees is that they tend to be extra strong-minded towards their exertion, shows fairly high output & are further active in offering their care.

5. **Employee Satisfaction**

Employee fulfillment can be used to designate “how pleased an individual is with his/her workplace environment”. Functioning explanations comprise of: Boldness toward present occupation, Fulfillment with reimbursement, Gratification by upgrade chances, Consummation through colleagues, Approval with administrator. Satisfied employees are incline to be extra creative & devoted towards their employers as well as to their organization.

6. **Employee Appreciation**

Employee “Appreciation discusses to the performance of recognizing a person squad’s performance, energy & success which service the administrative goalmouths & ethics. This inspires personnel to recurrence respectable presentations. It is a-system of non-monetary repayment. Accordingly, it has zero to do through currency. It purely denotes to perceiving, sympathetic and gaining constructive donations of the employees, assembly them comprehend that they are being observed and that their whole thing is cherished.

Need and Relevance of Study

The major need of the study is to know about the employee motivation at the workplace. “As in today’s scenario, employees are not motivated at the workplace because of many reasons like: cultural diversity, language barrier, inequality, workplace environment etc. So, it is mandatory for every organization to know the real problem of their employees because of which they are facing problems and ultimately it affecting their performance. According to (Gallup)[5] other than 13% employees are ‘not affianced’ at work which means that they are lacking motivation and seems like not putting any efforts in organizational goals or outcomes. Hence, motivation of employee is a critical aspect that helps the employees in increasing their performance in the organization. So, every organization’s requirements is to motivate their employee on a regular basis. Motivation of employee in an organization is an important tool to encourage and motivate employee at the work. The following are the important advantage of employee motivation:

1. **Helps in Increasing the Employee’s Commitment**

As when the employees are motivated, either “self-motivated” or motivated by organizational efforts, the employees always try his/ her best in order to achieve the organizational goals and objectives on or before time.

2. **Helps in Improving Employee’s Satisfaction**

When an employee gets satisfied from his/her organization it will help the organization as employees will be happy from his/her organizational culture and environment which ultimately lead towards a positive growth for the/company.

3. Helps in Regular Employee's Development

The best advantage of employee motivation is that it helps in achieving regular employee's development. As motivation not only helps an employee's to identify his/her personal goal but it helps them it achieving them at a regular interval.

4. Helps in Improving Employee's Efficiency

We cannot measure the employee's efficiency by its experience or qualifications but it can be measured by his/her willingness to perform the given task on or before time. When an employee works with efficiency it helps the organization in achieving the goals and objectives. It is truly said that the employee who is fully motivated can only/helps the organization to/increase the/productivity/and allow an organization/to achieve/ higher levels/of output./We know that/when the employees/are not satisfied/they did not/give their/best in/ achieving the organizational/goals and they/undoubtedly utilize his/her/time at their/desk while searching for/another/job and they cannot focus on their work and because of which their performance gets down[6].

REVIEW OF LITERATURE

Extensive Literature Review

Motivation

"Motivation" word is originated from Latin word moreover. It means to move. There are so many researchers who has given the definition of motivation. Guay. Who is a very famous researchers, he says that "motivation is a drive essential behaviour". According to the (Korth 2007), he states that motivation is a factor which creates reflection of something going up. he also said that it keeps employees working and helping them to achieve their goals. Jaffery S Nevid is a psychologist who states about the motivation that it refers to factors, direct, and sustain goal-directed behaviour[7]. In the "Merriam- Webster – dictionary", it is mentioned that motivation is term which is used to motivate something or someone. It is very popular definition of motivation. It helps to increase the performance efficiency of any employees so we can say that organisation performance depends on the motivation activities which are held in organisation. One can get motivated by internal feelings as well as some external factors. Both factors are fruitful to encourage and motivate employees towards their goals. Anyone can achieve one's goal by self motivation and any organisation makes them to motivate.[8]

According to (Eliot 2001) motivation is a process which provides reason that whatever we are doing for our goals must be in particular way. Motivation is known as psychology forces that determine employee's level of effort and level of persistence Jones and George [10]. They also mentioned that motivation consists three components those are persistency, intensity and direction. When we talk about direction, it is a goal that forces an employee to perform better and achieve it. Goal is chosen by employees consciously. When we choose our goal, internal and external, both factors affect your decision. Employee empowerment is also helpful to promote as a factor, by which we can increase our motivation (Kaplan and Norton 1992).[11]

Supremacy motivation, which comes from any authority, is also helpful to increase the employee's performance efficiency. This authority is defined as power, which can be personal and institutional (Habibah and Noram 1999). He also said that the person who has high need of institutional power is more effective than high personal power. Motivation is divided in two types which is followed by organisation to motivate their employees, which are *intrinsic* and *extrinsic* (Broussard and Garrison 2004).[12]

Intrinsic motivation is related to the one's self-desires to find out some new things and it is also a way to challenge oneself. It states about that how employees are eager to get new things and new ideas. They always try to do something innovative and creative (Ryan 2000). Intrinsic motivation makes people to do their job with willingness, enjoyment and eagerness. They are always motivated by internal feelings. They are interested in themselves that how they are valued and what are their capabilities. *Extrinsic motivation* comes from both factors external as well as internal but most of the time it impacts by the external factors. They get motivated by other (Ryan 2000).[13]

Why to Motivate Employees?

When this question arises it simply means what are the importances of the motivation. Why employees need to get motivated. Motivating employees is best way to make them honest towards their jobs and responsibilities. There are so many ways which are come to motivate employees. The simple and appropriate answer of this question is to achieve the organisational goal, every employees need motivation. Because organisations are completely depends on their workers and employees so it is very important to motivate them which is depend on the capabilities of mangers who has responsibilities to motivate them.

It is also a challenging for managers to keep them motivated at the same time manager must take care of employee's satisfaction level. Managers have responsibilities to take care of employee's needs and requirements. If employees are motivated, they will increase their capabilities to do their jobs. Which directly affects the organisational goals 14] Motivated employees feel that they are in partnership with organisation because organisation is giving them opportunities to take decision and this thing increases their performance, loyalty and commitments[15]

Buttner and Moore (1997), state on basis their research that “ Happy Employees Make Productive Employees”. If employees are committed towards their organisation and goals then they will enhance their satisfaction, which is beneficial part for any organisation and firm (Morris and sherma 1981). Satisfied and encouraged workers and employees are vital to organisational efficiency (Rachel, Yee, yeung, Edwin 2010). Any business and company are successful because of the motivated employees. They can create all the changes in the company which makes it more capable to survive and succeed (Hislop,2003). Motivated employees give best of their abilities. They don't work just does it because it's duty? (Ryan , Deci 2000).

Motivation Theories

Motivation theory are basically given by Some psychologists and some scientists in a systematic ways that how to motivate employees in organisation. Some of these theories have been given by the researchers. We are going to discuss about there theory which are mostly accepted by organisation.

1. The Abraham Maslow Theory,
2. ERG Theory,
3. Acquired –Needs Theory given by David McClelland,
4. Two Factor Theory of Fredrick Herzberg etc.

1. Hierarchy Needs of Abraham Maslow's Theory of Needs

Abraham Maslow (1908 -1970) along with Frederick Herzberg (1923), both of them have participated to create this theory, which is very famous theory of motivation. Most of the organisation uses this theory. According to a survey, which is conducted in 2002, it's named as “*review of general psychology*”. It is stated that Maslow will be known among the tenth most famous psychologists in the 20th century.

Those employees who are working in the organisation and what are their psychological need is all about this theory. It is defined as the hierarchy of needs. There are five different stages of human psychology is mentioned in this theory. This theory is described in the pyramid shape. At the top of this pyramid, self-actualisation is mentioned and at the



bottom of the pyramid, most elementary need is mentioned. This theory is completely successful to encourage employees (Stere 1998). The main goal is defined as to achieve the highest level of given five stages of theory that is self actualisation (McEwen and Wills 2014).[16]

1. **Psychological Needs:** it is a very basic need to survive the every individual such as shelters, food, homeostasis, health, water, sleep, clothes etc. These are very basic need of employees, without these all employees cannot go to next level of the direction.(Marry and Ann 2011).
2. **Safety Need:** it consists those all needs, which are related to the security and safety like personal security, emotional security, financial security , health and well-being etc.
3. **Love and Belonging:** It depends on the interaction with others. It focuses on the relationships of individuals with the people surroundings. Mostly social needs are required in friendships, intimacy, family etc. It states that how love and belonging can impacts well-being. If employee's feels loved and accepted they get motivated to achieve their goals.
4. **Esteem Need:** It is all about to feel good about ourselves. It is also related to the ego needs or status needs. Where every employees have desire to get recognition, status, importance, value and respects from others. These are some component such as self esteem, confidence, achievements, respects of others, and respect by others. Maslow defines two version of esteem needs first is lower version, which involves the need for respect from others and second is higher version, which involves the need for self- respect.
5. **Self Actualisation :** where employees feels that they are living up to our full potential it involves partner acquisition , parenting , utilizing and developing ,utilizing and developing talents, pursuing goals etc.

ERG THEORY



This theory is given by Alderfer. He defines basic needs of employees into existence needs, relatedness needs, and growth needs.

- **Existence Needs:** It includes psychological and safety needs. It can be in the forms of safety, psychological and material needs. Safety need can be defined as the prevention from those factors which demotivates individual such as fear, anxiety, anger, tension etc. Psychological needs refer to satisfaction in terms of leisure, food, shelter etc.
- **Relatedness Need:** it includes social and belonging needs. It focuses on interpersonal relationship. It involves to senses of security, belonging, and respect. Sense of security means the mutual trust of humanity. Sense of belonging involves around those all prevention which removes isolation, loneliness and distance. Employees have desire to loved and accepted in organization.

Maslow's social needs and external component of esteem needs fall under this class of need (Ryan, and Deci, 2000). [17]

- **Growth Needs:** It talks about the self-esteem And self-actualization. According to the ERG theory, the manager should concentrate all need at a time which will effectively motivate the employee.

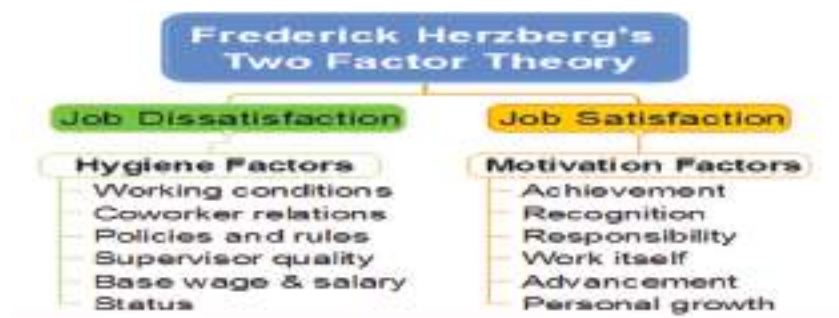
Acquired-Needs Theory Of David McClelland



David McClelland given this theory , according to him there are three needs of employees which are required at the workplace to satisfied and motivate them (Ryan and Deci 2000).

1. **Need for Achievement :** where employees works on those task , which results are based on their hard work and efforts rather than other things. Specially it involves with promotional positions.
2. **Need for Affiliation:** It is a need for open and sociable interpersonal relationship. Where employees have desires for relationship with mutual understanding the people who are motivated by affiliation have eager for a friendly and supportive environment.
3. **Need for Power:** Where employees have desire to give order. it is a managerial level. It involves high value of discipline. It is something where employees enjoy their power, position, recognition, winning arguments, influencing others etc. These all factors helps to motivate employees.

The two factor theory of Fredrick and Herzberg



Fredrick Herzberg has given this theory in 1959. He has divided motivation in two factors which are Hygiene factors and motivation factors. According to (Bradley 2003), the dissatisfaction factors are called hygiene and satisfaction factor is motivators. [18]

1. **Hygiene Factors:** it includes those all factors which are provided employees at workplace. Such as policies, procedures, salary and job security. If these all factors are not available in organisation, employees cannot get motivated (Bradely 2003). [19]
2. **Motivators Factors:** Motivator factors includes intrinsic factors which is a way of satisfaction. In the sense of achievement, recognition, responsibility, and personal growth which motivate employees for a greater performance, organisation can motivate their employees (Bradely 2003)[20]

Motivation approaches and their effect on employee's satisfaction and performance:

There are different motivation approaches are defined by the researchers which are discussed below:-

Praise

Managers can motivate employees by praising their performance, saying thanks and admiring them. it is very easy way to say by heart and naturally. If you say thanks and appreciate them it means a lot. Infact they feels appreciated and perform better (salasiah, zainab, rosmawati, ermy, 2010). [21]

Praise is served to employees to make them feel that what they are doing is appreciable. It is a way to make them motivated (David, Louis, Micheal 2004). [22]

Salary Wages Increments

Most of the researchers say that money and payments are important for every employee so it is a good way to motivate them. But it can be a temporary approach. Because if employees are satisfied financially, then they get motivated at workplace. If we want to make them feel that they are safe in organisation, we can provide them good salary instead of appreciation (Trank, Rynes, and Bertz 2002). There is high performance rating system and performance appraisal, which is a way to pay them according to their performance in terms of money. It is also a kind of reward (Harrison, Virick, and Williams 1996). [23]

Recognition

Organisation must provide recognition to employees for their works. According to their job done they receive recognition. It is a positive way to motivate employees. If they are recognised differently from others, it encourages them a lot. It is stated that employees work harder if organisation give name recognition and appreciation for what effort they are using towards their works and responsibilities. It is a very simple system as well as strengthens. (Pinar 2011). Recognised employees are very positive about their abilities and what they do so it makes a very healthy and innovative organisation environment (David, Louis, Micheal 2004).

Assigning New Roles

It is a way to realise them that you are doing well in the organisation. You have some value in the organisation. Which motivates them a lot? If managers assign new responsibilities to them. They did not feel bored in the organisation (Jurgensen 1978). If we assign role and responsibilities, employees get motivated to work harder at the same moment they will receive recognition (David, Louis, Micheal, 2004).

Management Style

It is focused on leader instead of manager. According to a researcher if we want desired outcomes we need a leader to motivate employees instead of managers. At same leader is important for motivation (Yomgsum, Barbara, and Christy, 2002). Leader must have concern for their employee's career and recognition. He or she need to help them by appreciating and guiding them. (Holly, Buttner, Dorothy 1997). Basically leader must understand employee's need and rank their importance. He or she must know that what employees enjoyed, what make them happy and motivated (Kurato, Hornsby, and naffziger, 1997).

Other Motivation Approaches have been Discussed by Researchers

Incentive Approach: By providing incentives in terms of money, spot awards, bonus, profit sharing etc. These things are given to employees except their salary. Which motivates them in positive ways? It comes from the external goals (Jurgensen, 1978). It is an approach which learns that employees get motivated by receiving positive incentives and avoiding negative ones.

Cognitive approach: It consists individual's beliefs, thoughts, perceptions, understanding etc. It shows the differences between extrinsic and intrinsic motivation. Intrinsic is all about employee's own enjoyment and extrinsic is all about to receive tangible reward etc (ID, 1983). This approach shows the relationship between character of individual and motivation, which is also known as cognitive motivational theory (Sara, Barry, and Kathleen, 2004).

The Impact of Approaches to Motivation on Employees' Performance and Behaviour

Employees' performance is defined in the way that a person is performing not just like a task or they are doing it just for bonus. It is a process where which stress on the main objective that is improvement of employees as well as business and company (Baker 1999). It is used to determine the ability of employees. Employees set their own goal for future. They perform their best to achieve that goal at the same time develop their right

skills (Vallerand 1993). It is way to evaluate the efficiency of performance of employee. Every organisation has performance appraisal system, which is helpful to know the weakness and strength of employees. By which we know that which thing need to improve in employee's skills. (Goldthrope, Lockwood, Bechhlofer, and platt, 1968). Employees, who have high performance rate they do their work and give extra efforts to the business and company. it is also requirement of organisation (spurgeon and Harrington).Infact their loyalty depends on the their motivation level because of that they are more productive(Ono, Watanbe, Kaneko,Matsumto, and miyako, 1991).

There are some guidelines which are mentioned by Bradely (2004)

1. Every organisation has responsibility to provide training to their employees at workplace when it is required.
2. Organisation must only hire those people who are always ready to develop themselves.

It is said that every organisation has two type of employees work, who are doing same job with different goals. (Park, Kim, Chung and Hisanaga, 2001). Unmotivated employees do not perform well, infact they loose their interest towards performance and work. But motivated employees wants to earn good reputation in the organisation, which is productive for business (Victoria, 2000).

The Impact of Employee Performance on Business Productivity

It is specified that more motivated employees can be the better shareholders, it affects the stock price (Ronald and Lisa 2009). According to the Development Dimension International (DDI) in 1997 stressed on the surveys and reviews about the effective service environment. It says that company profitability and productivity increses because of the relationship between loyalty and performances of employees. Whatever the result are received by employee's performance directly affects the organisation's stability as well as performance (Gregory,2000). When we talk about employee's satisfaction, it is related to their commitment and loyalty, it helps to create good and optimistic relationship (Dick, 2003).

OBJECTIVES AND RESEARCH METHODOLOGY

Objectives of Research

1. To know the impact of training on employee performance.
2. To analyse the impact of rewards on employee performance
3. To know the impact of career growth on employee performance

Research Methodology

It is used by the researchers with the purpose to collect information. Research methodology explained as a scientific and systematic search for knowledge. It includes all tools and techniques, which are used to collect information on a specific topic. When we use research methodology in any research report, it means that we have to describe those all factors which is mandatory for our research such as research design, sampling design, target population, data collection/procedures, analysis management etc.

Sampling Design: Researchers adopt some tools and techniques in collecting and selecting products for sample. It is defines as the subset or part of the target population. There are some types of sampling design such as systematic sample, stratified sample, cluster sample, convenience sampling. In this research report, we have used convenience sampling. Data is taken from people easy to reach and to contact.

Sample Size: It is defined in the terms of number of respondents. It helps to transform observation in statistical data. We have taken data from 276 respondents to collect data.

Sampling Method: If we conduct any research we need to collect data from respondents but we have problem that by whom we collect data, sampling method helps to take decision that from where we collect data, who will be our respondents etc. There are two sampling method, one is probability sampling and another one/is nonprobability/sampling./Probability sampling embraces simple random sampling, systematic sampling,, cluster

sampling etc and non-probability sampling comprises convenience sampling, voluntary response sampling etc. In this research we have used convenience sampling and simple random sampling.

Sample Locale: Sample is collected by the all over the country because we have prepared questionnaire, which is filled by the respondents through digital platform. There is no specific place for sample locale.

Sample Selection: Convenience sampling method is used for sample selection. it is simplest way to collect data.

Data Collection and Data Sources

We have used both sources primary and secondary to collect information and knowledge. Primary data which is collect from the respondents in terms of observations. This observation is original data. This data is not used before this research. Secondary data is being gathered from published research reports, books and some specific websites.

- **Tools to Be Used For Data Collection:** We have prepared questionnaire which is filled by respondents. it helps to collect information. This questionnaire is filled by those employees who are working in any organisation at present. This questionnaire consists 19 questions including age group of respondents.
- **Tools For Data Analysis:** Factor analysis is used for data analysis. It is tools to investigate the data. It makes the facts easy to understand and to manage.
- **Hypothesis:** It helps to propose a possible connection among two variables it can be dependent variables and independent variables. Dependent which are measured by researchers and independent which are changed by researchers? Null hypothesis and alternative hypothesis are used in this research.

Research Procedures

We have gone through the following procedures to complete our research report:

- | | |
|--|---------------------------|
| 1. Identify the problems | 2. Selection of topics |
| 3. Go through the existing research and theory of the topics | 4. Objectives of research |
| 5. Appropriate research methodology | 6. Data collection |
| 7. Examination of facts | 8. Explanation of data |
| 9. Conclusion | |

Data Analysis and Interpretation

Table 4.1: Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	178	64.5	64.5	64.5
	Female	98	35.5	35.5	100.0
	Total	276	100.0	100.0	

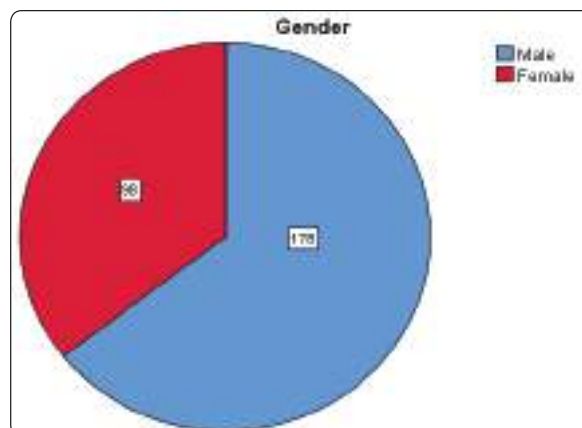
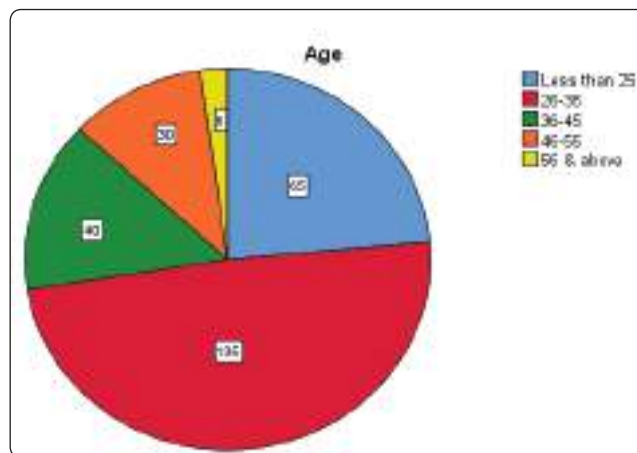


Table 4.2 Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 25	65	23.6	23.6	23.6
	26-35	135	48.9	48.9	72.5
	36-45	40	14.5	14.5	87.0
	46-55	30	10.9	10.9	97.8
	56 & above	6	2.2	2.2	100.0
	Total	276	100.0	100.0	

Interpretation

In the given table (i.e. table 4.1) we can see the gender analysis of the respondent in which the total 276 respondent who have participated in our survey, 178 are male members who contribute 64.5% of the total, on the other hand 98 are female members which contribute 35.5% in the analysis.



Interpretation

In the 2nd table (i.e table 4.2) it shows the analysis of age group to which these respondent belong, so we have differentiated 5 categories which are namely less than 25,26-35,36-45,46-55 ,56 & above. In the same manner we can see that 65 belongs to the category one i.e less than 25 , similarly 135 in category two, 40 in category three, 30 in category four, 6 in category five. Where it is clearly show that majority of the respondent are in category two & these contribute the highest of 72.5 of total respondent.

Table 4.3: Reliability of Scale

Case Processing Summary			
		N	%
Cases	Valid	275	99.6
	Excluded ^a	1	.4
	Total	276	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics	
Cronbach's Alpha	N of Items
.881	16

Interpretation

To measure the scale whether it is appropriate or not, we have performed reliability analysis & as per the threshold limit for Cronbach's Alpha that should need to be more than 0.7 & in our research the value of Cronbach's is 0.881 that is more than 0.7. Hence the sample size taken is appropriate.

Table 4.4: Descriptive Statistics

	Mean	Std. Deviation	Analysis N
Support	3.5782	.80389	275
Motivation	3.4400	.89557	275
Incentive	3.3709	.94785	275
Benefits	3.3491	.94074	275
Involvement	3.3745	.94061	275
Growth	3.4291	.96161	275
WLB	3.4109	.93310	275
Promotion	3.3309	.94151	275
Relationship	3.3818	.90196	275
Appreciation	3.3673	.91202	275
Decentralization	3.3709	.87580	275
Training	3.3055	.93657	275
Performance	3.3091	.93342	275
Workload	3.3127	.91441	275
Advertisement	3.2764	.93394	275
Rating	3.4800	.94491	275

Interpretation

The table above shown tells us about the descriptive statistics. In which we can see the mean, standard deviation and number of respondent (275) of those employees who are working in the different organizations. The above table represents the highest mean of 3.57 which indicates that the support is the most important variable that influence employees in the organization in their growth and their performance.

Table 4.5: KMO and BARTLETT'S TEST

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.897
Bartlett's Test of Sphericity	Approx. Chi-Square	1373.391
	Df	120
	Sig.	.000

Interpretation

KMO- This varies between 0 and 1, and the KMO's value to 1 are better or we can say that sampling is adequate. In the given table we can see that KMO value is 0.897, which is near to 1. 6 is the minimum value closer to 1.

Table 4.6: Correlation Matrixes

	Support	Motivation	Incentive	Benefits	Involvement	Growth	WLB	Promotion	Relationship	Appreciation	Decentralization	Training	Performance	Workload	Advertisement	Rating
Support		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.002	.000	.000	.000
Motivation	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Incentive	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Benefits	.000	.000	.000		.017	.000	.000	.000	.000	.000	.000	.000	.000	.002	.000	.000
Involvement	.000	.000	.000	.017		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Growth	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
WLB	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.002	.000	.000	.000	.000
Promotion	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000
Relationship	.000	.000	.000	.000	.000	.000	.000	.000		.222	.000	.019	.000	.000	.000	.000
Appreciation	.000	.000	.000	.000	.000	.000	.000	.000	.222		.000	.000	.000	.000	.000	.000
Decentralization	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000
Training	.000	.000	.000	.000	.000	.000	.002	.000	.019	.000	.000		.000	.000	.000	.000
Performance	.002	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000
Workload	.000	.000	.000	.002	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000
Advertisement	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000
Rating	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	

Sig.
(1-tailed)

Interpretation

Correlation coefficient is the output of the above analysis of the table. Correlation matrix is defined as the rectangular array of many numbers which describe the correlation between a single variable and every other variable in the investigation. The correlation coefficient between a variable and itself represented by blanks is always 1. Hence, the principal diagonal of the correlation matrix contains all the blanks. In above and below diagonals, the correlation coefficient is same.

Table 4.7: Communalities

	Initial	Extraction
Support	1.000	.467
Motivation	1.000	.431
Incentive	1.000	.463
Benefits	1.000	.491
Involvement	1.000	.532
Growth	1.000	.499
WLB	1.000	.521
Promotion	1.000	.454
Relationship	1.000	.596
Appreciation	1.000	.493
Decentralization	1.000	.598
Training	1.000	.531
Performance	1.000	.571
Workload	1.000	.474
Advertisement	1.000	.490
Rating	1.000	.613

Extraction Method: Principal Component Analysis.

Interpretation

The communalities table arising out of the analysis shows the variance in the variable accounted by the extracted factors of the Extraction method: Principal component Analysis

Table 4.8: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.778	36.113	36.113	5.778	36.113	36.113	3.406	21.288	21.288
2	1.323	8.267	44.381	1.323	8.267	44.381	2.557	15.984	37.272
3	1.123	7.021	51.401	1.123	7.021	51.401	2.261	14.130	51.401
4	.968	6.049	57.450						
5	.815	5.096	62.546						
6	.787	4.922	67.468						
7	.707	4.421	71.890						
8	.658	4.114	76.003						

9	.630	3.940	79.943						
10	.595	3.721	83.664						
11	.551	3.445	87.109						
12	.480	3.002	90.111						
13	.460	2.872	92.983						
14	.393	2.457	95.441						
15	.374	2.339	97.780						
16	.355	2.220	100.000						

Extraction Method: Principal Component Analysis.

Interpretation

Component- There is 16 components are used in analysis which is variables.

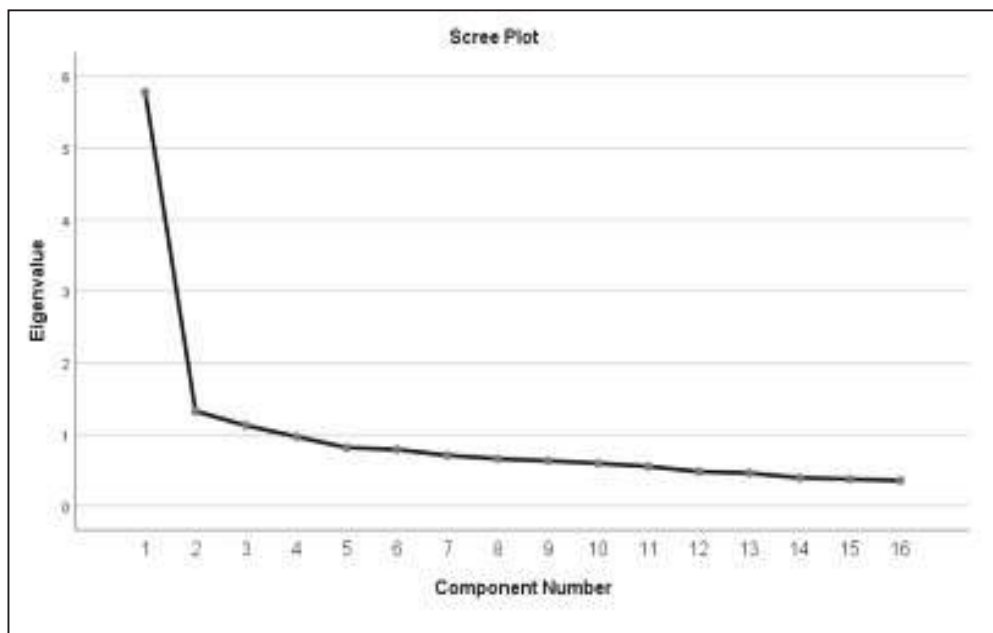
Initial Eigen values- this is known as the variances of components. We have conducted this analysis on correlation matrix, which shows that they are standardized and it means each variable carries variance of 1 and total variances is 16.

Total- this column consists the eigenvalues. The first component is accountable for the most variance.

% of variances. It accounted for by each component.

Cumulative % - if we shown third row carries value of 51.401. it means that first three value accounted together for 51.401 of the total variances.

Table 4.9: Scree Plot



Interpretation

It is defined as the line plot of the component number and eigenvalues of factors. This graph helps to determine how many factors to retain. On which point the curve starts to flatten is known as the point of interest. In this graph we can see that the curve begins to flatten between factors 2 and 3. With the purpose to finding statistically significant factors of components using a screen plot is known as screen test.

Table 4.10: Component Matrix

	Component		
	1	2	3
Rating	.733	-.270	-.045
Workload	.647	-.231	-.043
Promotion	.642	-.180	.099
Advertisement	.636	-.083	-.280
Growth	.624	-.182	.275
Decentralization	.623	.320	-.328
Involvement	.618	.196	-.334
Motivation	.603	-.153	.211
Training	.598	-.387	-.153
Incentive	.596	.324	-.054
Appreciation	.586	-.365	-.128
Performance	.581	.285	-.391
Support	.562	.023	.389
WLB	.534	.416	.252
Benefits	.522	-.015	.467
Relationship	.463	.564	.251

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Interpretation

Component- The highlighted column consists principal component that have extracted.

Above table shows component loadings, which shows correlation between variables and components. In correlation, the possible value ranges from -1 to +1.

Table 4.11: Rotated Component Matrix^a

	Component		
	1	2	3
Training	.701	.197	.024
Rating	.701	.271	.220
Appreciation	.675	.188	.047
Workload	.613	.245	.193
Promotion	.563	.184	.322
Growth	.539	.065	.451
Advertisement	.515	.470	.059
Motivation	.508	.110	.402
Decentralization	.218	.723	.168

Performance	.219	.718	.086
Involvement	.305	.653	.115
Incentive	.176	.542	.372
Relationship	-.111	.419	.638
WLB	.045	.372	.617
Benefits	.334	-.013	.615
Support	.340	.078	.588

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 15 iterations.

Interpretation

The rotated component helps you to know what the components represent. In the given table we can see that the 1st component is highly correlated with training and rating because both are carrying same value but 2nd component is highly related correlated with *decentralization* and 3rd component is highly correlated with *relationship*.

CONCLUSION

Major findings

1. As per our research, we found that the employees between the age group of 26-35 are more in comparison with other age groups which we have mentioned in our questionnaire.
2. "Support from the supervisor manager" is the utmost significant variable that effect employees in the organization to stay there for long.
3. The KMO is greater than 0.5 i.e 0.897, which told us that we can go ahead with our research.
4. In the correlation coefficient, we found that "Benefits & involvement of employees" are somewhat correlated as they are having correlation of 0.017.
5. The other correlated variables we found is that "Appreciation & Relationship". Both are having 0.222 correlation among them.
6. In the total variance, % of variance attributes to each factor in which first three factors are significant but the rest factors are not noteworthy.
7. Scree plot analysis that helped us to know how many factors to retain, and from where the arch jumps to compress. In our research the curve starts to level among 2 & 3 factors.

Recommendation

1. **Trust Always Brings Loyalty:** When an organisation trusts on their employees. Employees have responsibility to be loyal towards organisation's goals.
2. **Create Positive Workplace:** Employees feel comfortable at the workplace. It is positive thing because of that they have openly communicate with each other. They focus on their training, it develops the sense of unity, acceptance etc.
3. **Promote Transparency:** Organisation must be honest with employees. It is a only one way to promote loyalty so always informed them about plans. Make them involved in the decision making.
4. **Recognise and Celebrate Employee's Achievements:** It is a way to make them satisfied and happy at workplace.
5. **Work-life Balance:** Organisation must value their work-life balance. Allow them to take rest due to work load and give them time to return back at job with full potential.

6. **Listen Employees Ideas:** If organisation wants some fresh and new idea for business , it can idea from their employees.

Limitation of Study

Every research work ends with many limitations, we also faced some which are:-

1. Because of the small sample size, we couldn't get the effective results about the employees' motivation.
2. In between of the research, we faced lockdown because of COVID 19 outbreak.
3. Many other problems we faced as listed below:
 - (a) All the group members were not having their laptops with them at home as it was locked in the hostel rooms.
 - (b) We could not share our ideas with each other effectively.
 - (c) The only laptop which we had, was not compatible with SPSS software.

Scope For Future Research

1. We can do coming research on how to get individuals wants and requirement in the organisation as it will help the researcher to know the individual needs and requirement by which organisation can understand their problem and help them in finding out the solution.
2. From this study we can clearly perceive that motivation play a governing impression on worker act, which will certainly help our economic sector better.
3. If we get good outcome from these sector our country will be in better developing shape.
4. To get the material essential on individual wants, we can use the tools like interview etc.
5. When we are talking about the future scope of research we can do research on the female's motivations as men and women motivation factors are different sometime.

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Micro-Nanoneedle Case Study for Advanced Drug Delivery

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▶ ABSTRACT ◀

Needles are among the most often used medical instruments and have been successfully employed in the human illness prevention, diagnostic, medication, and rehabilitation. By applying extremely concentrated pressure with its pointed tips, a thin 1D needle can easily enter cells and also organs to perform biological liquid sampling, bio-sensing, medication delivery, surgery, and like similar tasks. The delivery of pharmaceuticals has also been a growing problem for researchers and patients, along with the increase in drug exploitation. The micro nano-needles (M-NN) is a new methodology that uses one or more micro or nano-needles and claims to be a reliable one strategy for effective, noninvasive, and practical medication delivery. This evaluation's objective is to provide the most current developments in M-NN-based medication delivery, including their different kinds, application scenarios, and illnesses, as well as improving delivery strategies and potential future developments.

Keywords: *Needles, NN (Nanoneedles), MN (Microneedle)., Micro-Nanoneedles (M-NN), Non-Invasive, Photolithography, Nanofabrication, Ferro Fluid, Mn. Arrays, Stimuli-responsive, Atomic Force Microscopy.*

INTRODUCTION

With the rapid advancement in modern medicine, drug delivery has become an increasingly popular topic. Over the years, many delivery techniques, including oral administration, injections, and ointment, have been used. We can maximise the treatment effects of the drug while minimising its side effects in the clinic by using

technology that is appropriate given the unique pharmacological properties of the drug. In the meantime, each of given drug administrative methods has benefits and drawbacks of its own advancements. Even while oral administration is common and convenient in daily life, some unique human surgeries can be uncomfortable. Additionally, due to gastrointestinal breakdown and hepatic first-pass clearance, it has a limited bioavailability. Although intramuscular, intravenous, and hypodermic injections can deliver pharmaceutical molecules to the subcutaneous vessels & tissues, they all carry the risk of discomfort and tissue damage. Injections also place strict standard on medications, such as good water-soluble properties.

The modern drug delivery techniques using micro- and nano-needles are summarised in this paragraph and including their development, types of M-NN, functioning of mechanisms, and implementations in the treatment of obesity, diabetes, also hair loss, cancer, and contraception. Recently advancements in these fields are openly distinguished. Additionally we, contrast the features of MNs. and NNs and talk about the most recent research findings and connections between them. Lastly, we outline the hurdles that the future development and clinical application of M-NN will face.

MICRO-NEEDLES

MNs. (MNs) are micrometer-sized needles that may penetrate the stratum corneum of the human skin and create micron-sized pathways for non-invasive diffusion and function of medications. Researchers have developed production techniques such as UV-lithography, laser beam cutting, micro electro mechanical systems, and chemical based etching to construct various types of MNs. Traditional MNs (such as solid, coated, and hollowed MNs) and developing MNs (such as dissolvable, hydrogel forming, and specifically structured MNs.) can be divided into two types.

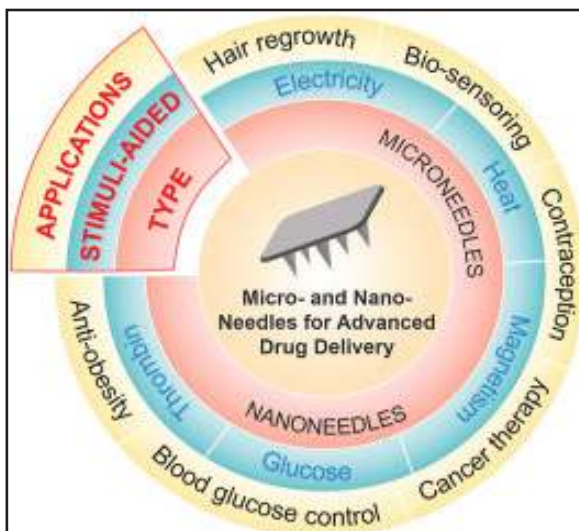


Fig. 1: Whole Explanation of Nano/micro Needles Applications and Types

Traditional MNs (such as solid, coated, and hollowed MNs) and developing MNs (such as dissolvable, hydrogel forming, and specifically structured MNs.) can be divided into two types.

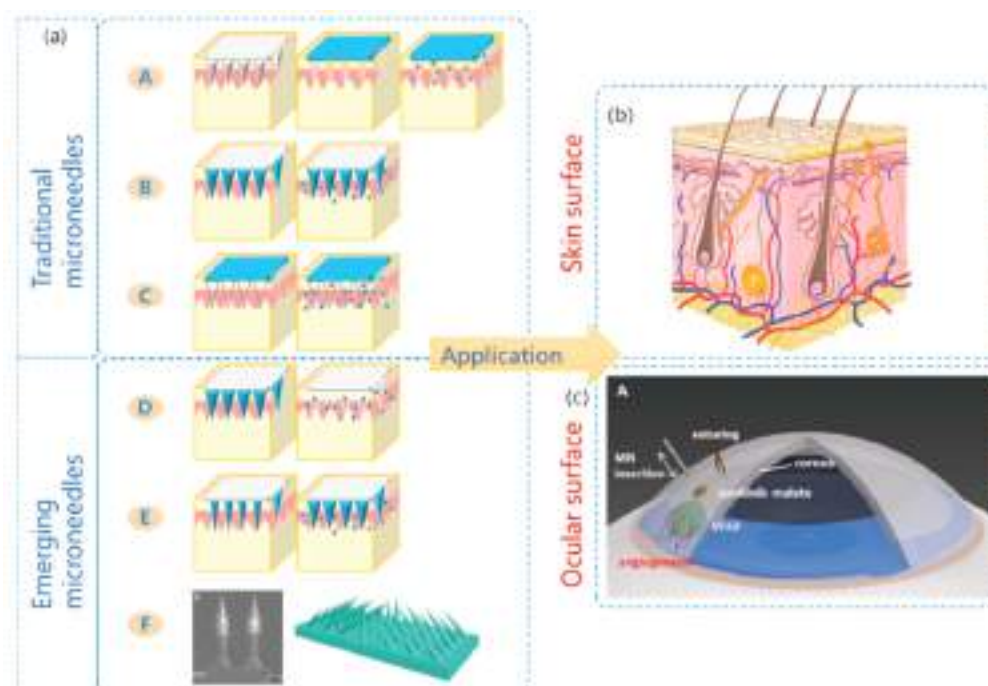


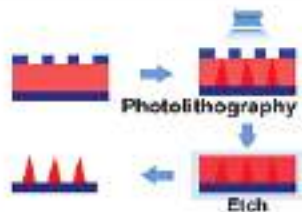
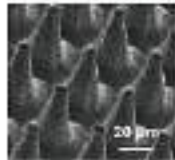
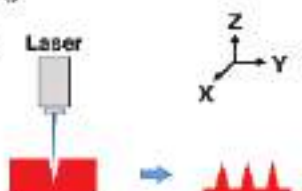

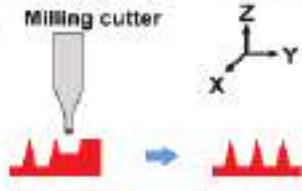
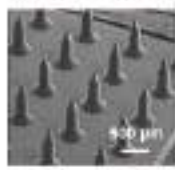

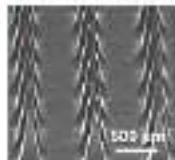
Fig.2: Types of MNs.

Traditional Needles

Solid MNs are used to penetrate the skin and form transient micro-channels in order for the drugs that are delivered to the skin's surface to reach the dermis and enter the bloodstream where they can have pharmacological effects. When the skin is pierced, cohesive microneedles (coated MNs), which are solid microneedles covered by a drug coating, release their contents into the blood and interstitial fluid. The actual drug loading is often minimal because MNs are tiny and have a thin coating layer. When inserted into tissue, hollow microneedles (also known as hollow MNs) can achieve a big dose and continuous drug release, but they can also get blocked, which can have a negative impact on further drug delivery.

Emerging Microneedles

Numerous novel MNs (MN) with intricate structures have been created by researchers, including hydrogel-forming, dissolving, and specially constructed MNs. Drug-loaded biodegradable polymers are used to create MNs that dissolve, while super-swelling cross-linked polymers are used to create MNs that form hydrogels. Drug loading rate and delivery effectiveness have been improved with specially built MNs. Additionally, Lee's team demonstrated specialised MNs with curved barbs facing backward, It showed tissue adherence that was 18 times stronger than MNs without barbs. Zhao et al. claim that ferro fluid-configured mouldings were used to create clamping MNs that resembled serrations. These mouldings were able to securely cling to the tissue and give patients durable function even while they were exercising. In addition, Lee's team showed customized MNs with curved barbs pointing backward, which showed 18 times higher tissue adherence than MNs without barbs. Zhao et al. claim that ferro fluid-configured mouldings were used to create clamping MNs that resembled serrations. These mouldings were able to stick to the tissue securely and give patients long-lasting function even while they are exercising.

Fabrication methods	Fabrication illustrations	SEM images	Materials	Advantages	Typical limitations	Typical applications
Photolithography and etching			Silicon, Tungsten	High precision, high efficiency, fit for mass production	Expensive equipment, harsh environment, multiple steps	Bio-sensing, drug delivery
Micro machining Laser machining			Copper, Titanium, Stainless steel	High efficiency, maskless, high flexibility, non-contact machining	Rough surface quality, lower machining accuracy, arched needle tip	Bio-electrode, bio-sensing, drug delivery, biodegradable microneedles
Milling machining			Aluminum alloy, Stainless steel 316L	High precision, good surface quality	Low efficiency, high cost	Microneedle template
Wire electrical discharge machining			Stainless steel	High precision, good aspect ratio, reproducibility	Time consuming, limited material	Bio-electrode

MNs. for Advanced Drug Delivery

MNs. in Skin and Ocular Surface

The outermost layer, the epidermis, and the interior layer, the dermis, make up the skin, which is the most widely distributed organ in the human body. The thickness of the epidermis varies from 50 to 150 μm depending on the location. There are several active areas in the dermis, which mostly consists of the vascular and reticular layer. MNs. are kept only in microscale and can localize drug release and control drug release accurately. Because the eye is a crucial organ, typical topical medication delivery calls for large dosage to ensure locally effective concentration.

In 2007, Prausnitz and colleagues developed coated MNs for ocular medication delivery for the first time. These MNs were hard enough to penetrate human cadavers and released fluorescein concentrations that were 60 times higher than those produced by standard topical administration. A unique double-layered Mn. patch was developed by Chen et al. to manage medication administration to the eyes painlessly. This patch significantly reduced neovascularization and improved the effects of diclofenac, an anti-inflammatory treatment. Ocular drug delivery based on Minnesota offers a low-cost, targeted, and highly effective technique. It is also able to transmit biomolecules and medications to other tissues and organs in an implantable manner. Since previous reviews have covered these non-transdermal drug delivery cases in great detail, we won't go into great detail about them here. The human body's biggest organ, with a surface area of about 2 m^2 , is the skin. It carries out a number of crucial functions (endocrine, thermoregulation, sensory, etc.) and can protect us from dangerous chemicals as well as physical and chemical aggressors from the outside environment. Mammalian skin has two primary layers: the dermis, which is at the base, and the epidermis, which is on top. The epidermis has five layers and ranges in thickness from 50 to 150 μm depending on the area (excluding the palms and soles). The dermis, which mostly consists of the papillary and reticular layer, has a number of active areas.

The reticular layer, which contains fibrous bundles, supports many crucial functions like immunologically active cells, blood capillaries, nerves, and eccrine and apocrine glands. The papillary layer, which is connected to the epidermis and is abundant in vessels and nerve endings, is in charge of many other crucial processes. Large, rigid needles can penetrate the dermis and hypodermis to deliver medications to deep areas of the skin, but they also run the risk of injuring nearby tissue and nerves, which can result in discomfort. In contrast, a Mn.'s length (length = 200 to 2000 μm , aspect ratio (AR) is about 0.7 to 100) is restricted to the microscale. It can make conduits non-permanently within a small microns after puncturing the skin's surface, enabling the medicine to get through the stratum corneum's barrier and diffuse it into the blood vessels except harming the nerves of humans.

Patients can self-administer drugs for the treatment of numerous chronic conditions thanks to a drug delivery system developed in Mn that can target a specific location and precisely control drug release. As the population ages and the number of people who wear contact lenses rises, the eye, a crucial organ, becomes more vulnerable. While topical drug delivery is simple, it has a lower bioavailability (5% absorption) and is simpler to clean than systemic drug delivery, which requires large dosages to ensure locally efficient concentration. Long-term, focused, and effective delivery of ocular medications with high patient compliance is still an unmet medical need.

This procedure is challenging, though, because of the eye's intricate structure. Tears and aqueous fluid, in particular, support the cornea because it lacks blood veins and needs both to function. The protection from continuous fluid turnover and eyelid blinking further hinders drug delivery. In 2007, Prausnitz and associates created the first coated Mn for the administration of ophthalmic medications. The 500 μm long MNs with a 45° tip angle were stiff enough to pierce human cadaveric tissue, and the drug coating came off the needles in less than 30 s, allowing it to reach cornea or sclera tissue. It has been demonstrated that the delivery of fluorescein using fluorescein-coated MNs is 60 times more than that of traditional topical administration.

However, because to the complex design of the eye, this process is difficult. The cornea is supported by tears and aqueous fluid in particular since it lacks blood vessels. Drug distribution is additionally hampered by the

protection from rapid fluid turnover and eyelid blinking. For the delivery of ocular drugs, Prausnitz and coworkers developed the first coated Mn in 2007. The drug coating degraded from the 500 millimeter long MNs swiftly (> 30 s) to reach eye or sclera tissue, and the needles were stiff enough to puncture human cadaveric tissue. The delivery of fluorescein using fluorescein-coated MNs was shown to be 60 times greater than that of traditional topical delivery.

This method of locally focused, cost-effective ocular medication delivery is based in Minnesota. It promises at-home, painless treatment for a range of eye conditions. Mn. array can implantably distribute drugs to a variety of tissues and organs, including the genitourinary system, gastrointestinal tract, and vascular tissue, in addition to the skin and eyes. We won't go into detail here because these non-transdermal drug delivery scenarios have already been covered in-depth in other publications.

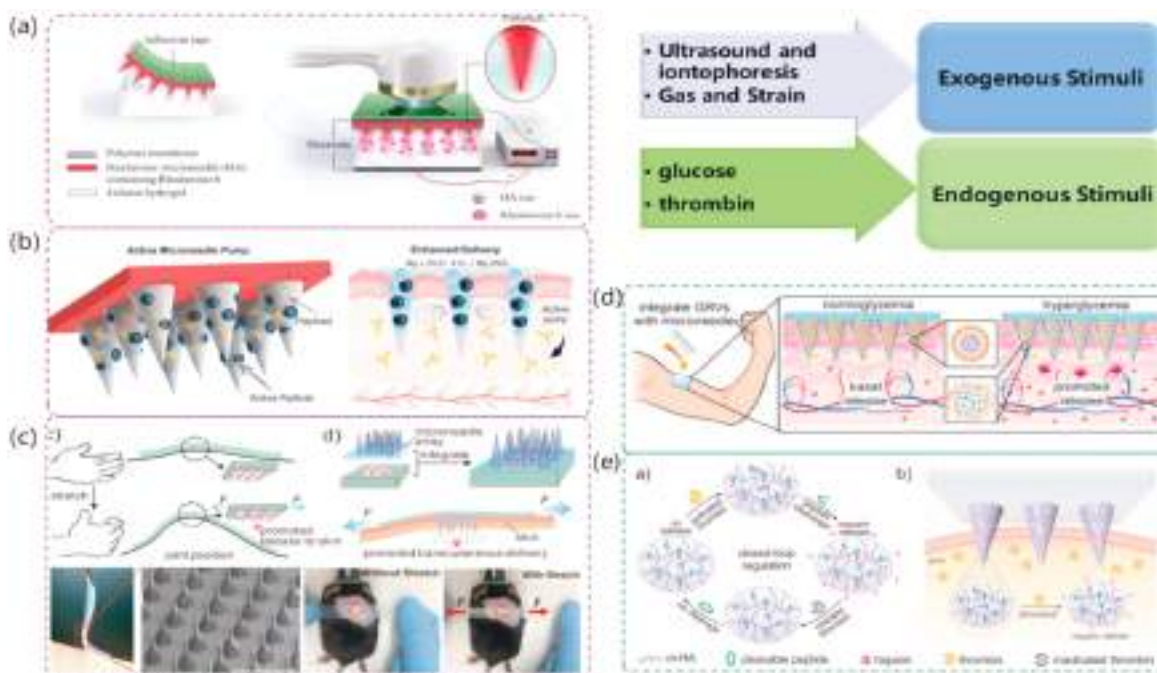


Fig.3. Smart Stimuli-Responsive Drug Delivery Based on MNs

Autonomous dynamic delivery strategy has driven by exogenous stimuli like (i) Ultrasound and iontophoresis [72] (Copyright 2020 Springer Nature), (ii) gas [77] (Copyright 2019 John Wiley and Sons) and (iii) strain [74] (Copyright 2015 American Chemical Society), and driven by endogenous stimuli like (iv) glucose [59] ((Copyright 2015 National Academy of Sciences) and (v) thrombin light [75] (Copyright 2016 J. Wiley & Sons). All figures were reproduced with permission.

Intelligent stimuli-responsive drug delivery System

The majority of Mn. arrays for drug delivery now on the market are administered in a "passive" manner, with transfection efficiency limited by the slow drug diffusion from needles, which could lead to unwanted concerns including uncontrolled release, a slow effect, or drug overdoses. An autonomous dynamic delivery approach based on stimuli-responsiveness was created to overcome these problems, which has created new opportunities for therapeutic applications. MNs, which are activated by both exogenous (like heat, force, and electricity) and endogenous (like glucose and thrombin) stimuli, can accurately and swiftly release medications in the targeted location to accomplish intelligent controlled release. (Fig 3).

Ultrasound and iontophoresis are also helpful in medication absorption. When used on skin, ultrasound can cause alterations (vibration, contraction, and relaxation) as well as temperature effects, whereas iontophoresis can speed the entry of ionised biomolecules into tissue in an electric field. Lim et al. created hyaluronic acid (HA) MNs. based on this principle for efficient active local delivery (Fig.3i).

Based on this, Wang's team developed a self-guided Mn. delivery method that propels intradermal payloads with the help of magnesium microparticles (fig.3ii).

The loaded magnesium microparticles in the patch responded to interstitial fluids once the patch was penetrated into the skin and promptly created H₂ bubbles, opening skin channels and enabling cargos to be released swiftly. In vivo investigations using this method to deliver anti-CTLA-4 demonstrated a significant improvement in immunity and survival rates. A straightforward stimulus for active, spatiotemporally controlled Mn. drug delivery is mechanical force. Gu's team described a stretch-sensitive drug-loaded unit and MNs in a strain-triggered drug transfer device (fig.3iii).

The device quickly released the drug when a tensile strain was applied because the microdepot produced Poisson's ratio-induced compression and an improved diffusion surface. Kim et al.'s integrated system for closed-loop, real-time diabetes medication included a stretchable device with gold mesh and gold-doped graphene, polymeric microneedles, and electrical parts like heaters, temperature, glucose, and pH sensors. Using painless MNs and insulin-containing hypoxia-sensitive HA vesicles, Gu et al. studied new enzyme-based "closed-loop" insulin release microneedles (Fig. 3iv). A feedback-controlled anticoagulant MNs patch that was noninvasive and had a minimal risk of under- or overdose was also revealed by Gu's team, who expanded the treatments. The recently created stimuli-responsive Mn. technology provides an autonomous dynamic delivery strategy to transfer biomolecules on demand, enabling the release of drugs in the appropriate regions in a very effective and thoughtful manner.

NANONEEDLES

With their razor-sharp nanostructures and sizes ranging from 1 to 100 nm, NN, which are employed for cell sensing and drug administration, can pierce the cell membrane because they are thin 1D nanostructures. Their 1D nanostructure allows for the division of these particles into solid and hollow NN. Semiconductors, metals, and metal oxides have all been used in the creation of high aspect ratio NN with a variety of adjustable dimensions, compositions, topologies, and properties. Based on fundamental fabrication principles, There are two types of production processes: bottom-up and top-down.

Mn. arrays are crucial, especially for transcutaneous medication administration, but prolonged use might irritate the skin. Nanoneedles (NNs) perform better in this regard because they use the same working concept as MNs but are significantly smaller—nanometers or less in size (sub-100 nm diameter)—than MNs. The cell membrane was successfully ruptured, and biological payload was delivered within the cell. Evidently, this penetration technique disrupts cells only minimally, and following delivery, cells typically continue to function normally. NNs provide a more efficient, user-friendly, and precise way to deliver payloads with less harm and high throughput than conventional microinjection and electroporation. Few studies have combined micro- and nano-needles for an overall result, despite the fact that each has advantages and disadvantages.

NN for Advance Drug Delivery

an extremely high aspect ratio nanoneedle To create highly effective nano-therapeutics, nanostructure adopts strong mechanical, electrical, and optical properties. It is also capable of active cytosolic transport, cell membrane coordination, and endo/lysosomal organisation. A nanoneedle can be made using chemical synthesis and nanofabrication (direct-write nanofabrication and focused ion beam machining). For molecular delivery, cell manipulation, gene transfection, and bio-sensing, it is a painless and effective technology, and significant advancements have been made in these fields over the past ten years. Nucleic acid delivery to specific muscle locations is still challenging and ineffective due to low transfection efficacy, questionable safety, and poor scalability among different cells or sites. Tasciotti's team came up with a biodegradable and programmable nanoneedle array to transport nucleic acids with high efficacy, low toxicity, and practicability without the need for sophisticated apparatus in response to this challenge.

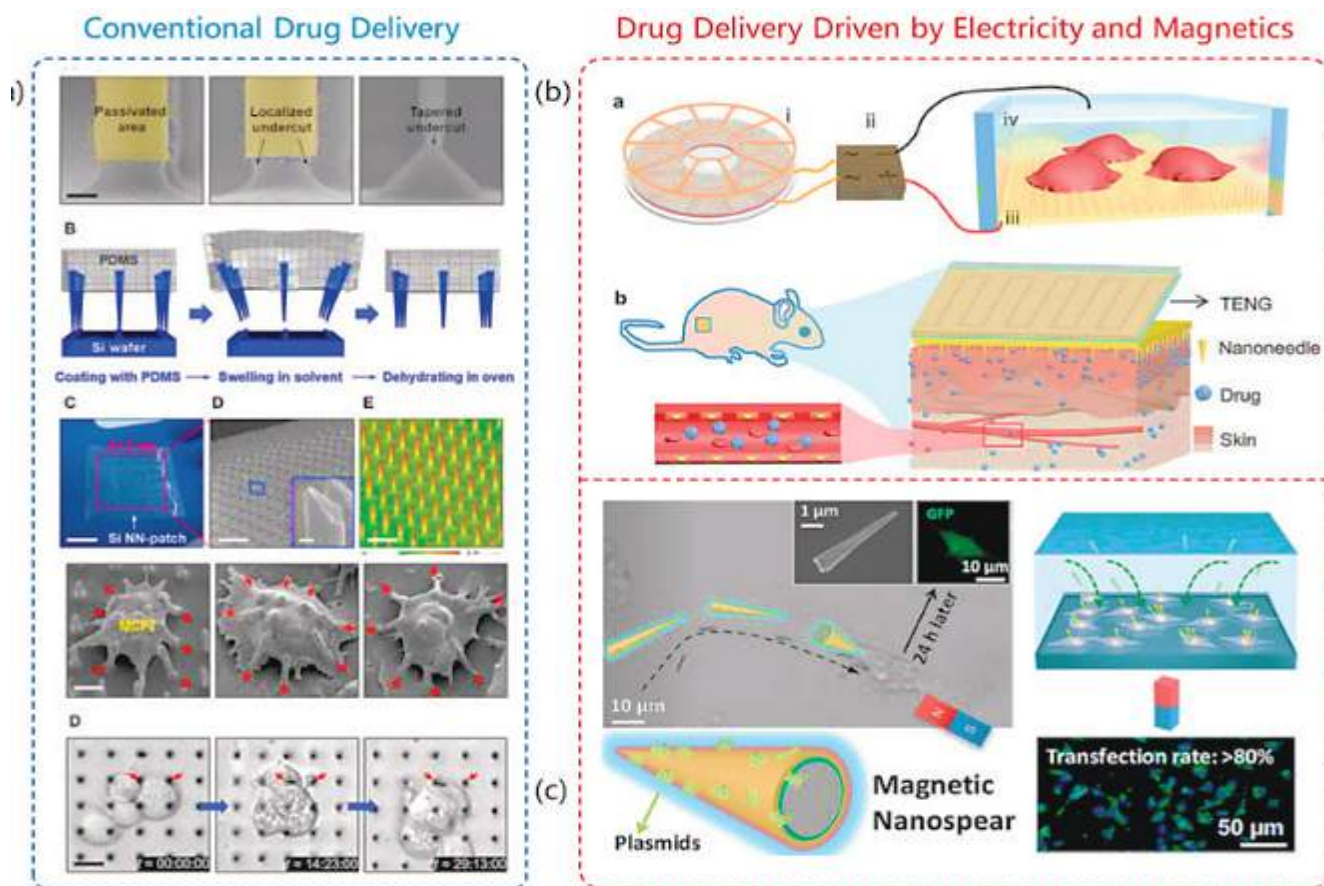


Fig.4. NN in Advanced Drug Delivery

NN were developed in (i) conventional drug delivery [91] (Copyright 2019 ACS) and novel drug delivery driven by (ii) electricity [93] (Copyright 2019 J. Wiley & Sons) and (iii) magnetics [94] (Copyright 2018 ACS).

In order to achieve mechanical flexibility and optical transparency, Lee's team invented a unique method for constructing vertically-ordered Si NN on a thin elastomer layer (Fig. 4i). They achieved the intracellular and intradermal nano-injection of biomolecules into living cells and tissues. NN, however, struggle with restricted tissue accessibility and poor delivery performance through pure mechanical penetration. Numerous complementary strategies, including electrical stimulation and magnetic forces, are useful in addressing these problems. In order to deliver biomolecules into cells, transitory gaps in the plasma membrane can be created using electroporation, and NN can serve as electrodes and drug reservoirs at the same time.

To create a NN-based self-powered medication delivery device, Li and colleagues combined silicon NN with a triboelectric nanogenerator (TENG). This allowed them to electroporate medicines with great efficiency. (Fig.4ii). TENG supplied a steady voltage pulse to elevate the plasma membrane potential and boost biomembrane permeability, whereas silicon NN generated nanoscale channels for the transfection of biomolecules and raised the electrical field at nanoneedle-cell interfaces to enhance molecular inflow. The TENG-exercised device displayed four times greater delivery efficiency without jeopardizing cell vitality when compared to passive mechanical penetration. To create magnetic nickel nanospears for accurate, chemical-free intracellular gene delivery, Weiss' team combined magnetic forces with nanospears (Fig. 4iii). When controlled by spinning magnets, nanospears might be produced progressively to process large numbers of cells in a batch while simultaneously targeting and transferring biological components to individual cells. After transfection using nanospears, cells had a high viability rate (> 90%) and transfection rate (> 80%).

Method of Medication Delivery Using NN

Understanding the processes that NN influence is essential for developing more logical technology and advancing clinical translation. Some studies initially believed that NN or NNs could effectively transfer bioactive molecules into cytoplasm by penetrating membranes of cells. AFM results showed pronounced dips in the force-displacement curve for NN interacting with lipid bilayers and cell membranes; these dips were attributed to cell membrane rupture. The nanoneedle-cell interface microscopy results, which consistently showed intact cells, corroborated this opinion. The theory of biomolecules passing via the nanoneedle-biomembrane interface was recently reported. To see how the lipid changed, they employed scanning ion conductance and electron microscopy.

The entire biological process is described using bilayers and related proteins. It has been shown that nanoneedle arrays can facilitate both macropinocytosis and endocytosis mediated by clathrin and caveolae simultaneously, which was beneficial for the nanoneedle-regulated transport of nucleic acid into the stem cells. These occurrences give strong suggestions for cutting-edge cell-manipulation technologies in addition to deepening our understanding of the biological processes and intracellular connections mediated by NN.

CONCLUSION & OBSTACLES

M-NN is a micro/nanosystem that can create tiny channels in biomembranes to get around obstacles in the way of drug release and diffusion. Since it originally appeared a few decades ago, it has greatly advanced in terms of fabrications, delivery strategies, and uses. MNs were developed to increase drug loading, bioavailability, and tissue adherence, whereas NN were designed to transport cargos (protein and nucleic acids) into live cells. There are still difficulties for M-NN in this field, as when biomolecules are loaded efficiently and then the process of activating cells after surgery. The final objective is clinic translation, which is a new challenge..

The elaborate design and execution of the advanced M-NN delivery systems, which are still active research areas, is another barrier. The physiological markers or drug release process linked with mobile devices is designed to be continually monitored and controlled in one particular disease (diabetes, cancer, and epilepsy).

Even though there is still a long way to go until M-NNs are commercialized, several MN therapies for diabetes, hair growth, wound healing, and skin rejuvenation have already been introduced to the market in conjunction with other approaches. More improvements in M-NN will eventually be developed to address current concerns as fabrication technology and medical research advance.

FUTURE PROSPECTS

Drug delivery systems (DDS), such as nanoparticles made of lipid or polymer, can be created to enhance the pharmacological and therapeutic effects of medications given intravenously. The majority of the initial problems that hindered clinical applications have been fixed, and a number of anticancer and antifungal drug formulations have been given clinical use approval. We can operate brain surgery, ocular surgery

There are evident difficulties that need to be addressed with the introduction of nanotechnology in the drug delivery applications for enhancing the deliverability of certain difficult-to-deliver medications. The safety profile of these nano-carriers for chronic treatment is the main area of worry, and the scientific community and healthcare organisations are working diligently to address this issue.

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TRACK : 4



A Review Paper On: Smart Green Highway Lightning System with Ambient Monitoring Capability Based on Internet of Things

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▶ ABSTRACT ◀

Given anticipated rises in power demand in the upcoming years, India's energy sector would need to undergo substantial alterations. Additionally, the practical integrated application of the technology is now finally potential due to the country's recent extensive availability of internet access. However, in terms of quality and generalisability, the ultimate guide for renewable technology-enabled highway lighting systems is still absent. The purpose of this paper is to explore diverse processes in the literature to establish techniques for planning and developing energy-efficient green highway lighting systems while considering performance and ecological effects. A completely used technique and design are presented to identify and organize the research paper into several categories, including fundamental design, disadvantage, and research challenges. The objective of this paper is to provide knowledge about the existing research for an ideal solution that we want to achieve and reduce power consumption. This model will help us to make the environment clean and green with the help of green energy. This paper includes many suggested used techniques based on IoT, microcontrollers, WSN (wireless sensor network), RFID cards, transceiver modules, network time protocol, etc. After reading many papers based on the above technique their disadvantage can be obtained. Overall, the final results of the paper are to reduce the power consumption on the highways and provide safety for the public.

Keywords: Smart Highway, IOT (Internet of Things), Automatic Lighting System, Green Energy.

INTRODUCTION

As we know that India is a developing country and the total number of National Highways is 599 to date (09/02/2023) according to the Ministry of Road Transport & Highways and many other highways are under construction. Most of the highways use the conventional lightning system, which are increasing the burdens on the power grid. We know that about 50% of energy is generated by coal which means it increases the CO₂ and other harmful gases which are affecting our environment and polluting the air quality day by day. So, we can say that as the number of highways is increasing CO₂ is also increasing. Due to this reason, all the country wants to adopt green energy. If we adopt the green energy then we will reduce the burden on the conventional energy sources and make the environment clean and green. So, we have to implant renewable energy resources on highways like solar energy, and vertical axis wind turbines which generate the power on highways for the new technology used. And all the poles on highways are designed as self-power generated for lightning and other uses.

We know that a smart highway contains like automatic irrigation system, automatically operated street lights, an accident prevention system, CCTV surveillance, RFID card for collecting the vehicle's information at a toll gate. All the technology is changing with time but our highways are facing the old technology. So, our youth want to replace the old technology with the new technology.

A REVIEW PAPER ON SMART HIGHWAY

There is much research done on intelligent and sustainable technology for smart highways for energy management along with safety/ panic alarms, automatic irrigation systems, and safety precautions for the accident on the highways. Some of the research is as follows:

Highway Lighting System Based on IOT

This paper proposes an IOT-enabled intra-network solution for the highway lighting system. In the proposed schemes solar panel and vertical axis wind turbine (VAWT) is used for energy generation. Solar panels can generate energy during the day and the energy generation by wind turbines is depend on the movement of the vehicle on highways which can generate energy in day and night both. This hybrid model can generate enough energy for the lightning system of highways. The generated energy is stored in batteries. The solar panel is used as the main source of energy while the vertical axis wind turbine is used to minimize the dependency on solar energy. This system consists of a solar panel, wind turbine, hybrid charge controller, battery, inverter, etc. [1]

Limitation

- Wind turbine installation cost is very high.
- Depends on the weather condition.
- No panic alarm or automatic irrigation system is available.

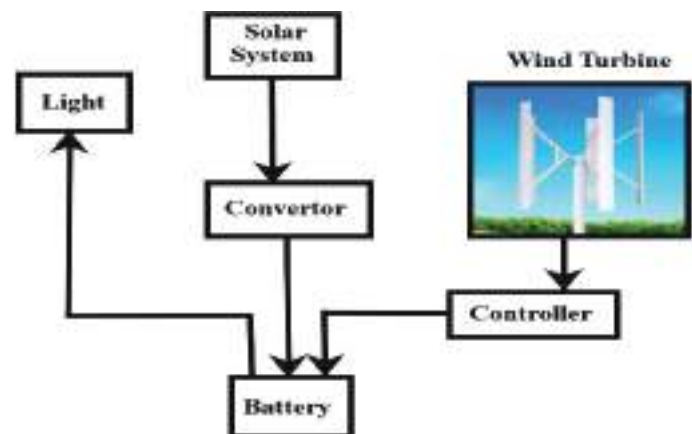


Fig.1: Block Diagram of the Proposed Model

Highway Lightning System with Controlled Light Intensity

This paper proposed the IOT-enabled system which detects the presence of vehicles on highways with the sensors and turns ON the lights. The intensity of the lights depends on the traffic on highways. According to this paper whole highway is divided into sectors and each sector consists of many lamps post. The first and last lamppost of a sector is considered an anchoring node. When a vehicle reaches the first lamppost the lights of that sector will be ON and some lights of the second sector will also turn ON. The intensity of light will be

less on the alternative pole. As the vehicle reached the second sector all lights in that sector will be ON and the light of the previous sector will be OFF. The presence of vehicles will be detected with the help of a sensor. First CSU (Channel service unit) detects the presence of a vehicle that is installed on every first lamppost of the sector, then it sends the data to the PU which is a primary controller which is programmed to take decisions based on the input and can turn light. The component of this system is Arduino UNO, 802.15.4, a proximity sensor, and other accessories.[2]

Limitation

- Maintenance cost is very high.

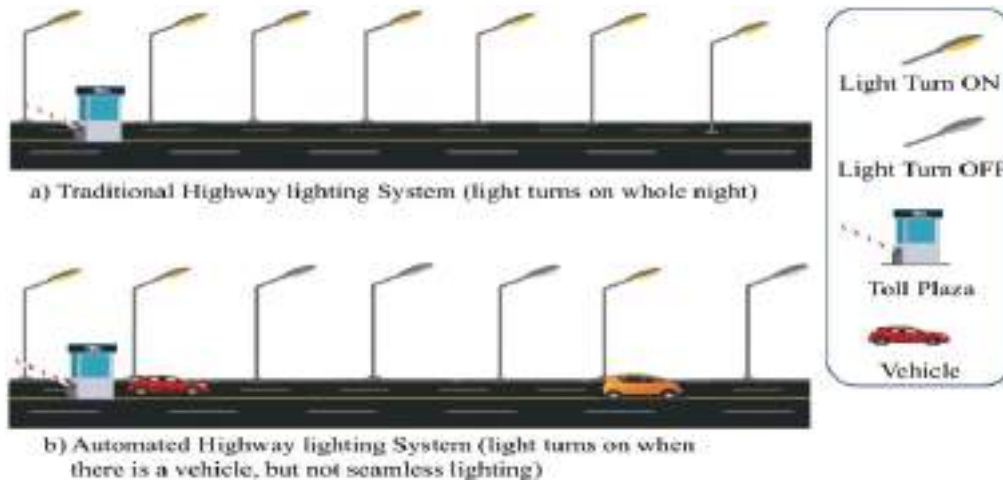


Fig.2: Block Diagram of the Proposed Model.

IOT-Based Highway Safety System

This paper tells us about the highway traffic information monitoring concept model, this model is based on IOT with wireless communication technology. This technology replaces the traditional highway toll card with a smart RF Id card, which is based on radio frequency. When the vehicle enters the toll station, the toll station initializes the radio frequency card (RFID card). In this card, there is some simple information about the vehicle stored in the card. When the vehicle runs on the highway the information of the driver is monitored and controlled with the help of the satellite. For safety purposes, when the vehicles reached the toll station the speeds of the vehicles are different due to that reason the highway lane is divided into different sections.[3]

- Every section should have an individual toll station.
- Every section should have a separate road like (Diversion, Uphill, Downhill, Tunnel, etc.).
- Every section should have a limit of the minimum and maximum length which is 1000m and 5000m.

Limitation

- It contains only simple information about the vehicles.

Cost Effective and Accident Detection System Based on Big Data

This paper talks about highway accidents which are fast and easy to implement on the highway and detect the accident with the help of the big

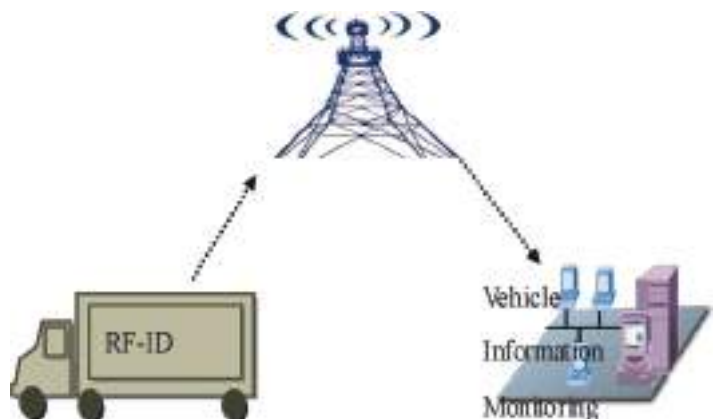


Fig.3: Block Diagram of the Proposed Model

data method and mobile operators. To reduce the additional installation of the model between the different departments it uses the mobile operator, and measurement report (MR) data. This method is used to avoid the cost of infrastructure construction, sensor installation, and data collection barrier. For the detection of accidents on the highway generally, we use GPS or triangulation data. The GPS data depend on the real time but it is not present at all the time. Triangulation data is not able to provide accurate data. So, a fingerprint map is introduced to detect the accident which provides us the accurate data.

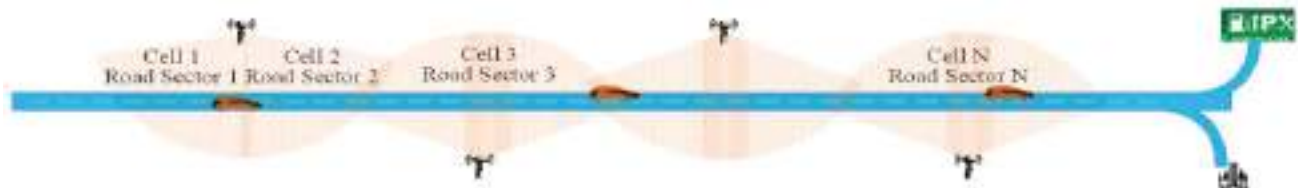


Fig. 1. Schematic diagram of one road divided by mobile sectors



Fig.4: Schematic Diagram of the Divided Road Sector in One Segment

For preventing the accident, roads are divided into many roads sector and all the road sectors contain a cell tower for detecting the location. The length of the road sector is different due to which the requirements of the cell tower are more. The distance between nearer mobile stations is greater than 1 km on the highway which will be too long for location detection. So, we further divide the road sector into small segments. With the help of various machine learning techniques, we detect the location using the data sample gathered from the DT and MDT as well as the segment model. It decides to categorize the position of the mobile vehicle using the LR method.[4]

Limitation

- The implementation cost for this model is very high.
- It is not reliable for the long distance.
- The accuracy of the location detection is low.

Highway Lightning System Based on Vehicle Movement

The objective of this paper is for the conservation of energy in street lights by designing and implementing the advanced development of submerge system. By using this system, we can control each street light individually with the help of NRF 24L01 (transceiver module), ultrasonic sensor, Arduino Nano, and lighting system. During the operation of the street light, if any fault occurs in the sensor/node it will not affect the entire row of the light. The reduction of the energy conservation of the street light is performed by an ON/OFF switch which is based on the movement of the vehicles. The need for a central logical unit is not compulsory because the logical computations are carried out along with the active sensor node by the automation system. Due to this reason, there is no longer a necessary sensor able to communicate the data across the long distance or to demultiplex the incoming signals.

The function of the ultrasonic sensor is to provide information on the detection of movement immediately in their surroundings. All the street light has a unique Id that is used to identify the position in the sensor array. For adjusting the intensity of the street light every street light has its sensor module which includes the NRF 24L01, ultrasonic sensor, and PWM (Pulse width modulation) controller.[5]

Limitation

- Installation cost is high for the entire highway.
- There is no safety for the vehicle during an accident on the highway.
- The simulation of the circuit model is complex.

Smart Highway with Green Energy

According to this paper, we are trying to focus on the utilization of green energy like solar, wind, and vibration energy, which are used in a focused manner. The objective of this paper is to make the highway road safe, smart, and make more energy efficient. We use vibration energy, wind energy, and solar energy, which will be clean and green. The vehicle moving on the road generate a large amount of vibration which is converted into electrical energy.[6] The conversion of the vibrational energy into electrical energy is performed by two methods, they are:

1. By Piezoelectric material.
2. By Magnetic induction.

The function of the piezoelectric material or crystal is to convert mechanical vibration into electric energy. We know that piezoelectric material produces enough voltage that can be used to supply power for many devices, as shown in Fig. 1. We know that the structure of the piezoelectric material is crystalline. When we apply mechanical force/stress, then it produces electrical energy [10] [11]

The function of magnetic induction is to convert the vibration energy into electrical energy with the help of the magnetic coil. In this method, we can make a specific lane for the vehicles on the highway which will help the vehicle to charge using the magnetic field through an induction coil.

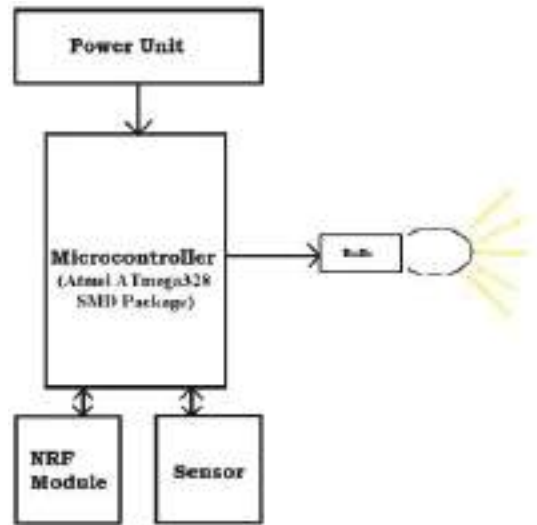


Fig. 5: Block Diagram of the Proposed Model

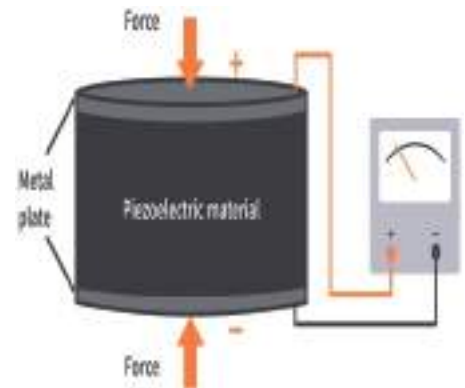


Fig 6: Schematic Diagram of Piezoelectric Material

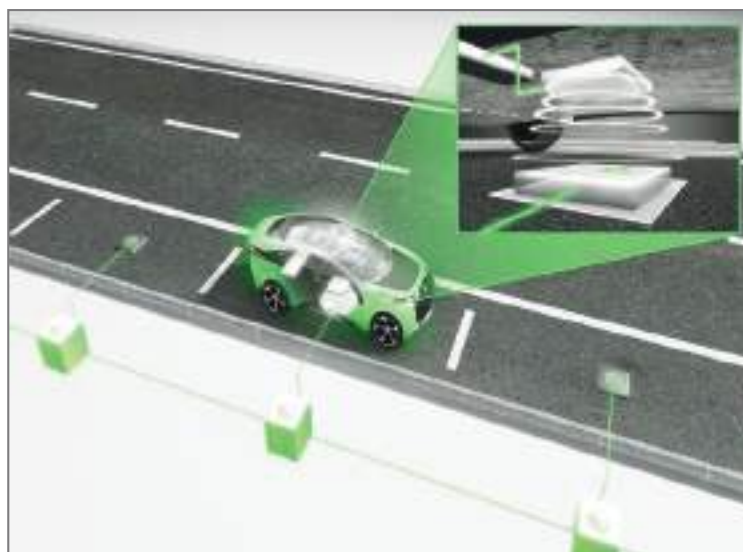


Fig. 7: Schematic Diagram of Magnetic Induction Wireless Charging on Highway Lane

Limitation

- Implementation of this method is complicated on a large scale.
- In this method, the losses of power are more.
- Installation cost is very high.

Smart Highway with Ambient Monitoring Capability and Solar Tree

This paper tells us about the smart highway based on green energy through the implementation of the solar tree and sensor-based street lighting system. The information is stored from the solar tree and explains the network's implementation features. The uses of solar energy are in many forms like population monitoring, surveillance, street lights, etc. For developing the server on the solar tree NODE.js and NODE-Red are used. The main goal of this server is to make it easier to operate and communicate with the tree. For the temperature and humidity, the 1wireDHT22 sensor is directly operated with the Raspberry Pi3. For the internet connection, Raspberry first initializes. Once the internet is connected the NTP (Network Time Protocol) server checks for a time and later.



Fig. 8: Solar Tree Installed in the Park with a Street Light

Limitation

- Programming on the Raspberry Pi is complicated.
- It is not easy to operate.
- Maintenance cost is very high.

Lightning System of Highway Based on Traffic

This paper, it is explained the management of the smart highway lightning system which is based on road habitation. Lights on the highways are controlled according to the vehicles present on the road which is detected by the Wireless Sensor Network (WSN).[12] The main purpose of this paper is to make power efficient. The idea of this model is based on the division of the road into different sections and creating a distance between the two light poles. WSN is attached to all the light poles at every node, including the sensor which detects the presence of the vehicles on the road, and a transceiver for the communication between the node of the section.[8]

When the vehicle is about to reach the first node the lights are ON between the first and second node. After crossing the previous node, the sensor senses the vehicle coming toward the next node and then send the signal to the lights pole to switch ON. [13][14]

Limitation

- Implementation cost is high.
- Manually operated for the first time to switch ON in a day.

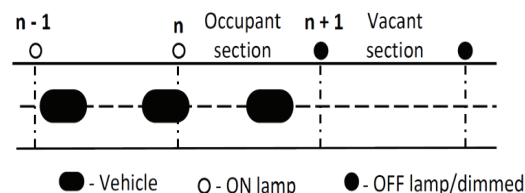


Fig.9: Distribution of Nodes Along the Road

Accident Avoidance and Detection on Highways

This paper presents the prototype model for real-time online safety which will regulate the speed of the vehicles when the driver will drive the vehicle. It is an improved system that will identify the driver's fatigue system and regulate the speed of the vehicle as needed to avoid an accident. The main part of the system is the real-time sensor, which includes an eye blink sensor, impact sensor, alcohol, and fuel gas sensor and for finding the correct location software interfaced with GPS and Google MAP.

The backbone of this system is the microcontroller. ARM controller is used in this system which will optimize the power sufficiency and deterministic operation. It is used in consumer electronic devices such as tablets, smartphones, and many more electronic devices. For measuring the temperature of the vehicle temperature sensor is used.[9]

During the driving of the vehicle if any faults occur due to the leakage of the gas at the time gas leakage detector detects the gas and indicates to the driver through a buzzer, which will help the driver to avoid an accident.

In case of drunk driving the alcohol detector will detect the alcohol and suddenly OFF the ignition which will help to avoid the accident.

If the driver is in normal condition eyes of the driver is blink continuously which will monitor the number of eye blink, in case of the eye blink decreases that means the driver is under sleepy condition the buzzer will start operating and the driver will pay attention and the causes of the accident will avoid.

Limitation

- People are not aware of this new technology.
- Failure of this system is riskier for the accident.

Smart Highway Powered by Green Energy Using IOT and Cloud Computing

The concept of developing smart highways has encouraged technologists and scientists to explore solutions for smart and sustainable road lighting. A smart highway concept employs innovative methods such as piezoelectric components and solar-powered chargers. Smart roads combine software infrastructures such as artificial intelligence and big data with physical infrastructures such as solar panels and sensors. Smart structures, such as automatic streetlight dimming, aid in energy efficiency. Automatic streetlight dimming is an energy-saving approach. This approach preserves energy until the requirements are met with the least amount of energy. The proposed technique employs LDR sensors, which turn on the lights under low-light circumstances and turn them off during the day [20].

Additionally, when there is no vehicle on the road, the lights are turned on at 30% intensity, saving 70% of the energy. If a vehicle approaches, the movement sensors detect it and increase the power of the light to 100% until the vehicle passes over that part. A lot of energy is rationed along these lines.

Solar cells, wind turbines, and piezoelectric sources are used as energy sources to power the lights and the automation system. Piezoelectricity refers to the ability of certain materials to generate electrical energy as a result of molecular vibrations in reaction to applied stress, although the energy produced by this approach is quite restricted. Mechanical vibrations can be turned into electrical energy by using piezoelectric crystals.

Piezoelectric crystals generate electricity when pressure is applied to them, causing the shaft attached to the generator to rotate. The generated electricity is then utilized to recharge batteries situated on roadways. One example of a smart technology that assists with energy conservation is the automatic dimming of street lights.

Limitation

- Cost-effective for the long highways.
- Complicated structure for designing.

FUTURE SCOPE

We have read many reviews paper on smart highways but all the papers are not able to conclude all the technology which are useful for the highway. Many of the papers are not able to fulfill all the conditions, so we have to design a smart highway based on new technology that concludes such as: - Smart Street lights, automatic irrigation systems, panic alarm systems, and U-turn systems for hilly areas. The design of the system should be cost-effective and power efficient.

CONCLUSION

Here we have reviewed many papers on Smart Highway and we saw many technologies used for smart highways. This technology helps us to the safety and less power consumption on the highway. The technology used in the papers is an Internet of Things (IoT), Raspberry pi3, RFID card, etc. It combines safe lighting protocols with the consumption of a minimal amount of power. In all previous review papers, all the power consumption is based on the grid which can be replaced by green energy such as: - solar energy, wind energy, etc.

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A Review Paper On: Power Theft Prevention and Detection Techniques

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▶ ABSTRACT ◀

The gap between the energy delivered and the power consumed on the low voltage side is referred to as electricity thievery. All power utilities prioritize efficient energy utilization and conservation while transmitting the produced energy to consumer load via transmission and distributed circuits. As we know, our present system is suffering from both technical and non-technical energy losses in Transmission and distributed circuits. Thievery of transferred energy on the consumer side is the primary cause of distributed losses. Power theft costs the world's electricity utilities billions of dollars per year. In India, most distribution companies face financial losses due to energy thievery and the government is providing financial assistance to electricity distribution utilities. As a result, smarter distribution system techniques that can detect and minimize energy thievery on the consumer side must be developed. This Review paper assesses acclaimed methods such as wireless monitoring, reducing the frequency of distribution, and smart prepaid energy metering systems for reducing theft in distribution systems.

Keywords—Power Theft, Smart Prepaid Energy Meter, GSM, IOT, Distribution.

INTRODUCTION

In terms of global power production, India comes in third. The total installed capacity is 407.797 GW according to India's National Electric Grid on 30 September 2022 [14].

Table 1: Installed Generation Capacity in India [1]

Type	Percentage (%)
Coal	50%
Hydro	11.5%
Wind	10.2%
Solar	14.9%
Nuclear	1.7%
Others	11.7%

Around 20% to 25% of electricity produced in India is lost in distribution due to energy thievery. Energy thievery costs India's electricity utilities billions of rupees per year. Electricity theft includes tampering with meters to show a low meter reading, stealing electricity by bypassing a meter, billing irregularities, and unpaid bills[16]. Electricity thievery, as referred to by Section 135 of the Electricity Act of 2003, is defined as tapping electricity lines, tampering with electricity meters or transformers, using a device to interfere with the reading of or damaging equipment, such as electric meters, or using electricity for non-authorized purposes [15]. The electric utility may instantly cut off the supply of electricity if electricity theft is discovered under the given circumstances. "Three times the financial benefit on account of such theft of electricity" is the penalty for such an offense [15]. If the offender commits the same offense again, they may lose their access to electricity for a period of not "less than three months but may stretch to two years."

Table 2: Power Theft in Some States [1]

State	2016(%)	2017(%)	2018(%)	2019(%)
Nagaland	70.90	73.60	-	-
Arunachal Pradesh	68.20	-	-	-
J&K	62.80	-	-	68.48
Gujarat	15.20	14.80	14.62	15.20
Mizoram	60.30	69.30	-	-
Uttar Pradesh	37.60	37.20	34.52	33.31
Orissa	34.71	37.80	37.13	34.71
Bihar	35.71	38.20	29.54	35.71
Jharkhand	34.87	34.60	-	34.87
Meghalaya	34.40	31.80	31.70	-
Tripura	34.20	29.80	-	-
West Bengal	28.85	34.90	32.10	28.85
Uttarakhand	30.00	31.20	31.65	27.60
Madhya Pradesh	29.10	30.10	31.02	25.20
Haryana	32.90	30.70	25.50	22.04
Rajasthan	31.40	28.00	23.65	23.64
Chhattisgarh	24.60	28.00	23.02	19.30
Pondicherry	20.20	19.80	-	-
Maharashtra	21.10	22.50	15.67	-
Punjab	18.00	19.50	19.20	18.70
Tamil Nadu	20.90	18.90	14.32	15.15
Kerala	16.20	17.40	14.20	11.74
Karnataka	15.40	15.70	15.20	14.58
Goa	11.60	17.20	19.40	-

Types of Electricity theft

- **Direct Line Tapping:** Nearly 80% of energy thievery is done by this method. In direct tapping, the illegal consumer directly taps the distribution line before the energy meter. This energy is not measured because it is directly coming from the distribution line without engaging the energy meter.
- **Meter Bypassing:** In this method, the load cable is directly connected to the input terminal of the meter hence no power flow towards the energy meter.
- **Tampering with meter:** Several methods are used to tamper the meter like injecting foreign materials into the meter, depositing highly viscous fluid, using strong magnets, resetting the energy meter reading, exposing the meter mechanical shock, etc.

Impacts of Power Theft

1. Electricity theft causes the utility to lose money.
2. Disrupts the local supply, which causes a transformer to get overloaded and produce blackouts or brownouts.
3. Damage to property of the utility.
4. A rise in transmission and distribution losses as a result of cable and wire tampering.

A REVIEW OF POWER THEFT CONTROL

Controlling Power Theft by Using Smart Prepaid Energy Meter

This paper presents a Prepayment energy meter to reduce power thievery by using a GSM network. The work in this paper is focusing on meter tampering and meter bypassing power thievery. In the suggested approach, the energy utilities establish a server and provide an energy meter to every consumer which is based on the GSM network. Using the GSM network, the server and prepayment meters connect using a GSM module, respectively [2].

The energy measuring chip generates pulses proportional to power utilities using the output of CT (Current Transformer) and PT (Potential Transformer). The output pulses generated by the energy-observing chip are counted to calculate the power utilization with the help of the microcontroller. The energy meter contains a battery as a backup. To detect the energy thievery battery backup must require [2]. This type of prepaid energy meter based on a GSM network has been proposed widely [17], [18].

Limitation

- Directly hooking from the distribution line can't be detected.
- Power companies have to maintain a server for monitoring the live meter reading which is costly.

IOT-Based Power Thievery Detection

This paper is based on IOT. IoT connects items to the Internet of Things, allowing data to be stored and services to be accessed, such as remote home sensors [19]. According to this paper, an operating system is installed on a Raspberry Pi, and an energy meter is connected to it through GPIO pins. Internet access is provided through

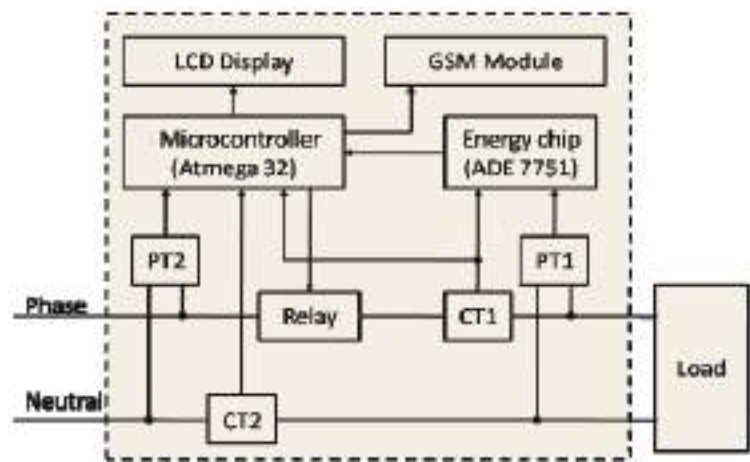


Fig 1: Block Diagram of Prepayment Energy Meter [2]

the Raspberry Pi and in the backend the utilities officials/observers can observe the reading of the energy meter in the form of charts [3]. By using this method, we can detect meter tampering.

Limitation

- In this system, there is a supervisor who is monitoring the reading of the energy meter and it is not easy to monitor it all the time.
- Directly hooking from the distribution line can't be detected.

IOT-Based Low-Cost Power Thievery Ascertain and Prevention System

This paper presents IOT based low-cost power thievery ascertain and prevention system using the Internet of Things (IoT) technology [19]. To inform the utility provider about the meter's reading, the technology merely connects the meter to the internet. There is a passive infrared sensor is installed to observe the human presence whenever the meter enclosure is opened. A solid-state relay is also provided which can open the load when there is any tampering [4].

Limitation

- In this system, there is a supervisor who is monitoring the reading of the energy meter and it is not easy to monitor it all the time.
- Directly hooking from the distribution line can't be detected.

GSM and ARM Processor-Based Power Thievery Device

This paper mainly focuses on meter tampering. The most popular methods of electricity theft are tampering with the meter to show low readings, bypassing the meter, and billing irregularities [20]. The features of the proposed method include an ARM processor (LPC1343), an ACS712 30A range current sensor, a potential transformer with a four-terminal regulated power supply, a GSM module (SIM 900), and a lever switch [5]. These techniques can prevent the energy meter from meter tampering, whole meter bypassing, only phase line bypassing, and disconnection of the neutral line. When any type of theft mentioned above is detected, an SMS is automatically forwarded to the distribution company's server via GSM. In a conventional energy meter, the load's energy consumption is calculated by multiplying current and voltage, by using only one CT and one PT. The power counted by the meter will be zero if any of these transformers (CT or PT) delivers a zero reading when external manipulation is used. The four types of electricity theft mentioned above can be detected by adding one extra CT and making a minimal modification to the meter architecture [5]. If the phase line is bypassed, the CT that is connected to it will experience zero current. When the neutral wire is cut off, PT won't detect any reading between the phase and the neutral. To tackle this, two CTs were put, one in the neutral line and one in each phase line. There will be a significant variation in the current CT measures if any of the lines are cut off from the meter. By detecting current using an ADC and analyzing the difference, the microcontroller sends the power authority through SMS.

Both the voltage and current in the meter are zero when the entire meter is being bypassed. A voltage transformer with four terminals is used in the proposed system (one for the energy measuring unit and the others for the DC constant voltage). The interrupt of the ARM processor is activated and the GSM forwards the SMS to the observer if the entire meter is bypassed then the voltage transformer will give zero output and represents the regulated DC voltage. When anyone will open the energy meter there is a lever switch that is connected to the interrupt pin of the processor is utilized in the event of meter tampering the interrupt pin gets input and GSM sends an SMS to the power authority. They can assign a person who can check the meter tampering physically. [5].

Limitation

- Directly hooking from the distribution line can't be detected.

PLC-Based LV Side Observing and Ascertain Power Thievery

This paper uses Power line communication (PLC) to protect from power theft. The PLC concept is mainly used for Automated Metering Infrastructure (AMI) and Automatic Meter Reading (AMR) applications [21], [22]. According to this paper, the distribution line carries a power frequency signal, and an additional high-frequency signal based on the principle of PLC (power line communication). The range of additional high-frequency signals is from 3 KHz to 500 KHz. As we know that the nature of the load is inductive hence there will be attenuation in additional high-frequency signal. If someone is directly tapping the line it can be easily detected due to attenuation. The formula for attenuation is given by [6].

$$\text{att.} = 20 \log \left(\frac{V_{\text{in}}}{V_{\text{out}}} \right)$$

Where, V_{in} = Input Voltage, V_{out} = Output Voltage. By using this method, electricity thievery can be detected accurately. At each pole, the high-frequency signal is removed with the help of filters, and the normal power frequency signal is transferred to the legal consumers.

Limitation

- Meter bypassing and meter tampering can't be detected.
- It is costly and not easy to implement due to high-frequency signals.

Using IMM to Tackle Energy Theft

This paper, includes an architecture of the electrical and communications network using IMM in a NAN [23], [24], [25]. It is using intermediate monitor meter to identify and prevent energy thievery. There is a smart meter placed at the consumer side to measure the power uses and measuring data is automatically transmitted to the meter data management system (MDMS) to analyze & identify the energy thievery. The collector which is at the distribution substation shows the total power supply to the whole consumer. An intermediate monitor meter (IMM) is installed at each pole which shows the total power supplied to the whole consumer which is connected to that pole. Real-time data of each meter is monitored by the meter data management system (MDMS) and compared. If there is any difference between the reading of the smart meter and the intermediate monitor meter then theft can be easily detected. By this method, we can prevent tapping, meter bypassing, meter tampering, etc. The detection accuracy is 95% in this method and false readings of the meter were also detected [7].



Fig. 2: Proposed Network Model [7]

Limitation

- It is very costly because we have to change the existing meter of the consumer and also have to install an intermediate monitor meter on each pole at the LV side of the distribution transformer.

Using Current Monitoring System Low Tension Poles

This paper uses a current-based observation system to identify electricity theft in distribution lines. In this proposed system power theft can be detected by installing the current observation system between two poles. When voltage is constant, there is almost zero difference in current between two poles if there is no illegal consumer tapping between the poles. When any illegal consumer is tapping between the poles there will be a

difference in the current. This difference in the current is noted and thievery location i.e., the illegal load can be detected easily [8]. By this method, hooking can be stopped.

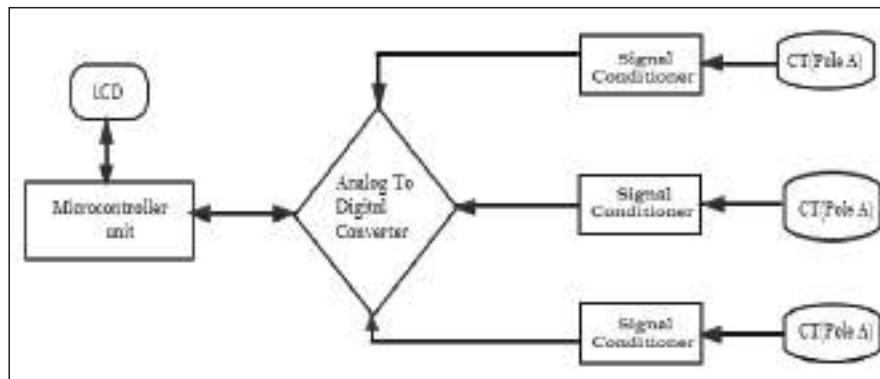


Fig. 3: Block Diagram of the Proposed System [8]

Limitation

- Meter tampering and meter bypassing can't be detected.

Smart Power Theft Detection System

According to this paper, an intermediate distributor box is installed on each pole in the distribution line and the supply to the different houses is given from this intermediate distributor box. This distributor box has a current measuring and comparing system. The reading of the distributor box and all the consumer meters is forwarded to the server database using the GSM module. All energy meter which is installed at consumer houses is capable of measuring current and sending the reading to the server database regularly using the GSM module. During the installation of the energy meter, the user's credentials are stored in the database with the help of the mobile application. The credential includes a photograph of the user's house, longitude, latitude, and address. After comparing the current value from the distributor box and energy meter if there is any difference then it indicates that energy thievery is happening. After that, the details of the user are shared with the concerned person who can visit the house to check physically. By this method meter bypassing and meter tampering can be stopped [9].

Limitation

- It is costly because each distribution box has an energy meter.
- Directly hooking from the distribution line can't be detected.

Controller-Based Detection Location of Power Theft

According to this paper controller-based mechanism is used to identify the power theft location. The method requires the readings of current and voltage drop at the transformer side and consumer end. The controller continuously monitors the current flowing through the energy meter and LV side of the distribution transformer. So if there are any differences between the distribution transformer reading and all energy meters connected that the distribution transformer, theft occurs.

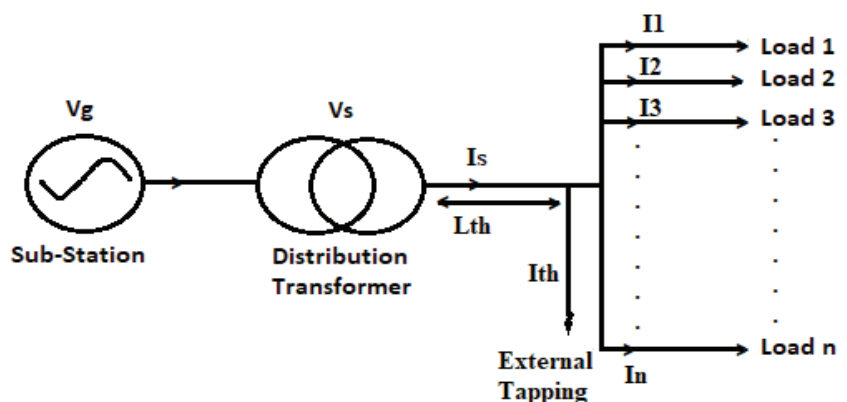


Fig. 4: Schematic Diagram of Distribution Line with External Tapping [10]

From the control layout, the system automatically identifies power theft and determines the distance from the distribution line if there is any voltage drop on the load side as a result of power theft. As a result, the controller simultaneously sent a signal to the circuit breaker. To stop the theft, the breaker shuts off the electricity and checks itself four times [10].

$V_{\text{theft}} = \Delta V^* - \Delta V$	(1)
$I_{\text{theft}} = I_s - \Sigma I$	(2)
$Z = \Delta V / I_s$	(3)
$L_{\text{theft}} =$	(4)

Where, **L** = Overall length of distribution line, **Z** = Impedance of distribution line (normal condition), ΔV^* = Voltage drop during theft, ΔV = Voltage-drop during normal condition

Limitation

- It is very costly because we have to change the existing meter of the consumer and also have to install a meter at the LV side of the distribution transformer.
- If many thefts are happening then it is not easy to locate.

(10) Using Low Frequency on LV Side: -

In this proposed system, direct hooking from the transmission line, tapping, and meter bypassing can be prevented. In this method, power theft is prevented by reducing the distribution line frequency from 6Hz to 7Hz at the consumer end. The frequency of the distribution line will be reduced by a step-down cycloconverter and inside the meter a step-up cycloconverter will be used which again converts the frequency to 50Hz. This method is very simple and very effective [11].

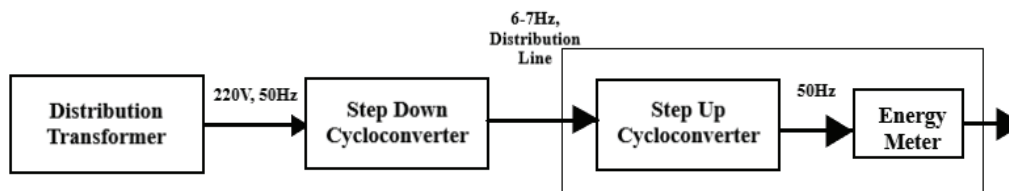


Fig. 5: Proposed Model [11]

Another design of an energy meter will convert 6Hz AC into 50Hz AC. First 6Hz AC will be converted into DC by using a rectifier and DC will be converted into 50Hz AC by using an inverter as shown in Figure 6.

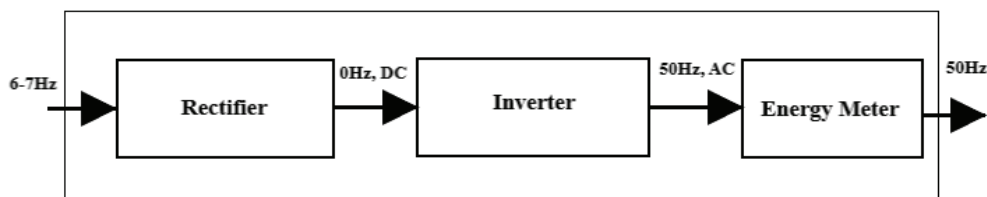


Fig. 6: Proposed model[11]

Limitation

- Meter tampering can't be detected.

(11) Converting the LV Side Power in DC

According to this paper, there will be a frequency variation between the LV side of the distribution transformer and consumer premises using a rectifier and inverter[12]. According to this paper, a rectifier will be installed on the distribution side of the transformer which will convert 50Hz AC into 0Hz DC and an inverter is used on the

pole which is near the house of the consumer. This inverter converts DC into 50Hz AC. All legal consumers will get a connection from this pole. By doing this legally consumers will get 50Hz AC and if anyone directly taps the distribution line for the power supply is 0Hz DC. And his appliances would not work and were hampered in the worst way [12].

Limitation

- Tapping from the pole can't be detected.
- Meter bypassing and meter tampering can't be detected.

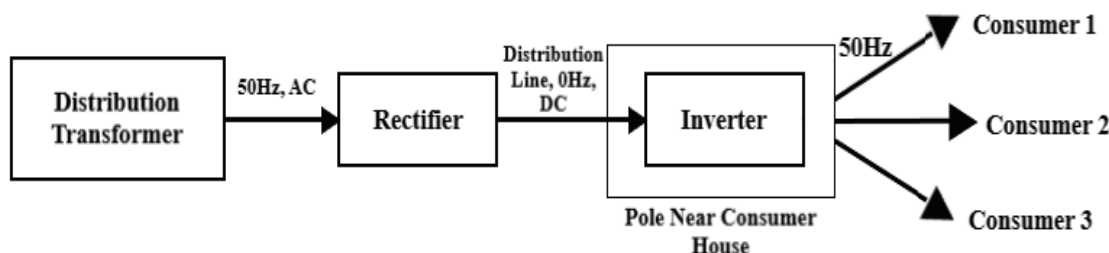


Fig. 7: Proposed Model [12]

(12) Based on Short-Term Pattern Detection of Fraud with the Help of AMI

In this proposed system, advanced metering infrastructure (AMI) is used to detect energy theft. It is a consensus that AMI deployments must be followed by some sort of fraud detection system [26]. AMI is a composite technology made up of several components, including consumption meters, a two-way communications channel, and a data store (meter data management). AMI enables utilities and customers to communicate with one another. It detects power theft based on the energy utilized reading of the energy meter. A smart meter monitoring system generates an alarm when a difference between the power provided by the grid and the total sum of power consumed by the energy meter. A new and innovative approach is given by the use of only a few sets of current readings to identify the energy consumption pattern. To detect energy theft we have to compare the consumption reading before and after the difference [13]. The unsupervised learning and clustering methods, as well as a semi-automated feature extraction technique, form the foundation of consumption patterns. These patterns are referred to as short-lived since it is anticipated that they will only capture customer behavior long enough to identify an ongoing theft. [13].

Limitation

- Directly hooking from the distribution line can't be detected.
- It is very costly because we have to change the existing meter of the consumer.

(13) Theft detection using IoT and blockchain

In this article [27], the authors are using two meters to detect the faults, one is at the LV side of distribution and the second one at the consumer end. Both energy meters are integrated with IoT. Both meter reading is transmitted to the server at regular interval of time, which reduce the dependency on

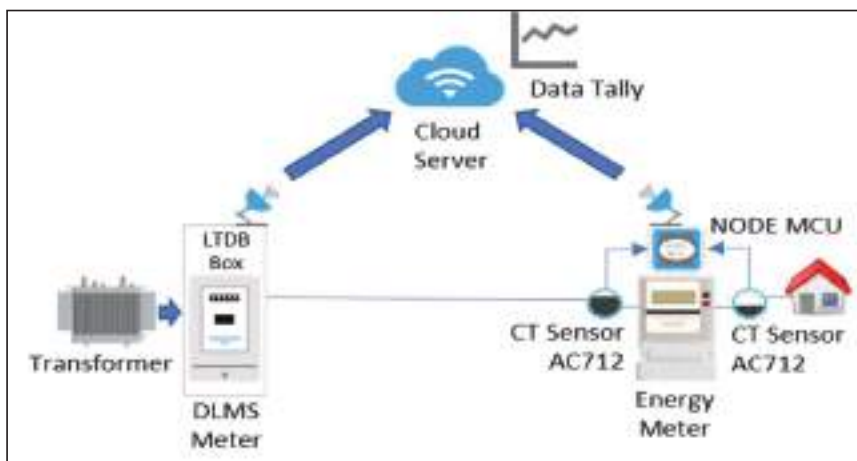


Fig. 8: Proposed Model [27]

monthly visits by lineman to note down the readings. The energy meter which is installed at the consumer end has two CTs at incoming and outgoing terminals, which provide a check to meter tampering.

Limitation

- Required a large number of people to check manually when power theft is detected.
- In this system, there is a supervisor who is monitoring the reading of the energy meter and it is not easy to monitor it all the time.

Table 3. Comparison of Different Techniques of Power Theft Prevention

S. No.	Title	Type of Theft Prevented				System Efficiency		
		Tapping from the distribution line	Tapping from Pole	Meter Bypassing	Meter Tampering			
1.	Controlling Power Theft by Using Smart Prepaid Energy Meter	No	No	Yes	Yes	Average		
2.	IoT Based on Power Theft Detection	No	No	Yes	Yes	Average		
3.	IoT-Based Low-Cost Power Theft Ascertain and Prevention System	No	No	Yes	Yes	Average		
4.	GSM and ARM Processor Based Power Theft Device	No	No	Yes	Yes	Average		
5.	PLC Based LV Side Observing and Ascertain Power Theft	Yes	No	No	No	Poor		
6.	Using IMM to Tackle Energy Theft	Yes	Yes	Yes	Yes	High		
7.	Using Current Monitoring System Low Tension Poles	Yes	No	No	No	Poor		
8.	Smart Power Theft Detection System	No	No	Yes	Yes	Average		
9.	Controller-Based Ascertain Location of Power Theft	Yes	Yes	Yes	Yes	High		
10.	Using Low Frequency in LV Side	Yes	Yes	Yes	No	High		
11.	Converting the LV Side Power in DC	Yes	No	No	No	Poor		
12.	Based on Short-Term Pattern Detection of Fraud with the Help of AMI	No	No	Yes	Yes	Average		
13.	Theft detection using IoT and blockchain	Yes	Yes	Yes	Yes	High		

FUTURE SCOPE

There are only a few techniques that tackle different types of power theft like tapping from distribution lines, tapping from poles, meter bypassing, and meter tampering which are very costly and very complicated to

implement in existing systems. There is a need for a technique that is cost-effective and easy to implement in existing systems.

CONCLUSION

Here we reviewed some power theft prevention and detection techniques. We have so many techniques for the prevention and detection of power theft like using IOT, using smart prepaid meters, using ARM processors, using power line communication (PLC), using intermediate monitor meters (IMM), using controllers, using current sensors between poles, using low frequency in distribution and using DC supply in distribution. All these detection and prevention methods were explained and reviewed in this paper. We have thoroughly studied and compared different types of power theft and detection and prevention techniques.

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“IOT Based Supply Control System”

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▶ ABSTRACT ◀

Many people got injuries or even die due to electrocution while working on electrical appliances, electricity poles and deteriorated, damaged or incorrect household wiring. The prime objective of our project is to protect people from electrocution by controlling the supply through IOT-based mobile application control MCB (Miniature Circuit Breaker). The Android interface is needed to send commands which are sent using any android-based phone.

In this, the person will shut down the electrical supply through IoT-based mobile application control MCB (Miniature Circuit Breaker). After completing the repair, the system should turn on through the mobile application. Using our application, the manual system became a complete IOT-based system. The application will available only to the officer of an organization so that no other person can interfere with the work. Our application will grant to turn ON/OFF the supply by IOT-based mobile application and then there won't be any interference.

INTRODUCTION

Electrocution is a major problem that one can face in institutions, hospitals, offices, etc., and the injury and death of people due to electrocution are increasing rapidly. Faulty appliances, damaged extension cords / leads, electrical device contact with water, deteriorated, damaged or incorrect household wiring.

Hardware and software are both used in this project. With the help of an application based on IoT, we can turn ON and OFF the main supply through the MCB by converting a normal MCB into a mobile controlling MCB. Local and remote control both are included in the control application. Remote controlling is done by using a Bluetooth module. This remote control can be utilized in many areas like controlling supply in substations, controlling large-size industrial machines, and controlling household and commercial appliances. This system is very easy to operate as it does not require a tech-genius so it can be easy to operate by local people. This data has been sent to the server via Arduino UNO and could be accessed remotely via a mobile application interface.

BLOCK DIAGRAM

The figure 1 shown below represents the arrangement of the various elements of the IOT- based Supply Control System in the form of a simplified block diagram:

User will make connection with the system using his mobile phone through Bluetooth connection. The Bluetooth module is connected with Arduino UNO so that UNO can receive signals from the user through Bluetooth connection and can proceed further. Relay module is connected with Arduino UNO to turn ON/OFF the appliances as per need. Miniature Circuit Breaker (MCB) is connected in the circuit through relay and the supply source so that it can be controlled remotely and can protect the circuit in case of fault. Other electrical appliances are connected in the circuit through MCB so that they can be protected at the time of fault.

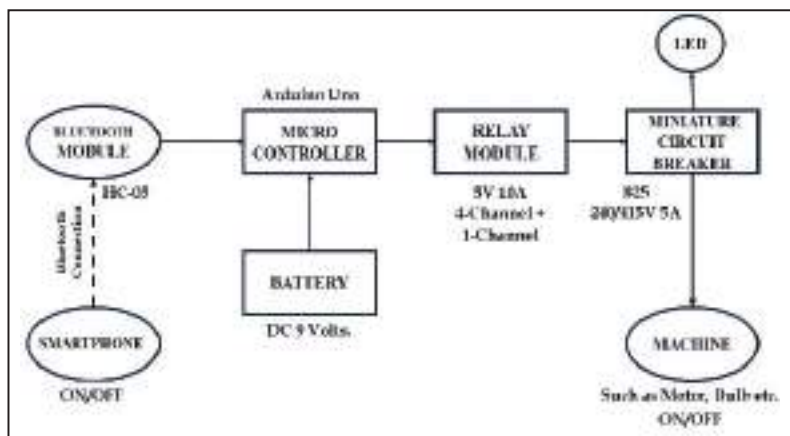
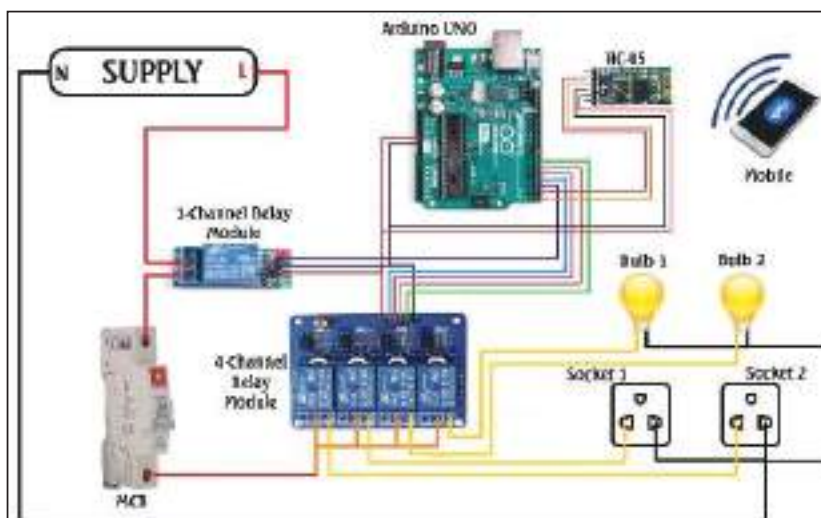


Fig.1: Block Diagram of IOT Based Supply Control System

BACKGROUND

In India, from 2011-20 a total of 109,667 people died due to electrocution. A detailed study shows a rapid increase of 50 percent from 8,945 in 2011 to 13,446 in 2020. Regarding the occurring places, cases occurred at domestic areas are 47.7%, besides workplace / home are 29.5%, cases at the work place are 22.7%. Cases of electrocution fall outside of homes and work by trains' over-head transmission lines, followed by non- insulated transmission lines in farms and public places which open accidentally. In addition to electrocution due to touching phase wires, water heating rods responsible for 18.1% of electrocution deaths, overhead cable lines responsible for 15.9%, evaporative water coolers responsible for 11.36 percent, and electric switchboards responsible for 90% of electrocution deaths. Without electricity the modern society is unthinkable. Electricity has already become an essential part of human life, so we've the cases of electrocution. Electrical injuries and burns are fatal and may lead to death in some cases.



CIRCUIT DIAGRAM

The figure 2 shown below represents the complete circuit of all the elements of the IOT- based Supply Control System diagram:

First, Phase wire and neutral wire is taken out of the supply then the phase wire is sent through a single channel relay module to which MCB is connected and the relay is connected to Arduino UNO.

A wire taken out the load terminal of the MCB is connected to NO pins of the 4-channel relay module and 4 more wires connected to COM pins of the relay module which are further connected with phase terminal of loads and the neutral terminal loads are connected to the neutral of the supply.

The input pins of the 4 relays are connected to Arduino to get command from Arduino UNO according from user to either turn ON or OFF the load. To get signal from user through our app HC-05 Bluetooth Module is used, Tx & Rx pins of the Bluetooth module HC-05 are hence connected with Rx (D0) & Tx (D1) pins of Arduino UNO, respectively.

The VCC pins and GND pins of single channel Relay Module, four channels relay module and HC-05 Bluetooth Module are connected with Vcc pin and GND pin of the Arduino UNO respectively.

After giving the power to Arduino through battery or laptop HC-05 will be activated automatically and then the user will be able to connect his mobile with the project through our project.

METHODOLOGY

Our project is completely based on control. For control purposes, we used a microcontroller and for stabilizing the connection between MCB (Miniature Circuit Breaker) and mobile, we used a Bluetooth module.

Arduino Uno, the microcontroller is used for controlling. Arduino Uno is connected to the Bluetooth Module; it'll receive signal (sent from mobile) to turn ON/OFF the supply. After receiving the signal Arduino Uno will command the relay to turn ON/OFF the MCB (Miniature Circuit Breaker).

HC-05 Bluetooth module is used for connecting the mobile with the system. After connecting the HC-05 Bluetooth Module with the mobile, the user will be able to send a signal to turn ON/OFF the supply, from his mobile to the machine through a Bluetooth connection.

5V 10A Single Channel Relay is used for switching purposes. The relay will receive the signal from Arduino Uno and turn ON/OFF the MCB.

5V 10A Four Channel Relay is used for switching purposes. The relay will receive the signal from Arduino Uno and turn ON/OFF the connected Load.

Miniature Circuit Breaker (MCB) will get a command from the relay to turn ON/OFF the supply.

Light Emitting Diode (LED) is used for indicating when the supply is turned ON/OFF.

DC Battery is used to supply power to Arduino Uno. All the connections are done on **Breadboard**.

Software

The software we used for this project is Arduino IDE (ver. 2.0.4) to write the code/program for the project.

The software we used to make the application for this project is MIT App Inventor to create an android application to establish the connection between the mobile and the device. A web application integrated development environment originally provided by Google and maintained by MIT has been rebranded as MIT App Inventor. The language we used for this project is Embedded C Language to create a virtual connection between the user and the system.

IMPLEMENTATION

First, we need to turn ON the MCB manually from the supply board and then we need to turn ON the MCB through the android application as well so that power can be supplied throughout the system.

Now we can send signals to either turn the ON or OFF appliances using the android application. The application sends the signal to either turn ON or OFF to HC-05 Bluetooth Module which is controlled by Arduino UNO, depending on the signal the Arduino UNO will command the relay modules to turn ON or OFF.

And then relay modules will turn ON or OFF their respective devices.

The android application consists of a few buttons i.e Bluetooth, Bulb 1, Bulb 2, Socket 1, and Socket 2. We used Bulb 1, Bulb 2, Socket 1, and Socket 2 as loads for our project; the user can alter the layout as he needs.

If the user needs to turn ON the Bulb 1 so he can send the signal to Arduino UNO from the application to turn it ON and similarly he can turn it OFF using the application and similarly he can turn ON the remaining devices as well.

If he turns ON all the loads and wants to turn OFF all of them at the same time so he can turn them OFF by turning OFF the MCB using the application without any manual controlling.

RESULT

The manual system became a complete IOT-based system. If any fault occurs at the transmission/distribution line, the person needs to check the wire at the electrical pole or circuit for which he has to come near the electrical circuits or electric poles. But after applying the mobile application, the person can operate the electrical system from a distance without the risk of electrocution. The application simply cut down the supply at the time when work of that particular system is finished or at the time when any repair work occurs at the time of the fault, after completing the repair, the system should turn on through the mobile application. The rate of deaths due to electrocution will be decreased after implementing the mobile application. Electricity supply will only be controlled by the person and officer of the substation, school, college, hospital, industry, office, etc. The mobile application will be a user-friendly application so it will be easy to operate. Controlling electricity will be easy without getting any complex errors.

CONCLUSION

- The manual system will become a complete IOT-based system.
- The normal existing MCB can be controlled through Mobile applications through a controlling box.
- The range of the Bluetooth module is 50m, which means we can operate our device anywhere under the range of 50m.
- The Proposed solution can easily operate through mobile if some how you are away from MCB, switches, and sockets.
- To save humanity is one first duty, and engineer continuously works for it.
- Our Project not only works to save innocent lives but also works in the enhancement of the approach towards automation of machines.
- The rate of deaths due to electrocution will be decreased after implementing IOT Based Supply Control System.
- App title IOT Supply Control which we provide with our System is only given to the Person who is working on Supply system and he/she can only download the app after we provide the OTP and can't share to any other person, so that no mishappening occurs.

FUTURE SCOPE

1. This project will be modified further. Its accuracy can be enhanced by using new technologies and good signal connectivity.
2. It can be modified to operate & control a number of machines at the same time.
3. Using Artificial Intelligence (AI), this system will become more user-friendly.
4. NRF24L01 Transceiver Module can also be used in this project as it provides a wide range of operation compare to HC-05 Bluetooth Module. But NRF24L01 is costlier than HC-05.
5. Our prime objective is to make this project cost effective for now.

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To Design and Performance Analysis of a Grid Connected Roof Mounted Solar PV System by Using PV*SOL in Rural Area

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▶ ABSTRACT ◀

*This paper presents a Designing, Performance Analysis and assessment of a rooftop PV system connected to a grid for an Industry in rural area of Gwalior, Madhya Pradesh, India. Solar energy is a form of renewable energy so it can be easily transformed into electric energy. The estimation study shows a kw grid-connected Solar PV system and can produce enough electric energy as compared to the power consumption and diminish the energy consumption in the network and also bring down the dependency of grid. This paper consists of Design, functioning and This study also includes a financial research analysis of the PV system using the PV Simulation programme PV*SOL premium and a financial analysis of such a system under specific conditions.*

Keyword: *Solar Photovoltaic, Grid Connected, Performance Analysis, Energy Consumption, System Designing Financial analysis, PV*SOL Premium, Payback Period.*

INTRODUCTION

Solar energy is currently the most attractive energy source in utility-scale power generation when looking at costs alone. The recent decade witnessed an urgency in transitioning to net zero and pivoting to renewables for attaining so. According to Our World in Data, the cost of utility-scale solar photovoltaic electricity came down by around 89% over the last decade. As 2023 starts, there is the potential for global solar power generation capacity to surpass 1 Terawatt, and huge multinational corporations are now undertaking numerous renewable projects. These firms frequently also proclaim astronomical development goals. In this mix of things, solar

energy is positioned to take the lead in power generation as nations work to meet ambitious decarbonization goals.[1].The basic drawback of solar photovoltaic system is its poorer efficiency because the panels depend so heavily on erratic weather conditions., i.e., the temperature and sun radiation. As a result, getting the most power possible from the panel is a little challenging, which lowers system efficiency.Different MPPT (Maximum Power Point Tracking) approaches are utilised to boost system efficiency and capture the most power possible from the panels[2][3].The obtained panel voltage and current are dc quantities that must be transformed into ac quantities using inverters in order to power ac loads or connect to the grid. Grid-connected systems and Standalone systems are the two types of solar PV systems. In a grid-connected system, both the linked grid and the loads will receive power from the solar PV system. Different configurations of grid-connected solar PV inverters, such as central inverters, string inverters, and multi-string inverters, are possible. The biggest disadvantage of the central inverter setup, which is the simplest, is that the strings of the panel will function at various MPPs. when varied solar irradiation falls on the moduleThe advantage of string inverters is that they can operate at a common MPP regardless of the irradiance value. The cost, required power, and project area are taken into consideration while choosing an inverter arrangement. The solar PV system will power the loads that are directly linked to it in the standalone system. Both systems are capable of feeding both ac and dc loads. Most often, standalone devices are recommended for use in domestic settings.[4]. When compared to other sources, photovoltaic systems may produce energy in a straightforward method. When compared to other systems, the number of separate components employed in solar PV systems is quite low. Additionally, it does not use any components of a considerable size. [5].The most crucial factor to take into account throughout the design process is the photovoltaic solar system component's performance.There are a variety of photovoltaic system configurations depending on the voltage system and busbar used to link the source and loads.[6], [7].Industrial solar panels are advantageous because they can be used for both on-grid and off-grid solar panel systems, making it possible for industries to employ solar panel power that can be used at night.



Fig.1: Annual Temperature Profile for Location

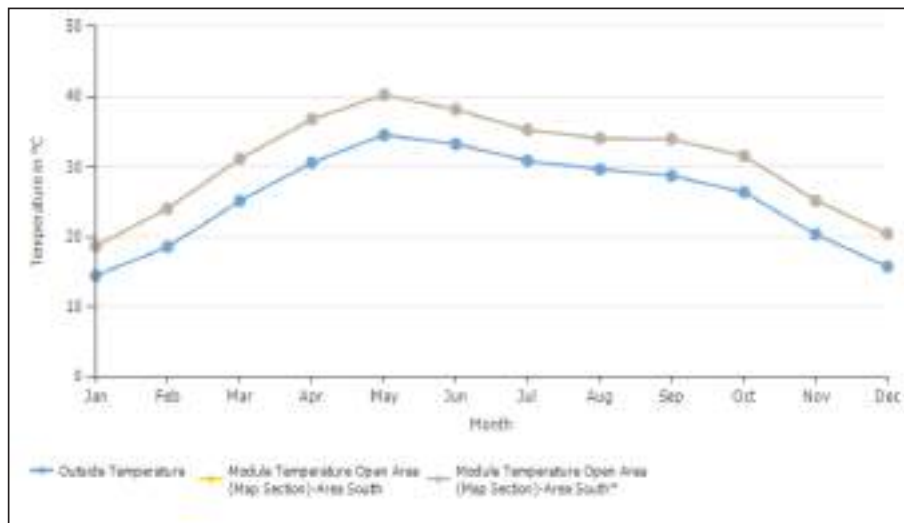


Fig. 2: Temperature Per Module Area

FEED IN DATA AND SPECIFICATIONS

The details regarding the monthly consumption of the building on which we have to setup our system is very crucial before designing a PV system. That is an Industry in Rural area of Gwalior Tehsil, Near Tighra Road, lashkar, Gwalior ,474001, Madhya Pradesh, India.

Table 1: Monthly Energy Consumption

Months	Consumptions
January	22670
February	23529
march	29049
April	27838
May	38647
June	40828
July	35728
August	32837
September	32398
October	31344
November	28368
December	25836
Total	369072

System Designing

A large-capacity solar system had to be installed in order to meet the energy requirement given the consumption. To the right we are using a system designing tool called PV*SOL premium 2021 (R8).

*PV*SOL premium 2021 (R8)*

The best design tool is simulation software, which makes precise forecasts simple. By putting systems into perspective and producing expert reports, you can provide consumers the best return on their investment. The photovoltaic system performance simulation software for solar systems is known as PV*SOL® premium. For people who do not want to utilise 3D to model shading and see the landscape, it is a fully functional programme. [10].

Configuration of the System

By supplying various system parameters to our simulation tool as input. We learn that the system needs many components.

We need to build a solar photovoltaic system with a capacity of 241.2 kW for the specified energy usage. Additionally, this system needs 1342.66 m² of surface area for the installation of PV modules.

Data of Project Area and Grid



Project Data	
Project Name	pv 2D
Offer Number	20
Project Designer	Tapan
Start of Operation	20-01-2023

System Type, Climate and Grid	
Type of System	3D, Grid-connected PV Syst...
Climate Data	GWALIOR (1H-4PB), IND
Time step of simulat...	1 min
AC Mains	230 V, 3-phase, cos φ = 1
Maximum Feed-in P...	No

Consumption	
Total Consumption	369072 kWh
Load Peak	56.7 kW
Resolution of the data	1 h

3D Design	
Total Power	241.2 kWp
Module Area	Open Area (Map Section)-A...
Module Data	REC300TP2M
Manufacturer	REC Solar
Number of PV Modu...	525
PV Generator Output	157.5 kWp
Inclination	30°
Orientation	185°
Installation Type	Mounted - Open Space
Module Area	Open Area (Map Section)-A...
Module Data	REC300TP2M
Manufacturer	REC Solar
Number of PV Modu...	279
PV Generator Output	83.7 kWp
Inclination	30°
Orientation	185°
Installation Type	Mounted - Open Space

Configuration	
Total Power	222 kW
Sizing Factor	100.6 %

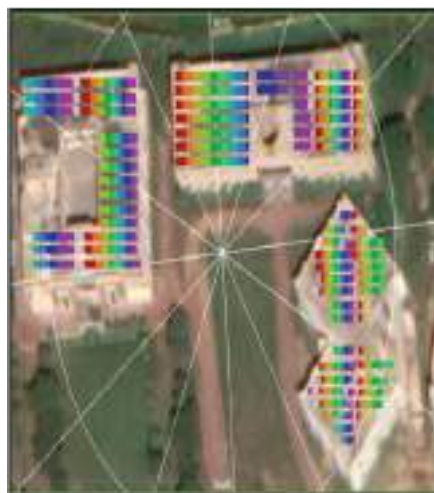


Fig. 3(A): System Planning with 3D Visualization

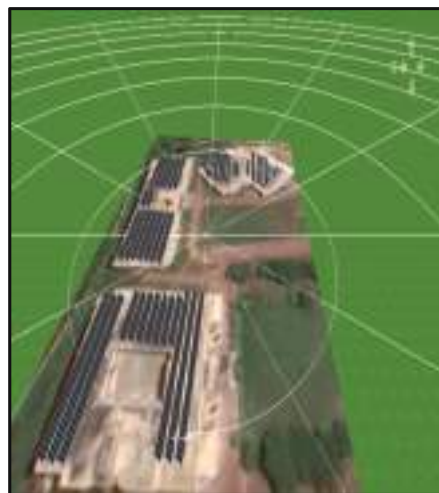


Fig. 3(B): System Planning with 3D Visualization

There is total 804 modules which are mounted in two rooftop buildings one is having 525 module and there are 279 PV module in the other building of an Industry are positioned in solar to generate energy. There are 24 inverters connected in the necessary configuration to regulate and deliver this generated power.

CIRCUIT DIAGRAM

In this system, we have used modules of REC Solar which model number REC300TP2M having capacity of 300 W and the Inverters of Solintegwith model numberMHT-10K-40 having capacity of 10KW and Samsung SDI. co. ltd. All in one series 8.

There is total 804 PV modules are positioned in a solar field to generate energy. There are 24 inverters connected in the necessary configuration to regulate and deliver this generated power.

In this a single line circuit schematic for the suggested setup. For setup the system, we have used modules of REC Solar which model number REC300TP2M and Inverters of Solinteg and Samsung SDI which model is MHT-10K-40 and All in One Series 8 respectively.

Array Designing

In arrangement of the solar PV module system, we use two module area of an industry for the research we had mounted REC solar REC300TP2M ,525 PV module mounted in 876.74 m² surface area by which we got 157.50kwp as an output and with same manufacturer we mounted 279 PV module in the second module area which had provided 83.7 kWp as an output. In both the module area the inclination is 30° and orientation is 185° mounted open space rooftop area. So total 804 PV module is mounted on the rooftop which provides 241.2 kWp and for this we use 24 inverters ,15 is of solinteg MHT-10K-40 and 9 is from Samsung SDI and the area receives roughly 1870 kwh/ m2 of total global irradiation every year.

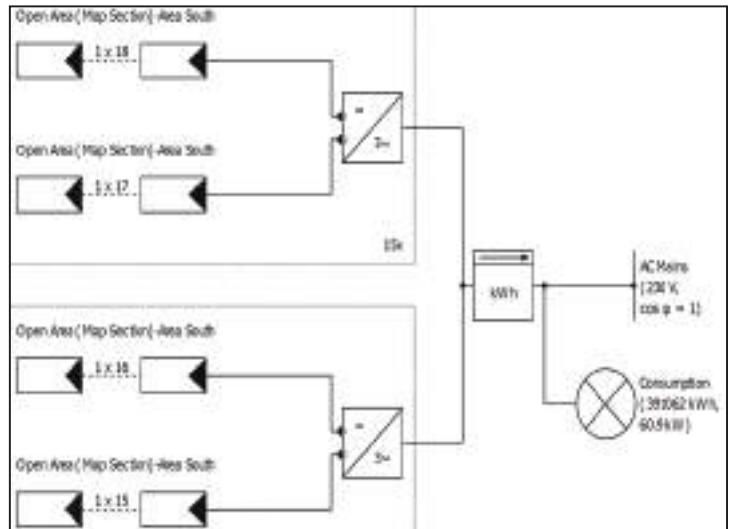


Fig. 4: Block Diagram of a Solar PV System that is Connected to the Grid

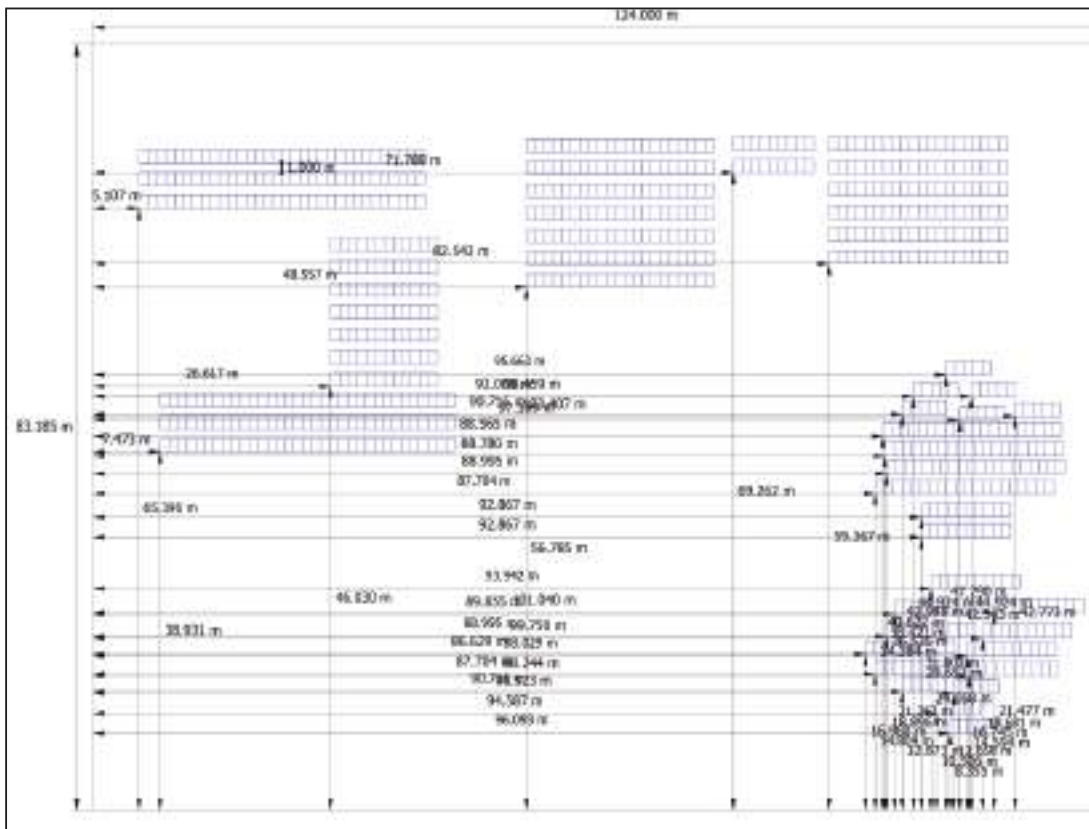


Fig. 5: Array Designing of PV System

PV Energy During Observation Period

As per company module of REC solar the degradation module of the solar system in the observation period in which the remaining output is 83% after 25 Years.

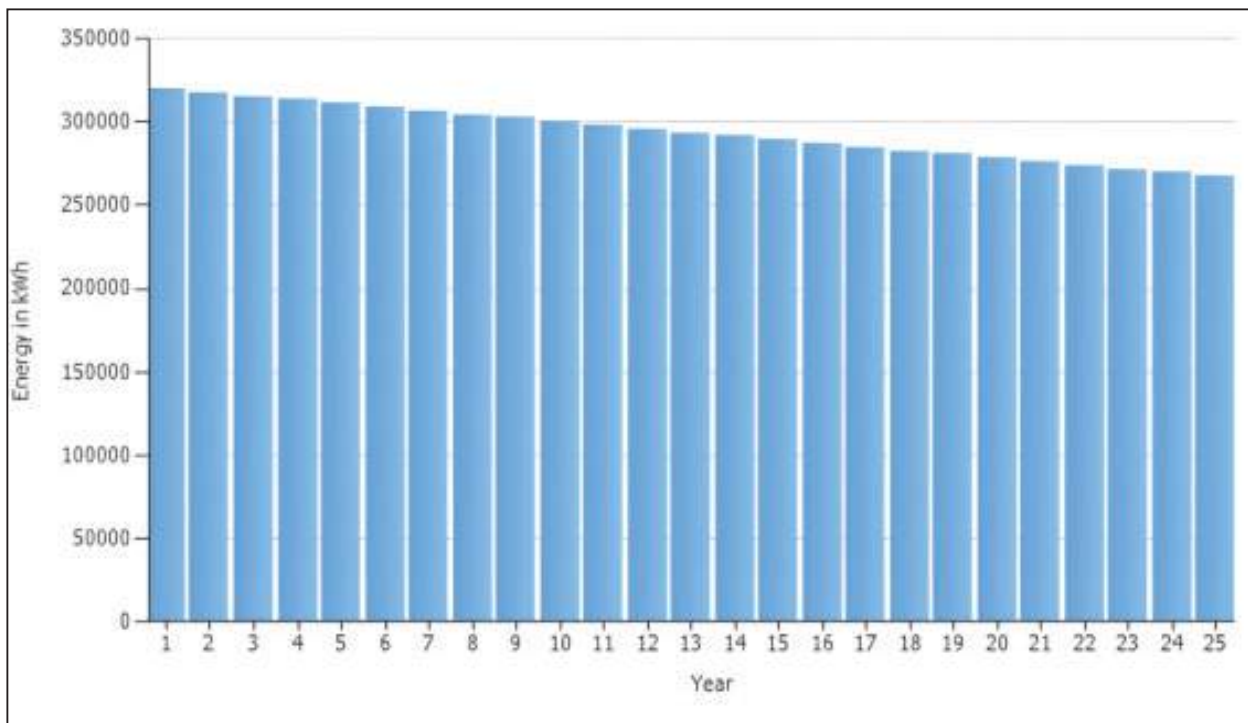


Fig. 6: PV Energy During Observation Period

Losses

There are Different types of losses that occur in a photovoltaic system. There is approximately 10% total losses that occur in this system in which Shading loss is 2%, Reflection loss is 1.2%, Irradiation loss is 0.8%, Spectral loss is 1%, Cable loss is 1.5%, losses due to array mismatch is 0.5% , and Inverter loss is approximately 3%. most losses are with design issues, while none of them are stable so they vary according to temperature, weather, and load conditions.

SIMULATION RESULTS

Our simulation tool produces various outcomes for various sections of our solar photovoltaic system after compiling all the input parameters. These are associated with system performance, yearly production prediction, performance ratio, etc. In addition to these, the PV*SOL also calculates other financial outcomes, which are covered individually in the next section.

System Performance

The output of the system after executing a simulation using PV*SOL is displayed in Table 2(A). A 241.2kW solar system that is adequate for the utility location was obtained from this simulation. And this system can produce 3,20,980 units annually, which is enough to meet the demand for all the machinery of an Industry.

Systemoutput Parameters

PV System

Table 2(A): System Output Parameters

PV Generator Output	241.2 kWp
Spec. Annual Yield	1326.71 kWh/kWp
Performance Ratio (PR)	75.34 %
Yield Reduction	14.7 %
Pv Generator Energy (AC Grid)	320,980 kWh/Year
CO ₂ Emission avoided	1,50,401 kg/Year

Appliances

Table 2(B): System Output Parameters

Appliances	369,072 kWh/Year
Standby Consumption	978 kWh/Year
Total Consumption	370,050 kWh/Year
Energy From Grid	49,069.7 kWh
Solar Fraction	86.7 %

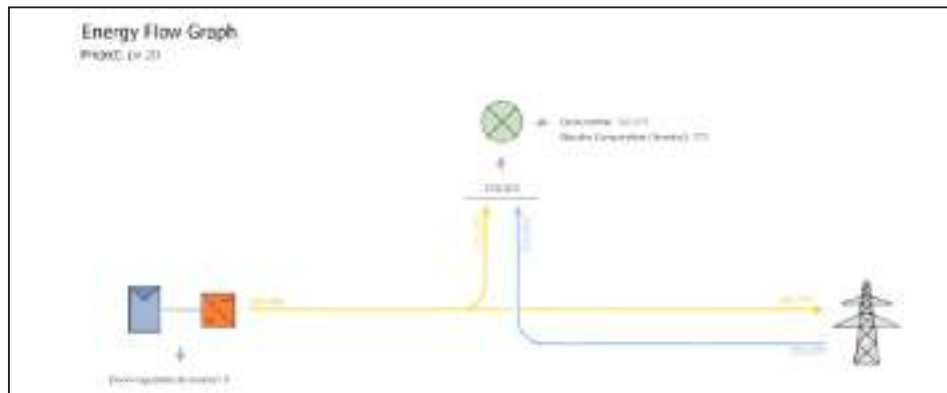


Fig. 7: Energy Flow Graph

Fig.7 represents the Flow of energy from source to consuming device it also called the energy flow chart which is used to illustrate a flow of the energy or transforming visual force combined with quantity.

Production Forecast & PR (Per Inverter Performance Ratio)



Fig. 8: Production Forecast With Consumption

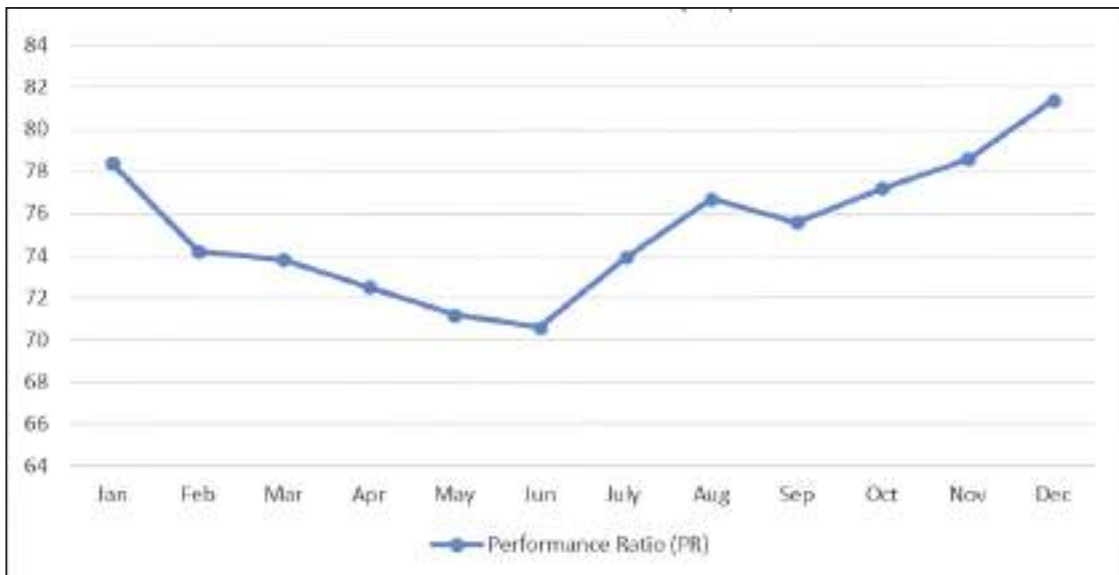


Fig. 9: Performance Ratio (PR)

Irradiance per Module Area

Power per unit area is the unit used to measure solar light. Fig. 9 represents the graph of energy in kWh/m² for each month of the year.

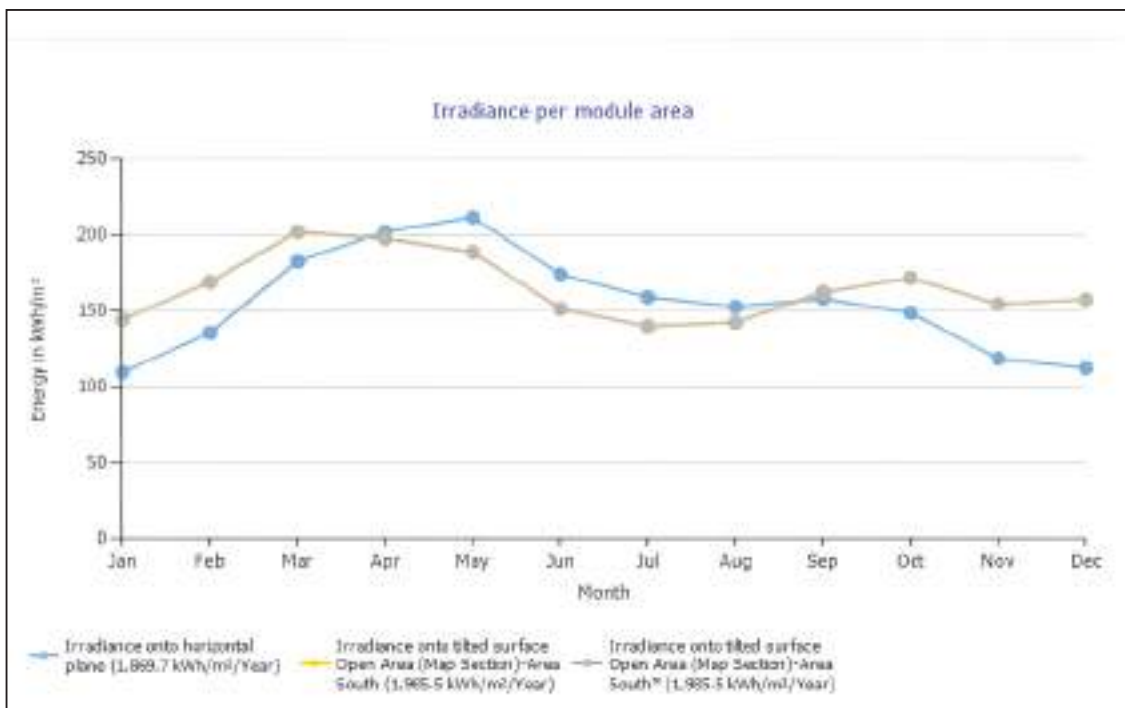


Fig. 10: Irradiance Per Module Area

FINANCIAL ANALYSIS

For a thorough review of the system, financial analysis is required. Any system cannot be considered feasible without conducting a financial analysis. As a result, it is a crucial factor in this entire investigation.

Output Result

Table 3: Output Result

PV Generator Energy (AC Grid)	320,980 kWh/Year
Output of PV Generator	241.2 kWp
Period of Assessment	25 Years
Price of electricity (Net-metering)	6.74 ₹/kWh
Return on assets	16.28 %
Accrued Cash Flow	10,42,659.50 ₹
Amortization Period	6.3 Years

Energy Cost Saving

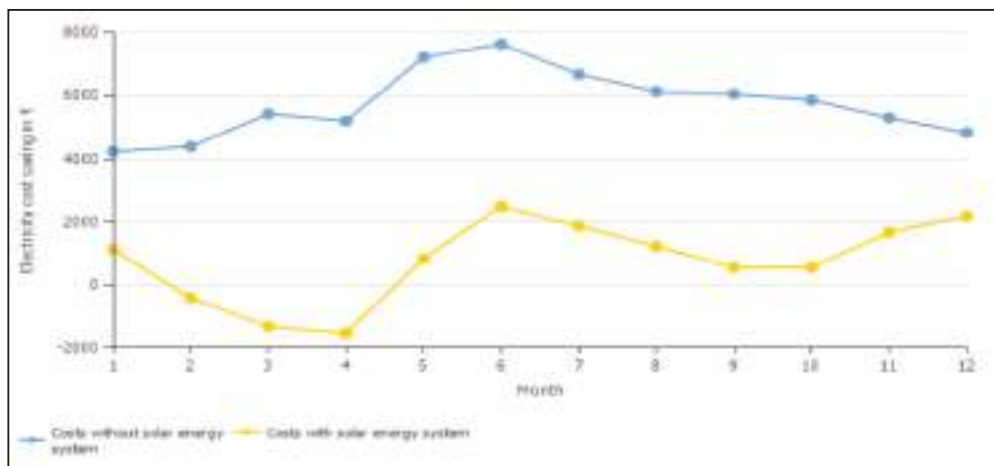


Fig. 11: Electricity Cost Saving

Fig. (11) represents the electricity cost saving graph where the fall in the amount of electricity cost is clearly seen after the installation of PV system. The reduction in the electricity cost shows that there will be a high amount of saving in terms of electricity cost which will make the system economical.

Development of Energy Costs

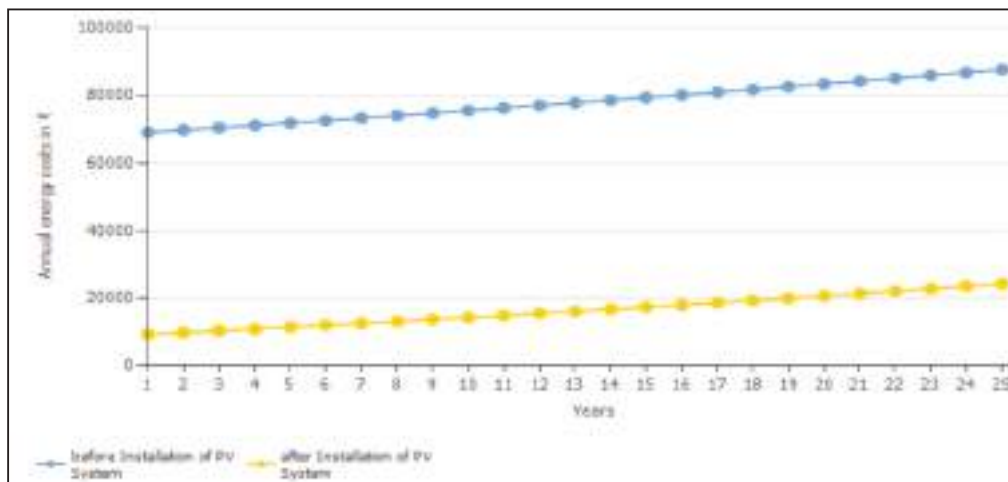


Fig. 12: Development of Energy Costs

As like Fig (11), Fig (12) represents the Deduction in annual energy cost, it shows the development of energy costs in increasing time yearly but after the installation of PV system there shall be similar development in the cost but it will be much economical then before the installation of the PV system.

Accrued Cash Flow

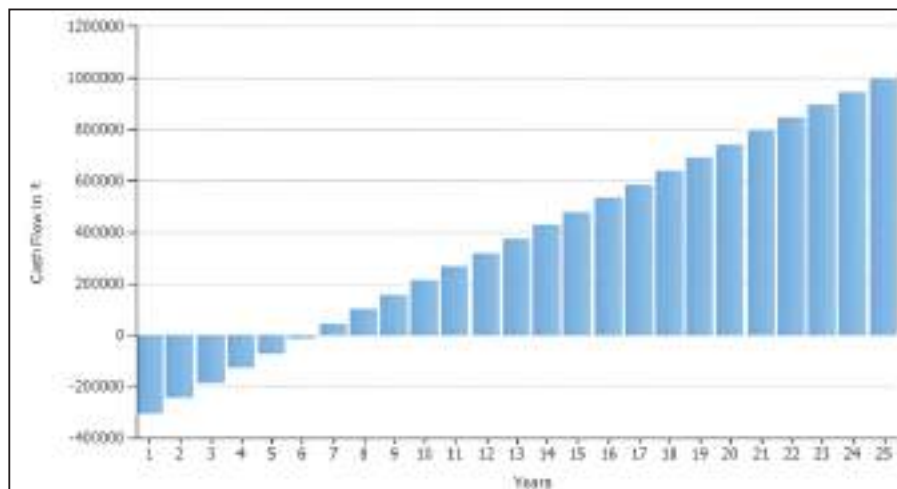


Fig. 13: Accrued Cash Flow

The grid-connected PV system's financial analysis was determined using the PV*SOL programme. Figure (13) depicts how the PV system built at the site meets demand and generates a profit 6.3 years after the installation period.

CONCLUSION

The site for this photovoltaic solar system's 241.2 kW capacity has been researched. And as a result of the research study, we have come to certain results that support the profitability, viability, and utility of our system in the given context. This system produces 3,20,980 units annually, which is very close to the amount of utility used. The assets' annual rate of return is 16.28%. When using conventional energy, the yearly CO₂ emission can be cut down to 1,50,401 kg/year. Therefore, one of the most quantifiable criteria for the acceptability of renewable energy is included here. The system's average performance ratio is 75.34%, and its annual yield is 1326.71 kWh/kWp. This system has a payback period of about 6.3 years. Utilising solar energy enables people significantly reduce their energy use and eliminates dependency. For many consumers, the drop in electricity costs is a huge comfort as shown in this study. Users receive the highest returns on investments which will generate more job opportunity in future. The study's conclusion is that PV*SOL Premium Simulation Tool may also be utilised as a tool for system design.

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Experimental in Loop Analysis of Reduced Device Count Hybrid Multi-Level Inverter Topology Control by Universal Control Technique

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▶ ABSTRACT ◀

This research paper explores the hybrid topology of symmetrical nine-level inverter that uses fewer devices and a universal control PWM technique. The objective is to develop an efficient and cost-effective solution for power electronics applications. The proposed hybrid topology combines the advantages of the cascaded H-bridge and flying capacitor topologies to reduce the number of required devices. The universal control PWM technique is used to generate the gating signals for the inverter switches, ensuring reliable and precise control of the output voltage. Simulation and experimental results demonstrate the effectiveness of the proposed hybrid topology and universal control PWM technique in achieving high-quality output voltage waveforms with reduced harmonic distortion and lower switching losses. The proposed approach presents a promising solution for improving the performance and reducing the cost of multilevel inverters (MLI).

Keywords: PWM (Pulse Width Modulation), MLI (Multi-level Inverter)

INTRODUCTION

Recent years have witnessed substantial advancements in the field of power electronics, and multilevel inverters are now a crucial component of contemporary power conversion systems. Due to its capacity to deliver high-voltage output with little harmonic distortion, the multilevel inverter technology is being employed in a growing number of applications, including motor drives, power transmission systems, and renewable energy systems. [1]. The harmonic reduction of an inverter output current in a typical two-level inverter arrangement is done mainly by increasing the switching frequency. However, because of the higher switching losses and the amount of de-

bus voltage in high power applications, the power device's switching frequency must be limited below 1 KHz. On the other hand, the electromagnetic disturbance and motor winding stress are caused by the extremely high dv/dt produced with high dc-link voltage. Multi-level inverters are better from the perspective of distortion reduction and high dc-link voltage level [2].

MLI does have certain limitations, however, including the need for more peripheral devices like gate driver circuits, protection circuits, and heat sinks as output levels are increased [3]. The total system becomes more complicated, heavy, and expensive as the number of devices increases, which also lowers the converter's efficiency and reliability.

The Reduced Device Topology-MLI is a topology that addresses these issues by using a reduced number of switching devices. The RDT-MLI topology provides several advantages over traditional multilevel inverters, including reduced cost, low switching losses, and the ability to easily expand the system to achieve higher voltage levels [4]. As a result, many topologies and control schemes have been presented in recent years with fewer devices and that use a combination of unidirectional and bidirectional switches with varying ratings.

By changing the width of the pulses sent to each switch, universal control pulse width modulation (UCPWM), a modulation technique, can be used to regulate the inverter's output voltage. In comparison to conventional two-level inverters, utilizing a multi-level inverter with UCPWM may provide advantages such as better power quality, less harmonic distortion, and higher efficiency [5-8]. Additionally, the use of UCPWM permits greater control over the output voltage, allowing for the optimization of energy efficiency and adaptation to changes in load conditions [9-10].

The implementation of a nine-level inverter using the universal control PWM technique is the major subject of our research article. A potential area of research in the realm of power electronics is the application of the universal control PWM approach in a nine-level multilevel inverter. This method is easier to use and less expensive than others since it only needs one controller to produce the pulse width modulation signal for each level of the multilevel inverter.

INVERTER TOPOLOGIES

Flying Capacitor (FC) Multilevel Inverter

A type of a multilevel inverter that use flying capacitors to create stepped voltage waveforms is the flying capacitor multilevel inverter. The output of a flying capacitor inverter exhibits a stepped voltage waveform because each phase is connected to a group of capacitors that are switched between the load and the DC supply.

A flying capacitor multilevel inverter's key benefit is that it can provide an output waveform of excellent quality and low harmonic distortion, which is crucial for applications like motor drives and renewable energy systems. The biggest drawback is that it necessitates a lot of capacitors, which might raise the system's cost and complexity.

Diode Clamped Inverter

It is also referred to as an "NPC inverter" or "neutral point clamped inverter." An inverter that uses clamping diodes to limit the voltage across each of its phases is known as a diode-clamped inverter. The output waveform can then be controlled more precisely by generating numerous voltage levels that are higher than the input DC voltage.

The diode-clamped inverter's advantage is its capacity to generate high-quality output with minimal harmonic distortion.

The diode-clamped inverter’s drawback is that it requires more parts and is more complicated than other inverter kinds. To ensure effective operation and fault protection, it also needs careful design as well as control.

Cascaded H-bridge (CHB) Multi-level Inverter

Several H-bridge inverter units are connected in series to create a cascaded H-bridge multi-level inverter, which creates a multi-level output voltage waveform. Usually, four power switches, such as MOSFETs or IGBTs, are assembled into an H-bridge unit, which is then placed in a bridge configuration.

Cascaded H-bridge inverters have the benefit of producing a high-quality output voltage with minimal harmonic distortion, which makes them appropriate for use in applications requiring a high-quality AC power supply.

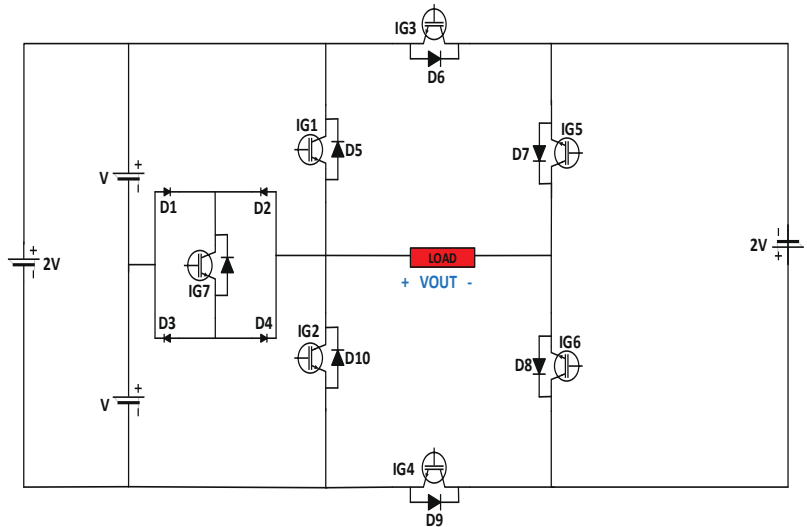


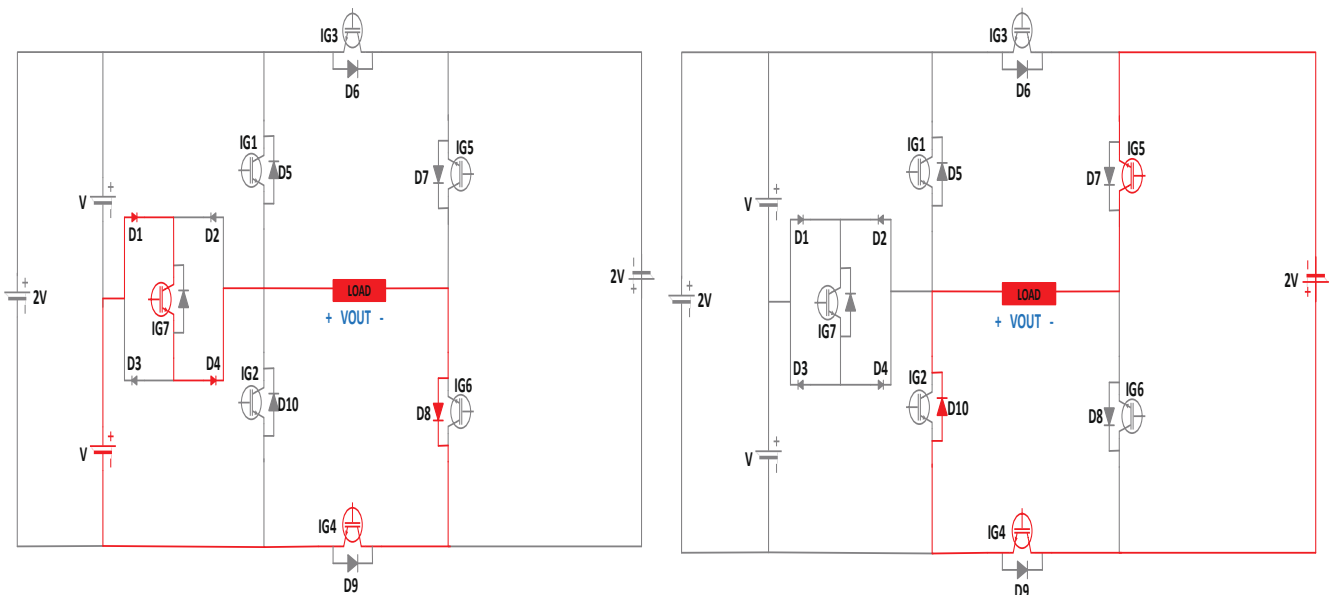
Fig.1: Basic Structure of Proposed Topology

Proposed Multilevel Inverter Configuration

Fig.1. depicts the topology configuration. The voltage divider circuit is made up of two DC voltage sources, V and 2V. The controlled switch IG7, along with the four diodes D1, D2, D3, and D14, constitute an auxiliary switch that is connected to the HSC, which is made up of six switches IG1, IG2, IG3, IG4, IG5, and IG6. It can be referred to as symmetrical MLI if the levels of the DC voltage sources are equivalent.

Main power switches: The proposed topology-I in symmetrical configuration reduces the number of main power switches needed by 56.25% (7 instead of 16) as compared to classical topologies.

Power diodes: The suggested topology-I in symmetrical arrangement reduces the number of power diodes needed by 37.5% (10 instead of 16) when compared to Flying Capacitor and Cascaded H-Bridge, and by 86.11% (10 instead of 72) when compared to Neutral Point Clamped.



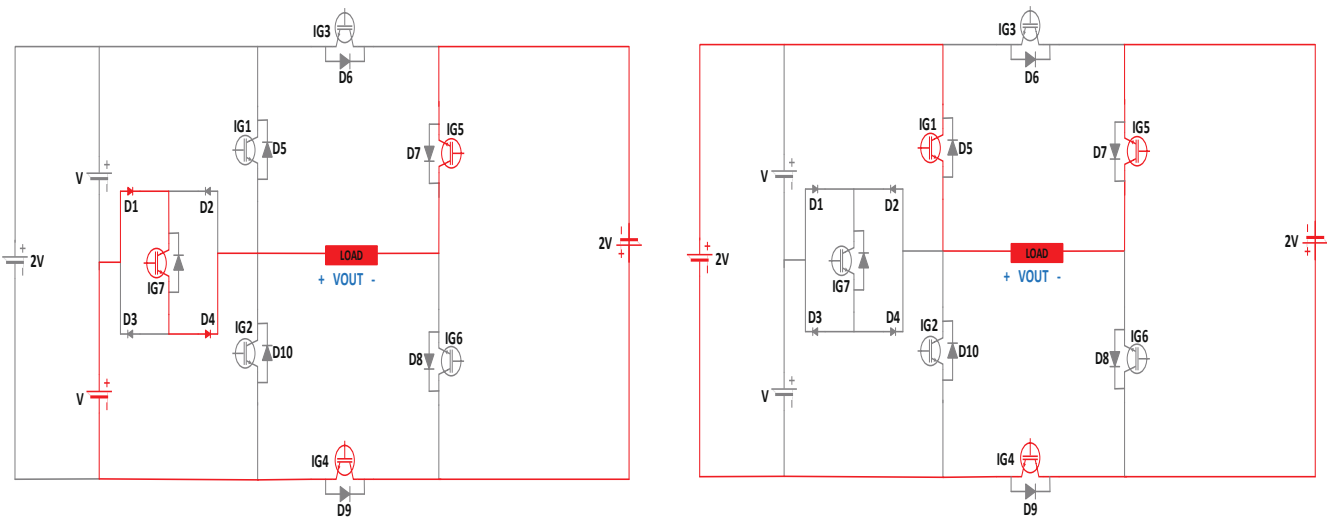


Fig. 2: Demonstrates the Different Levels Obtained using Different Switching Modes

Comparison of Various Symmetrical Multi-Level Inverter Nine-Level Inverter Topologies

There are various advantages of using proposed topology based inverter instead of using the traditional Multi-Level inverter. The biggest advantage is that it requires less number of devices which effectively reduce the cost of inverter as well as the switching losses and hence efficiency also increases [15]. Table 1.1 compares the proposed topology inverter with three widely used traditional multi-level inverters on the basis of number of devices used in it.

Table 1.1: Evaluation Of Different Symmetric Nine-Level Inverter Topologies

Elements	NPC	FC	CHB	Proposed topology
Main Power Switches	16	16	16	6
Auxiliary Switch	0	0	0	1
Diodes	72	16	16	10

UNIVERSAL CONTROL TECHNIQUE [4]

In this section, the suggested universal control technique is explained. It can be used with any multilevel inverter topology because of the way it is designed. Let the total number of levels in the phase voltage for the supplied inverter will be N level. If N level is greater than 3, a voltage source inverter can function at various levels. Since level 0 is noteworthy, level N is viewed as odd. **The N level waveform’s number of positive levels will also be:**

$$N = (N_{\text{level}} - 1) / 2$$

A sinusoidal waveform of amplitude B_{ref} and frequency f_{ref} constitutes the modulating signal $b_{ref}(t)$. For sine PWM and low-frequency schemes, there needs to be triangular, constant, $2N$ carrier signals. The frequency of these carriers is f_{car} and B_{car} is their peak-to-peak amplitude. Carrier signals that are higher than the zero level are known as $b^+ \text{ car}(t)$ and those that fall below the zero level are known as $b^- \text{ car}(t)$, ($j = \text{to } N$). The zero reference is positioned in the middle of the continuous bands that the carrier signals occupy.

Accordingly, the following quantities can be defined:

$$\text{Index of frequency modulation, } Q = B_{car} / (B_{ref})$$

“ Q ” determines the output waveform’s harmonic profile as well as the power switches’ switching frequency.

$$\text{Index of amplitude modulation, } L = B_{ref} / (NB_{car})$$

The output waveform’s peak value and number of levels are determined by the value of “ L ”.

Every time, the modulating signal is compared to each carrier. For each comparison, the outcome is either “1” if the modulated signal exceeds the carrier, or “0” otherwise. All carrier signals above the zero reference are affected by this. For each comparison, the outcome is either “0” if the modulating signal exceeds the carrier or “-1” if the carrier signal falls short of the zero reference.

That is,

$$b_{out,j}^+(t) =, \text{ for } b_{ref} \geq b_{car,j}^+(t)$$

$$= 0, \text{ otherwise}$$

$$b_{out,j}^-(t) =, \text{ for } b_{ref} \geq b_{car,j}^-(t)$$

$$= -1 \text{ fo otherwise}$$

The results so obtained are combined to create an “Aggregated signal” that is designated as b_{bgg} .

That is,

$$b_{bgg}(t) = \sum_{j=1}^N (b_{out,j}^+(t) + b_{out,j}^-(t))$$

It should be observed that the waveshape of $b_{bgg}(t)$ gains the same property as the anticipated output voltage. With a certain topology, power electronic switches require real-world driving signals, which requires the use of logical components and a look-up table to be generated from $b_{bgg}(t)$. Using Boolean operations,

$b_{d,i}(t)$ are derived from $b_{bgg}(t)$ using following criteria:

$$b_{d,i}(t) = 1, \text{ if } b_{bgg}(t) = j$$

$$= 0, \text{ otherwise; where, } j = -N \text{ to } +N$$

As a result, a total of N-level derived signals will be produced, each of which will be used to operate the switches that must remain ON at the voltage level indicated by the output waveform. In order to acquire the switching function $b_{switching}(t)$ for a certain switch, the necessary derived signals would be sent into an OR gate. The mathematical formulation of the switching function is

$$b_{switching}(t) = \prod \overline{b_d(t)}$$

Where,

$$\overline{b_d(t)} = 1 - b_d(t)$$

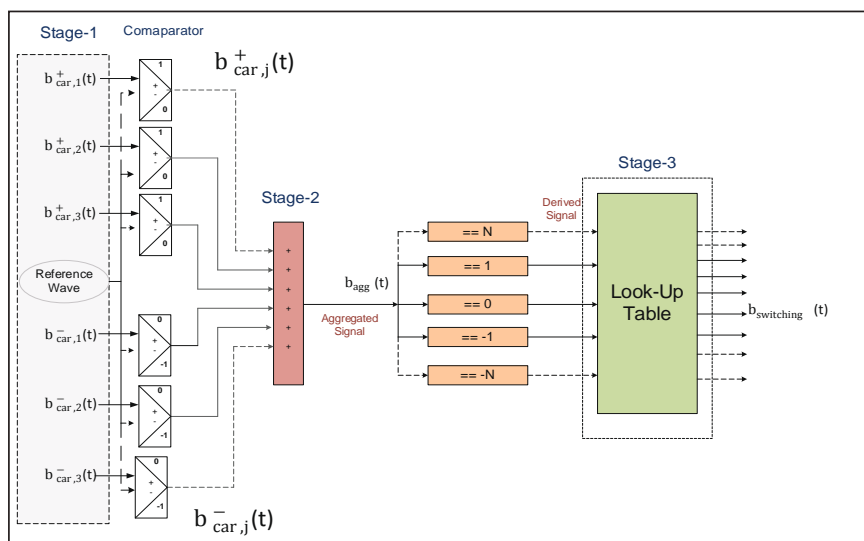


Fig. 3: Block Diagram of Universal Control Scheme

Table 1.1 summaries each switching configuration that was employed to produce the necessary output of Nine-level.

**Table 1.1 Switching Configuration
For Positive Cycle**

Output levels, V	ON State Switches	Conducting Diodes
1	IG4, IG7	D1, D4, D8
2	IG4, IG5	D10
3	IG4, IG5, IG7	D1, D4
4	IG1, IG4, IG5	-----.

For Negative Cycle

Output levels, V	ON State Switches	Conducting Diodes
-1	IG3, IG7	D2, D3, D7
-2	IG3, IG6	D5
-3	IG3, IG6, IG7	D2, D3
-4	IG2, IG3, IG6	-----

CONTROL AND MODULATION TECHNIQUES IN PROPOSED TOPOLOGY [12]

In the literature, several modulation techniques for MLIs have been suggested. The many carriers used in multilevel carrier-based PWM techniques can be triangular or saw-tooth signals. Frequency, phase of each carrier, amplitude, and offset between the carriers are all variables that are free in carrier signals. Additionally, the reference wave (modulating signal) offers flexibility in terms of frequency, amplitude, and phase angle, as well as the injection of zero sequence signals. As a result, a variety of multilevel carriers-based PWM techniques can be obtained by using these combinations. An inverter with n levels of phase voltage would typically need a series of $n - 1$ carrier signals. These Modulation Techniques are as:

Phase Disposition PWM

An inverter's output voltage can be regulated using a phase disposition technique, a form of modulation technique, in power electronics. The outcome is a stepped output waveform, which is achieved by segmenting the input voltage waveform into various parts and applying various voltage levels to each part. This method is appropriate for high power applications such as motor drives and renewable energy systems since it can produce more output voltage levels than conventional two-level inverters [11].

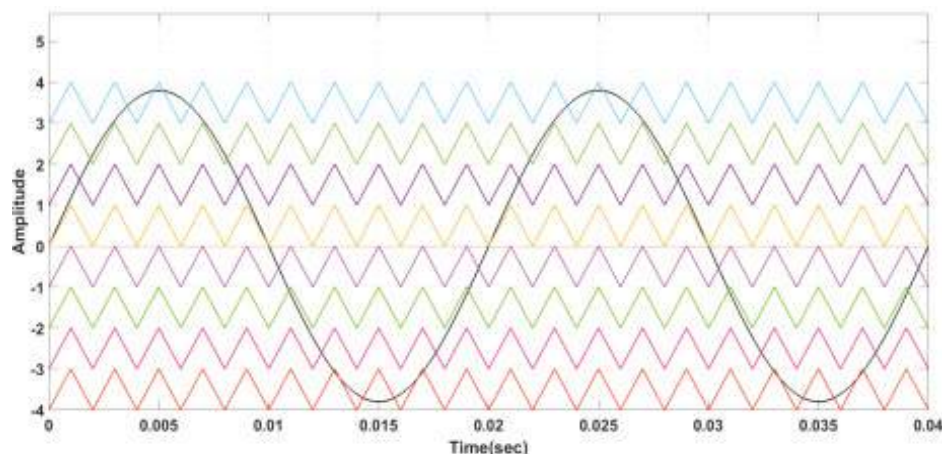


Fig. 4: PDPWM

Phase Opposition Disposition (PODPWM) PWM

A modulation technique called phase opposition disposition (POD) is used in power electronics to regulate an inverter's output voltage. In order to produce a stepped output waveform, it first generates two sets of output voltage waveforms with opposite polarities [12].

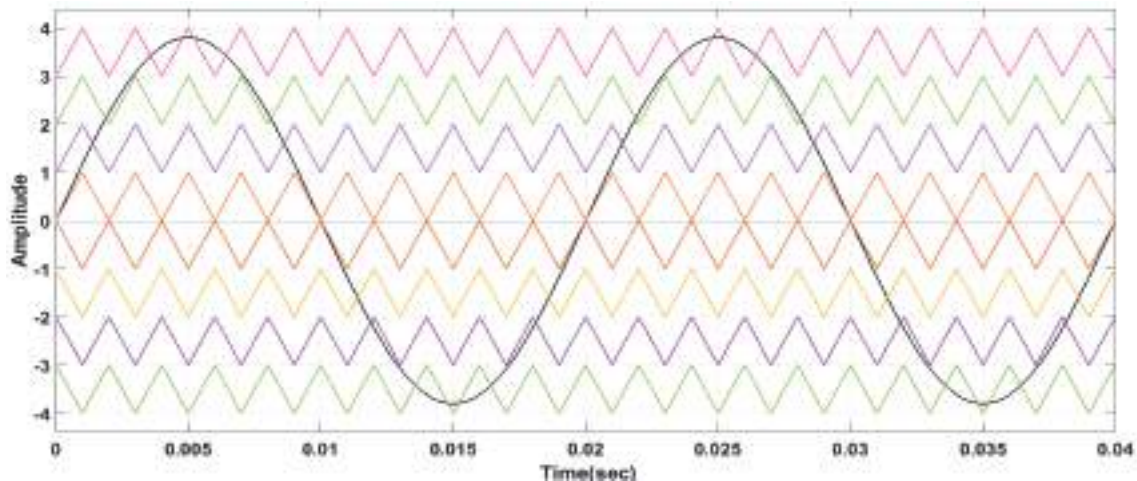


Fig.5: PODPWM

Alternate Phase Opposition Disposition (APODPWM) PWM

Alternate Phase opposition disposition (APOD) is a modulation method used in power electronics to regulate the inverter's output voltage. In this approach, the carrier signals alternatively phase-displace by 180 degrees.

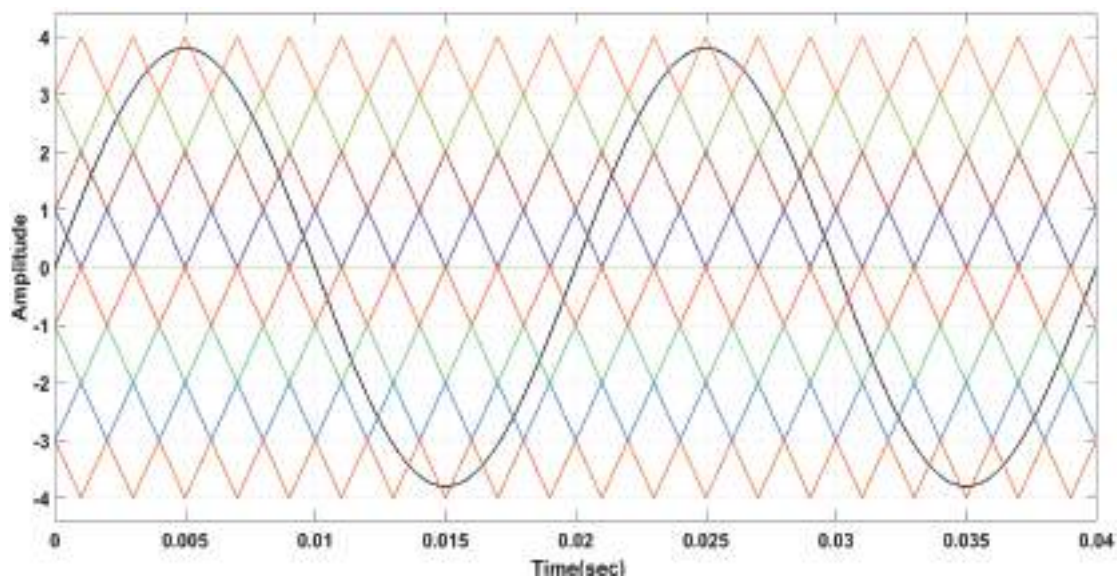


Fig.6: APODPWM

Variable Frequency Inverse Sinusoidal Carrier PWM (VFISCPWM)

This method uses an inverted sine wave with variable frequency as the carrier wave and a sine wave as the reference wave, with the carrier signals having different frequencies from one another. The control technique will produce pulses whenever the reference sine wave's amplitude exceeds that of the inverted sine carrier wave [14].

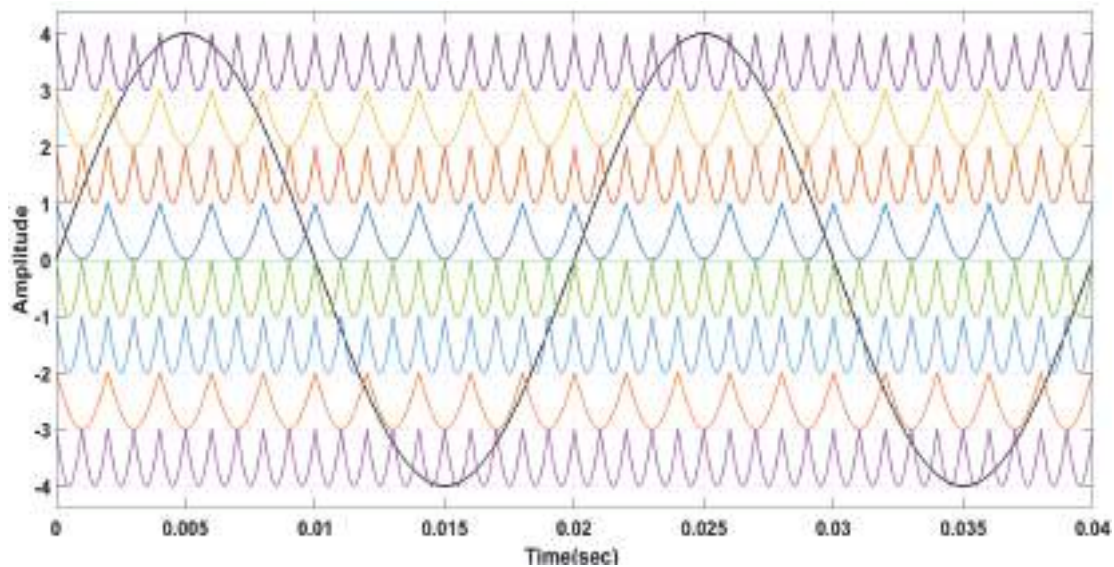


Fig.7: VFISCPWM

Inverted Sinusoidal Carrier PWM

In this method, a sine wave serves as the carrier wave. The inverted sine carrier PWM (ISCPWM) technique uses an inverted sine carrier with a high frequency as the carrier signal and a sine wave as the reference signal. Low harmonic distortion is achieved by combining reference and carrier signals with different modulation indices.

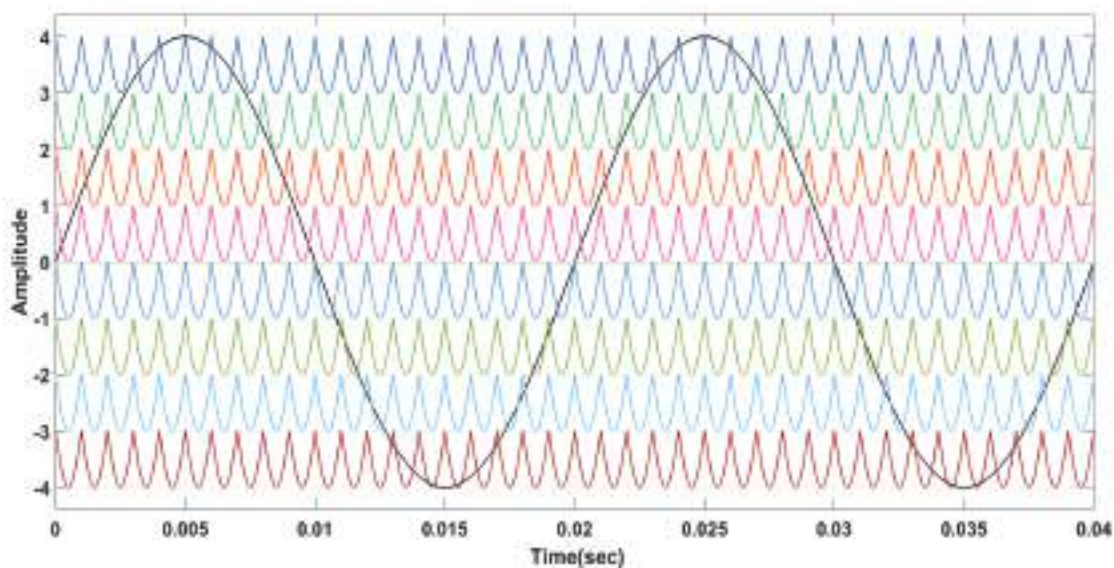


Fig.8: ISCPWM

SIMULATION RESULTS AND DISCUSSION

Using MATLAB/SIMULINK R2016a, the suggested multilevel inverter topology is simulated. The following simulation parameters are $R=50$ ohms and $V=12$ volt for dc voltage. The switches are considered to be perfect, and the carrier signal frequency in this paper's five PWM approaches is 10 kHz. These techniques include PD, POD, APOD, ISC, and VFISC, each with a distinct Modulation Index (MI). In table 1.2, the THD of five PWM techniques are displayed. In MATLAB/Simulink, the harmonic spectrum is calculated via FFT analysis.

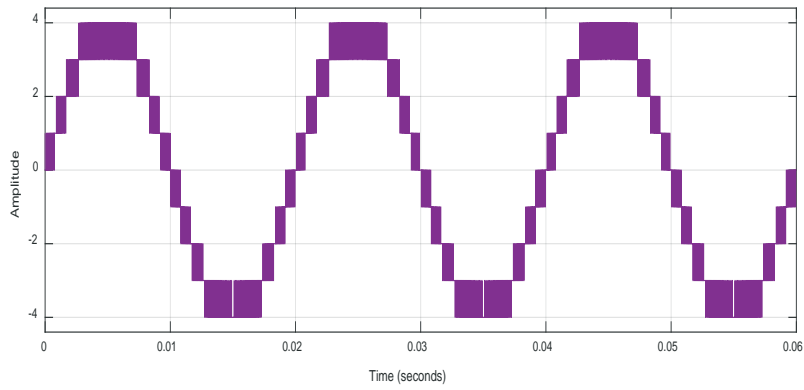


Fig.9: Output Waveform of Proposed Topology

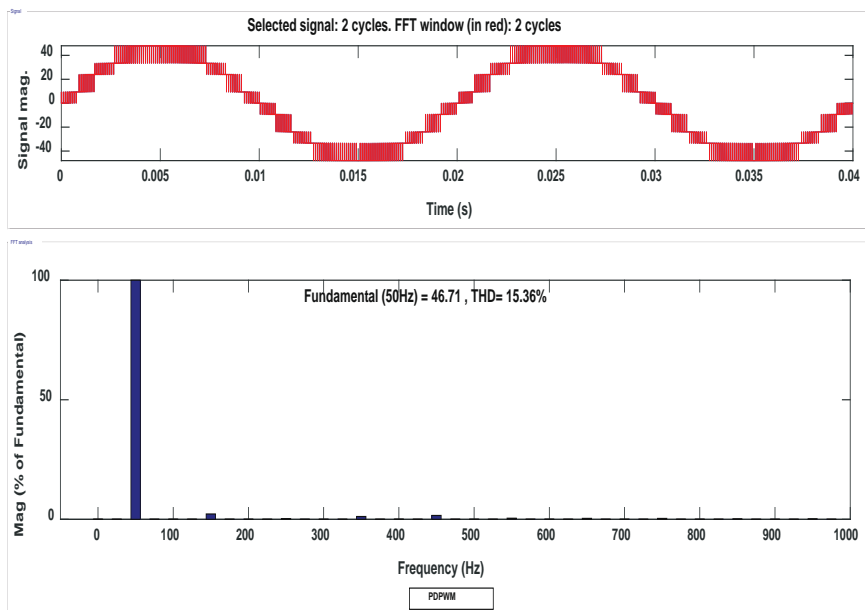


Fig.10.:THD in 9-level inverter with PDPWM Technique

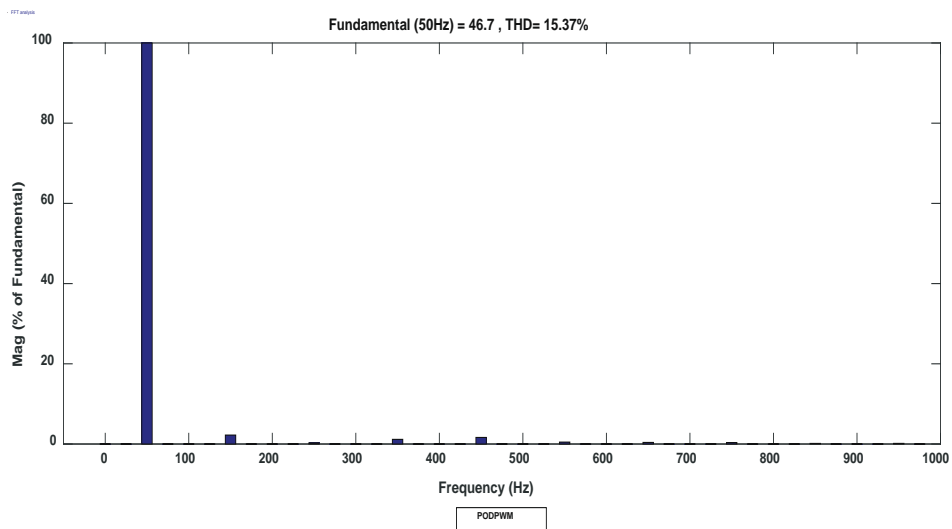


Fig.11. THD in PODPWM Technique

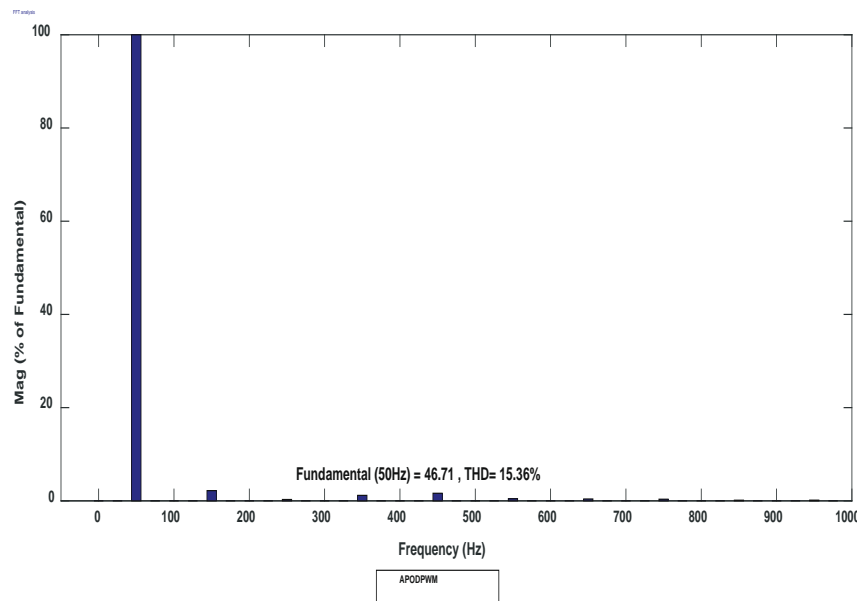


Fig.12. THD in APODPWM Technique

Table 1.2: Results of Different Modulation Technique

Level	Modulation Index	Modulation Technique				
		PD	POD	APOD	VFISC	ISC
9-level	1.1	14.31	14.30	14.30	14.96	14.94
	1.0	15.36	15.37	15.36	16.11	16.13
	0.9	16.78	16.71	16.71	17.72	17.72
	0.8	18.23	17.71	17.72	18.03	18.02

EXPERIMENTAL RESULTS AND DISCUSSION

In the paper, the universal control techniques have been implemented to control the MLI. Six different PWM modulations techniques have been presented on varying modulation index. In experimentation, a low cost STM32F4 discovery board have been used to verify universal technique experimentally. The experimental photograph is shown in Fig.15. The discovery board has ARM Cortex-M4 32-bit microcontrollers installed and have fifteen analog to digital pin (PA0-PA7, PB0-PB1 and PC0 to PC5), two digital to analog pins (PD0-PD1). In this paper DAC pins are used to extract the outputs of multilevel inverter. Real-time implementation of created Simulink models can be readily created and loaded into the board memory by using Keil, STM32F4 embedded coder target, together with other useful tools.

Create a model using Simulink that includes embedded target blocks in accordance with the applications and accessibility requirements. Before creating any files for Simulink models, ensure that the primary directory path is correctly located in MATLAB's command window. Simulink models can be created and executed on a discovery kit by using the Support packages for STMicroelectronics' STM32F4 exploration board. Integrated into the support package are Simulink blocks for setting and gaining access to board's auxiliary devices. The STM32F4 blocks' third-party interface, in addition to MATLAB, is Waijung software. The user must install the STM link utility driver before they can finish installing the Waijung block. Choose the parameters for the target arrangement based on your requirements. Fig.16-18 displays the experimental findings at various modulation indices.

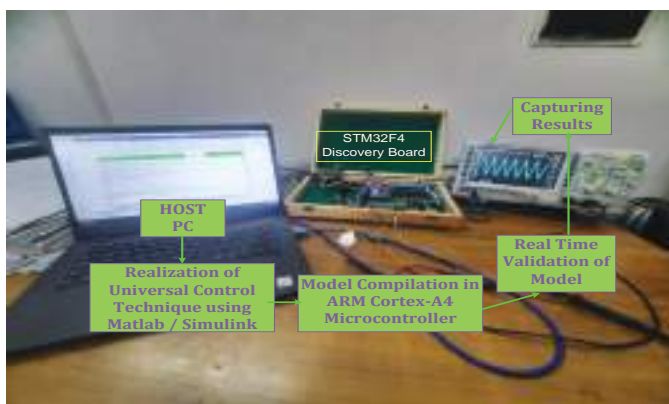


Fig.15: Experimental Realization of Universal Control Technique



Fig.16: Experimental Output Voltage at Modulation Index of 1



Fig.17: Experimental Output Voltage at Modulation Index of 0.9



Fig.18: Experimental Output Voltage at Modulation Index of 0.8

CONCLUSION

In place of the traditional multilevel inverters, a new nine-level inverter design was introduced in this study for the grid-integrated system. The number of components was decreased by the suggested topology. Moreover, it ensures the lowest hardware implementation cost. The suggested inverter topology is controlled by switching pulses produced by the low-frequency modulation approach, which also offers the lowest total harmonic distortion. There is no need for a filter with the suggested inverter. Consequently, in the future power system, the proposed inverter topology makes the grid-connected systems more compact, efficient, and dependable. The simulation outcomes for an inverter with a 9-level design have been given. It was shown that the inverter's THD varies when different PWM techniques are applied, and the Phase Opposition Disposition (POD) Method achieves the lowest THD.

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Hybrid Power Generation Using Rooftop PV: A Case Study

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▶ ABSTRACT ◀

Currently these days electricity is most needed facility for us. All the non-renewable energy resources are depleting day by day. So we need to transition from non-renewable to renewable energy resources. In this the combinations of different energy resources is takes places but we would talking regarding solar energy. This approach reveals the utilization of renewable energy resources without causing harm to the environment. By employing a hybrid energy system, we can provide uninterrupted power supply. Essentially, this system combines different energy sources to ensure a continuous flow of power. Solar panels play a crucial role in converting solar energy into electrical energy, which can be employed for various applications. The generation of electricity through this method proves to be cost-effective, offering affordable rates. Solar power is acquiring significant prominence in the contemporary world. The objective of the project is to create a hybrid power generation system that is connected to the grid, utilizing solar energy as its primary source, after that the upcoming benefits of solar etc.

Keywords: *Hybrid Energy System, Continuous Power, Non-Renewable Energy Resources, Renewable Energy Resources, Solar Panels.*

INTRODUCTION

Hybrid power generation using Solar involves combining solar power with another form of power generation. This approach allows for more reliable and consistent power production, as well as the ability to generate power even when the sun is not shining.

The basic idea behind hybrid solar power generation is to combine the strengths of multiple power sources to create a more robust and efficient system. The hybrid power generation system consists of solar photovoltaic

(PV) panels, batteries, inverters, and a backup power source such as a inverter For example, during the day, solar panels can generate electricity from the sun's energy, while at night or during periods of low sunlight, a backup power source, such as hybrid power generator, can provide additional power to meet the electricity demand.

Hybrid solar power systems are experiencing growing adoption in distant regions where access to grid electricity is limited or unreliable. These systems can provide reliable and affordable electricity for households, businesses, and communities, while reducing their dependence on fossil fuels and lowering their carbon footprint.

That's why the institute MITS Gwalior also uses these hybrid solar grid system since 2019.

Conversion of Sun Light into Electricity by Solar Cell

Solar cells or photovoltaic cells, converts the sunlight directly into electricity known as photovoltaic effect. Sunlight (which is made up of photons) hits the solar cell. The solar cell is made up of a semiconductor material such as silicon that contains both positively and negatively charged layers. When photons hit the solar cell, they transfer their energy to electrons in the semiconductor material, causing some of them to break free from their atoms and form an electric current. The electric current generated by the freed electrons is captured by the metal contacts on the solar cell, which then conducts the electricity out of the cell and into a circuit. The solar cell continues to generate electricity as long as it is exposed to sunlight. By combining multiple solar cells into a solar panel, larger amounts of electricity can be generated. This electricity can be used to power homes, businesses, and other electrical devices.

Material is Used for Construction of PV Panel for Maximum Power Generation

Silicon semiconductor is used in PV cell. Crystalline silicon is the most common material that used in solar cells due to the lifespan of crystalline silicon which is approximately more than 25 years, due to the band gap and energy efficiency of silicon 1.34 eV and 22% respectively.

Orientation of PV Panel for Maximum Power Generation

In India, the optimal orientation for a photovoltaic (PV) panel to achieve maximum power generation is facing due south (i.e., oriented towards the equator) with a tilt angle equal to the latitude of the location. This orientation ensures that the PV panel receives maximum sunlight throughout the year, as the sun is at its highest point in the sky at solar noon and during the summer months in India, it is located in the northern hemisphere. This configuration ensures that the panel receives maximum direct sunlight during the peak sun hours of the day. However, the optimal orientation and tilt angle may vary depending on the specific location, the type of PV panel being used, and the desired level of power generation. It is recommended to consult with a solar energy expert to determine the most appropriate orientation and tilt angle for a specific PV panel installation.

Microgrid

A microgrid is a localized group of electrical generation, distribution, and consumption units that operate together as a single system, often including renewable energy sources and energy storage systems. It is designed to provide reliable and resilient electricity to a specific geographic area, such as a campus, neighborhood, or community. Micro grids can operate either connected to the main power grid or as an independent system.

In institute of MITS Gwalior generally we uses the voltage controller, current controller, PWM controller for the microgrid.

- **Voltage Controller:** A voltage controller is a device that regulates the voltage level in the microgrid by adjusting the power factor and reactive power flow. It can adjust the output voltage of the power source to match the voltage requirements of the load, ensuring that the voltage remains within a specific range to prevent overvoltage or under voltage conditions.

- **Current Controller:** A current controller is a device that regulates the current flow in the microgrid by adjusting the active power flow. It can adjust the output current of the power source to match the current requirements of the load, ensuring that the current remains within a specific range to prevent overcurrent or under current conditions.
- **PWM Controller:** A PWM (Pulse with modulation) controller is a device that regulates the power flow by adjusting the duty cycle of the power signal. It operates by switching the power on and off rapidly, and by varying the width of the on-time and off-time of the signal, the average power delivered to the load can be regulated. PWM controllers are commonly used in microgrids to control the voltage and frequency of the AC power output from the inverter, ensuring that it matches the grid requirements and maintaining the stability of the microgrid.

SYSTEM DESCRIPTION (MITS POWER SYSTEM)

Details of Equipment's Installed in MITS Gwalior

A solar module consisting of 308 panels with a total capacity of 50kW was installed by Vikram Solar Company in November 2019. The total cost of the installation was approximately 70 lakh, with 2 inverter of 50 kW capacity of Sungrow Company.

The 100 kWp solar rooftop PV plant was installed in November 2019 and is running successfully since then at MITS Gwalior under Renewable Energy Service Company (RESCO) scheme of MP Urja Vikas Nigam, Bhopal and installed by and maintained by Azure Power Rooftop Five Pvt. Ltd. This plant is Net-metered grid Connected with MPMKVV Co Ltd.

Economic Emission Dispatch of Microgrid in MITS Gwalior

Economic Emission Dispatch (EED) is an optimization problem that involves determining the optimal power output of generators in a power system that minimizes the operating cost and reduces the emission of pollutants simultaneously. In a microgrid, the EED problem is solved to optimize the power dispatch between various distributed energy resources (DERs) in the microgrid. The objective is to minimize the total operating cost of the microgrid while meeting the power demand of the loads and satisfying the operational constraints of the DERs.

The EED problem can be formulated as a nonlinear optimization problem with constraints. The optimization objective is to minimize the total operating cost of the microgrid, which includes the fuel cost of the generators, the cost of purchasing electricity from the grid, and the cost of emissions from the generators. The constraints include the power balance equation, which requires that the power output of all the DERs in the microgrid must match the power demand of the loads at all times, and the operational constraints of the DERs, such as the upper and lower thresholds of power output, ramp rate limits, and voltage and frequency constraints. The solution to the EED problem provides the optimal power dispatch of the DERs in the microgrid, which can be used to operate the microgrid in an efficient and environmentally friendly manner. The EED problem can be solved using various optimization techniques, such as linear programming, quadratic programming, and particle swarm optimization.

In summary, the EED of microgrid is an important aspect of microgrid control that optimizes the power dispatch of DERs in the microgrid to minimize the operating cost and reduce the emission of Through the simultaneous integration of renewable energy sources, there is an observed decrease of 18% in fuel costs and a reduction of 3.4% in emissions during static load demand analysis. Similarly, when considering multiple load demands over a 24-hour period, fuel costs decrease by 14.95%, and emissions are reduced by 5.58%.

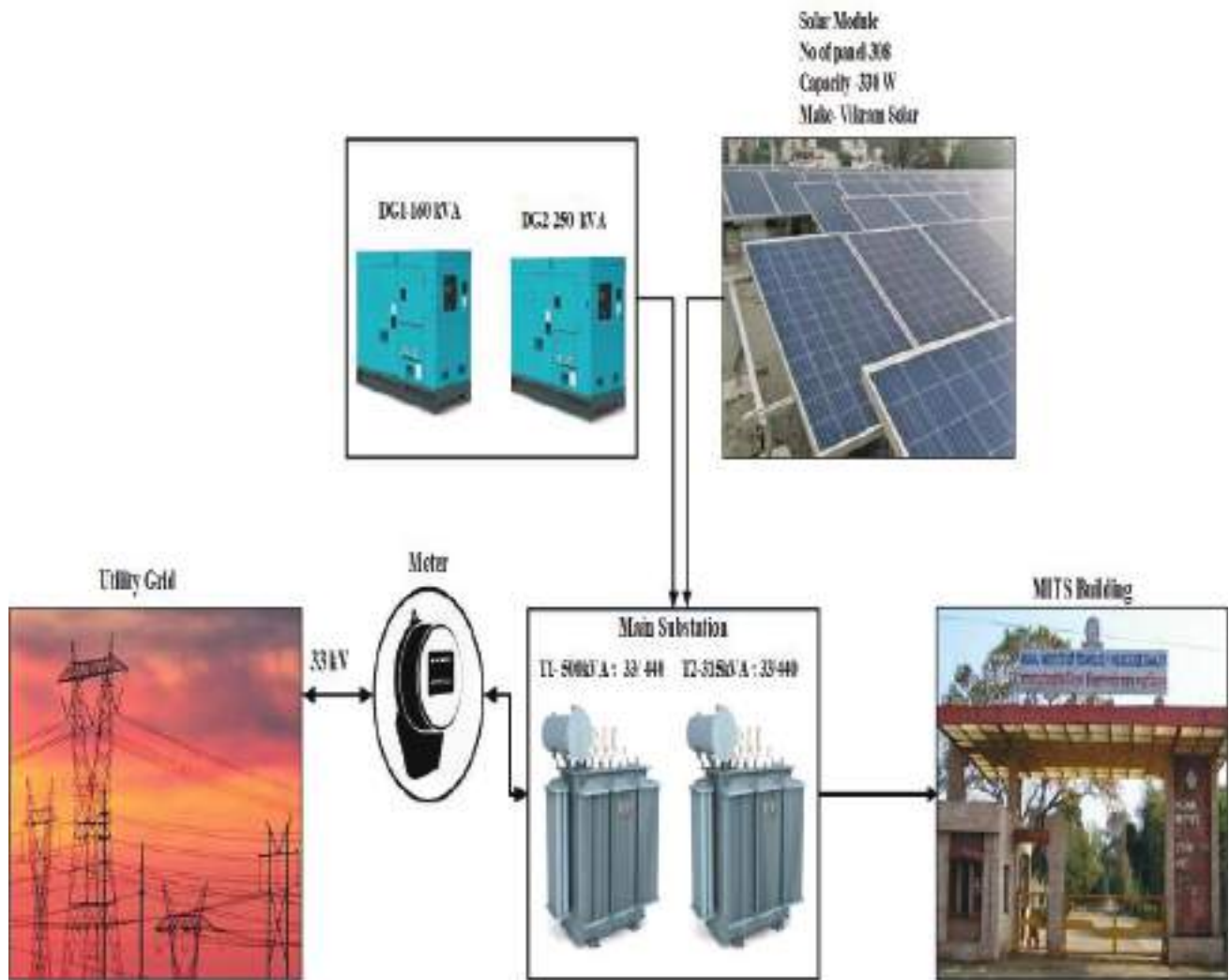
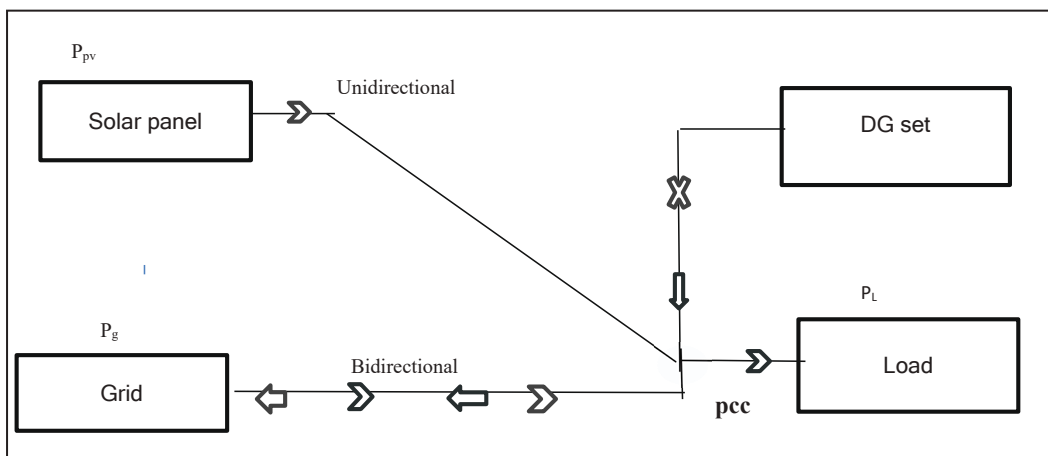


Fig. 1: Mits Power Supply System

Power Flow Diagram of MITS Gwalior



Case 1: Unidirectional

In this case,

- The power is flow from source to load.
- Like as Solar panel, DG set and load is working as unidirectional

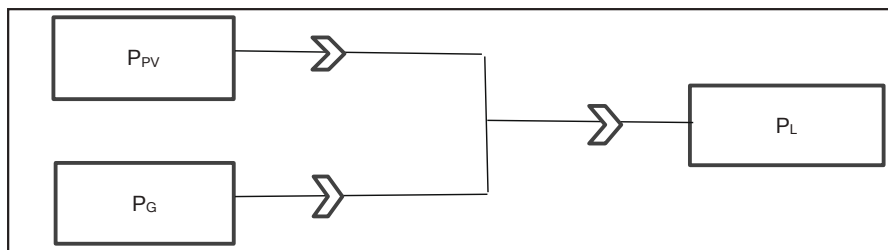
Case 2: Bidirectional

- The power is flow both the directions.
- Like as source to load and load to source

If,

$$P_L > P_v$$

When P_L is greater than the P_v , then the load required the extra power from the PV array.

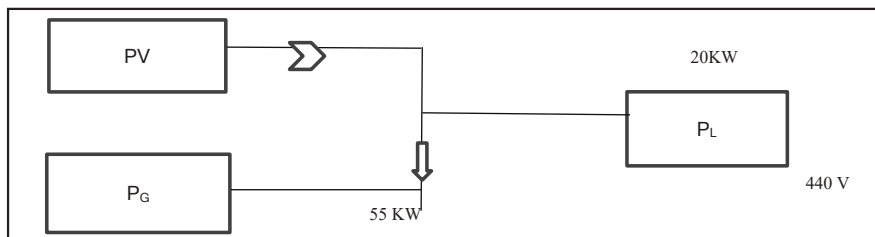


If,

$$P_{PV} > P_L$$

PV array generates a more power than the required power. So these extra power goes to grid.

75 KW



METHODOLOGY

The Maximum Power Point (W_p)

It is the point at which the panel generates maximum power. It is the operating point at which the product of the voltage and current is maximum.

The Maximum Power Voltage (VMP)

It is the voltage at which the panel produces maximum power. At this voltage, the panel is operating at the MPP.

The Open Circuit Voltage (VOC)

It is the voltage at which the panel is not connected to any load and no current is flowing through the circuit. At this voltage, the current is zero and the panel produces its maximum voltage.

The Maximum Power Current (IMP)

It is the current at which the panel produces maximum power. At this current, the panel is operating at the MPP.

The Short Circuit Current (ISC)

The short circuit current is the current that flows when the positive and negative terminals of the solar panel are connected directly together. At this point, the voltage is zero and the panel produces its maximum current.

The Fill Factor (FF)

The fill factor is the ratio of the maximum power that can be obtained from the solar panel to the product of its open circuit voltage and short circuit current. It is a measure of the efficiency of the panel in converting sunlight into electrical energy. A higher fill factor indicates a more efficient panel.

$$\begin{aligned}
 FF &= V_M \times I_M / V_{OC} \times I_{SC} \\
 &= P_M / V_{OC} * I_{SC} \\
 &V_M * I_M < V_{OC} * I_{SC}
 \end{aligned}$$

These all parameters are helpful for measuring the load, battery size calculation, solar array design, etc

RESULTS

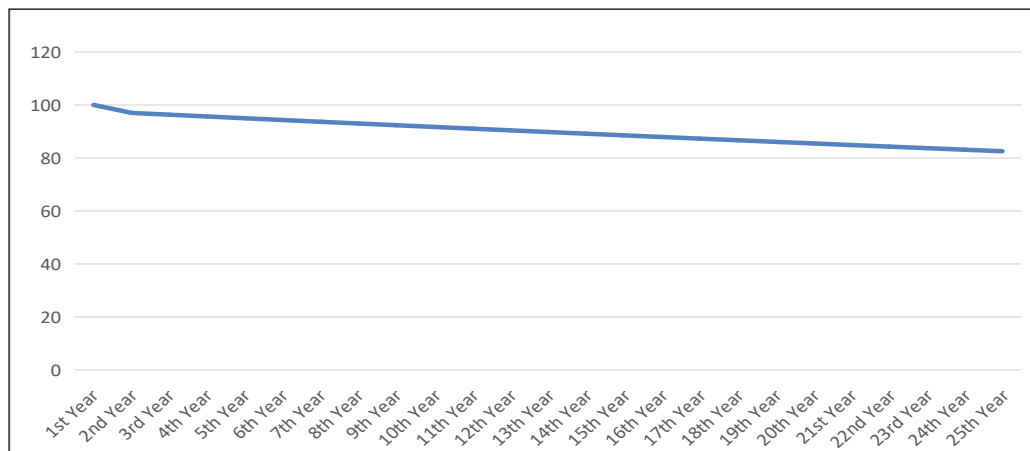


Fig. 2: System Percentage Output

The output of a hybrid power solar generation system can reduce over time due to various factors, such as:

Aging of solar panels: Solar panels have a limited lifespan and their efficiency decreases as they age. Exposure to sunlight, temperature fluctuations, and other environmental factors can cause the panels to degrade over time, leading to reduced efficiency and output.

Accumulation of Dirt and Debris: Dust, dirt, leaves, and other debris can accumulate on the surface of solar panels, which can reduce the amount of sunlight that is absorbed and converted into electricity. This can lead to a decrease in the output of the solar panels and the overall efficiency of the system.

Battery Degradation: Hybrid power solar generation systems often use batteries to store excess energy for later use. However, the batteries have a limited lifespan and can degrade over time, reducing their capacity and overall efficiency.

Poor Maintenance: Regular maintenance of the solar panels, batteries, and other components is essential to keep the system running at optimal efficiency. Neglecting maintenance can lead to system failures, reduced output, and other problems.

Changes in Environmental Conditions: Changes in weather patterns, such as cloudy or rainy weather, can reduce the amount of sunlight that reaches the solar panels, leading to decreased output. Similarly, changes in energy demand can also affect the overall efficiency of the system.

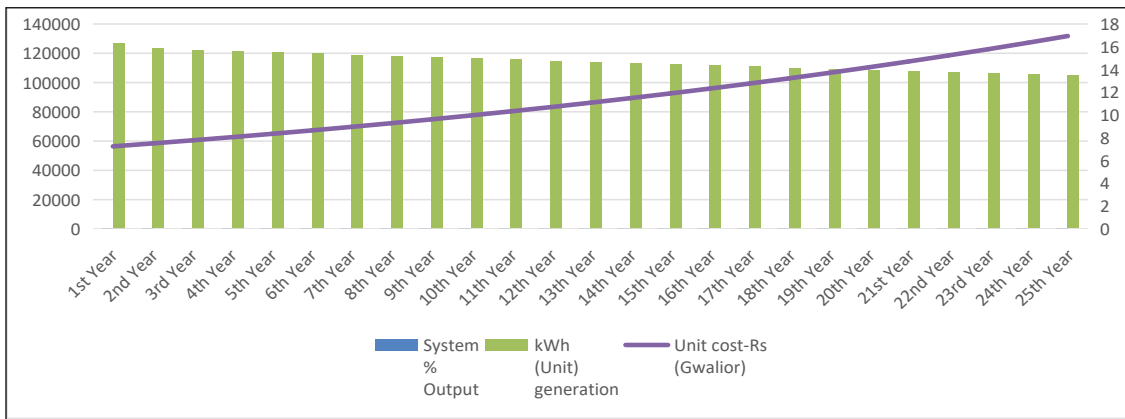


Fig.3: Graph Showing Unit Generation Per Unit Cost

The kWh unit generation of a solar hybrid power generation system may reduce and the unit cost may increase over time due to several factors, including:

Degradation of Solar Panels: Over time, the efficiency of solar panels can degrade due to exposure to environmental factors such as heat, moisture, and dust. This can lead to a reduction in the amount of electricity generated by the system, which can increase the unit cost of electricity.

Battery Degradation: Hybrid solar power generation systems often use batteries to store excess energy for later use. However, batteries have a limited lifespan and can degrade over time, reducing their capacity and the amount of energy they can store. This can lead to a reduction in the amount of electricity generated by the system, which can increase the unit cost of electricity.

Maintenance Costs: Maintenance costs for solar hybrid power generation systems can increase over time, as components may require repair or replacement. For example, if the batteries need to be replaced or the solar panels require cleaning or repairs, this can increase the unit cost of electricity.

Changes in Energy Demand: As energy demand increases, solar hybrid power generation systems may struggle to keep up with demand. This can lead to the need to install additional capacity, which can increase the unit cost of electricity.

Changes in Government Policies: Government policies regarding solar power incentives and subsidies can change over time. These changes can affect the cost of electricity generated by solar hybrid power generation systems, and can increase the unit cost of electricity if incentives are reduced or eliminated.

Overall, it is important to regularly monitor and maintain solar hybrid power generation systems to ensure optimal performance and to keep costs under control. Regular maintenance, component replacement as needed, and careful monitoring of energy demand can help to mitigate the factors that can lead to a reduction in kWh unit generation and an increase in unit cost over time.

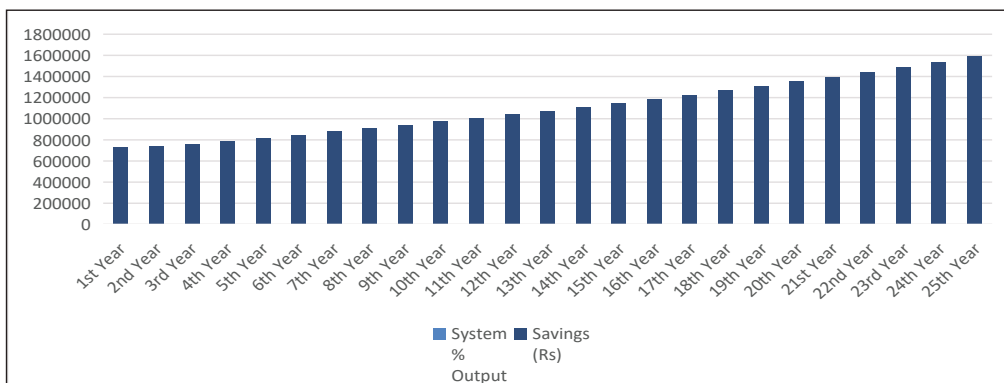


Fig.4: Total Savings

As per above graph, we can conclude the total savings cost by using solar of 25 years respectively

- In every upcoming year the savings increases i.e. it gives the benefits more if we using solar as long term.
- By installing solar it gives us to minimize or negligible electricity bills.
- Majorly the total saving decided by the total electricity bill with including the total cost of up-fronts of solar and solar systems.

CONCLUSION

With the escalating usage of fossil fuels, the environment is facing detrimental consequences, while the depletion of these fuels continues to accelerate. A future without reliance on fossil fuels is imminent. Given the indispensability of energy sources for electricity generation, a substantial shift towards renewable energy sources becomes imperative. Expanding our dependence on renewable energy and maximizing its utilization is crucial. The implementation of smart poles presents an opportunity to augment the utilization of solar power. Once this system undergoes necessary advancements, it can potentially replace existing energy systems. Moreover, the installation of rooftop solar power plants on the premises has demonstrated a significant reduction in CO₂ emissions, contributing to a substantial decrease in atmospheric pollution over the course of a year. Hybrid power generation using solar energy is an efficient, reliable, and sustainable approach to meet the energy needs of today's world. With advancements in technology and increasing demand for clean energy, this approach is expected to gain widespread adoption in the coming years.

ACKNOWLEDGEMENT

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Air Pollution Detection & Monitoring Using Internet of Things (IoT)

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▶ ABSTRACT ◀

The term "internet of things" is used to describe a worldwide system of connected, self-aware devices that may gather data about their surroundings and share it with other networks (IOT). Since more people are breathing in polluted air due to growing rates of car usage, industrialization, and urbanisation, it poses a serious threat to public health. To combat this, a cutting-edge Internet of Things (IoT)-based air pollution monitoring system has been developed. This system is able to identify and quantify dangerous gases and compounds such as carbon dioxide, nicotine, alcohol, benzene, NH_3 , and NO_2 . Sensors connected to an esp32 microcontroller collect data on the surrounding environment and send it to the cloud in real time using the MQTT protocol. Accessible from anywhere with an Internet connection, the data is shown on both a website and an LCD. This system has the potential to provide employees real-time information about the source and location of any pollution. By providing precise data on air quality and issuing alerts when pollution levels reach over acceptable limits, an IoT-based air pollution monitoring system has the potential to decrease threats to public health.

Keywords: Internet of Things (IoT), Smart Devices, Air Pollution, Air Quality Sensors, Microcontroller, MQTT Protocol, Cloud Platform, Webpage, Remote Monitoring, Alert, Real-time Data.

INTRODUCTION

One of the most promising applications of the Internet of Things (IoT), which is changing the way people interact with technology, is in the field of air quality monitoring. Air pollution is the most pressing problem, because it has consequences for both the natural world and for human health. Rising populations, industrial activities, and transportation contribute significantly to air pollution worldwide. To better monitor air quality in real time and alert nearby workers and residents when pollution levels rise over safe thresholds, an Internet of Things (IoT)-based system is proposed. A microcontroller named ESP32 controls the device's temperature, humidity, and air quality sensors. The MQTT standard paves the way for information to be saved in the cloud. A web interface and an LCD screen provide remote monitoring capabilities. Nicotine, alcohol, benzene, NH₃, and NO₂ are just some of the compounds that the system might potentially identify. In theory, the monitoring system's findings may be useful in a variety of contexts. Possible benefits include more precise localization of polluted areas, tracking of the effectiveness of pollution-reduction programmes, and simpler access to reliable data on air quality.



Fig 1: Air Pollution in Atmosphere

Analyzing monitoring data allows us to calculate the daily air pollution level, allowing us to take the appropriate measures. The Internet of Things-based air pollution monitoring system is a viable alternative for businesses that must maintain tabs on pollution levels for purposes of employee safety because of its dependability and cheap cost. The technology might be used to protect not just commercial buildings, but also residential areas, parks, and other public areas. It's likely that Internet of Things-based air pollution monitoring devices hold the key to figuring out how to solve the massive issue of air pollution and its devastating impact on the ecosystem and human health. The ability of these technologies to identify dangerous substances in real time and provide relevant data has the potential to improve air quality and protect human health. It's important to get the word out about them and take steps to make them more affordable and accessible to the general population.

Analyzing monitoring data allows us to calculate the daily air pollution level, allowing us to take the appropriate measures. The Internet of Things-based air pollution monitoring system is a viable alternative for businesses that must maintain tabs on pollution levels for purposes of employee safety because of its dependability and cheap cost. The technology might be used to protect not just commercial buildings, but also residential areas, parks, and other public areas. It's likely that Internet of Things-based air pollution monitoring devices hold the key to figuring out how to solve the massive issue of air pollution and its devastating impact on the ecosystem and human health. The ability of these technologies to identify dangerous substances in real time and provide relevant data has the potential to improve air quality and protect human health. It's important to get the word out about them and take steps to make them more affordable and accessible to the general population.

OBJECTIVE & AIM OF AIR POLLUTION DETECTION MONITORING

Air quality data are collected and analysed as part of air pollution detection and monitoring to determine where and how much pollution is present. Our mission is to improve air quality and preserve human health by sharing accurate and timely information with politicians, environmental groups, and the general public. By keeping tabs on where pollution levels are highest, we can cut down on emissions from vehicles and companies. To further minimise pollution and encourage the use of eco-friendly technology, this data might also be used to draught laws and direct the creation of regulations. The identification and frequent monitoring of air pollution is crucial to achieving the goals of sustainable development, public health, and climate change mitigation.

LITERATURE SURVEY

N. S., Vuayalakshmi (2016) [1] Standard AQI values and more information are available here. Anywhere between 0 and 100 ppm is safe for human habitation. The dangerous threshold is reached if the ppm level rises over 100. When the concentration rises over 200 parts per million, it poses a significant risk to human health.

Anand Jayakumar and Yesyand, Praviss. (2021) [2] The DHT11 sensor module can detect both the temperature and humidity of its surroundings. The MQ-135 gas sensor is used to evaluate air quality. Oxygen-rich air, alcohol, carbon dioxide, Page hydrogen, and methane are just some of the gases and liquids that may be utilised to alter it. In this study, the quality of the surrounding air serves as a standard.

Amir Chetri and Heniel (2018) [3] It has been shown that Node MCU exhibits dominant behaviour. This study demonstrates how useful a scripting language C++ may be for programmers. Because of its built-in Wi-Fi module, it's easy to incorporate IoT into preexisting software. The coding for this project is done in the Arduino IDE. The cloud service is provided by Thing Speak. There is a free version, but it adds 15 seconds to the time it takes to upload a file to the cloud.

Jesif Ahmed (2018) [4] Due to the power drive, the sensors' output voltage levels vary and display unpredictable behaviour even when both are switched ON; this is because the project employs two sensors, each of which incorporates internal heater components and hence consumes more power ($P=V*I$). Since the Node MCU can only power one sensor at a time, we needed to find a different way to power them.

SYSTEM REQUIREMENTS

Hardware Components - LEDs that emit green, yellow, and red light, AC-DC adapters, resistors, and sensor modules like the Node MCU V3, the DHT11, and the MQ-135.

Technology: ThinkSpeak Cloud and the Arduino Software Development Kit.

Node MCU V3: The Node MCU V3 development board runs on open-source software and is based on the ESP8266. The built-in USB connector simplifies the process of creating and debugging IoT apps. It contains GPIO (general-purpose input/output) pins for easy connection to various gadgets and sensors..

DHT11 Sensor Module: The DHT11 is a digitally output voltage-based temperature and humidity sensor. A thermistor and a capacitive humidity sensor are used to examine the surrounding air. The Vcc pin must be connected to 5V DC and ground (GND), as shown in Fig. 2. It is easier to interpret the sensor's output voltage when using the Data pin in digital mode. Comparing Dry and Wet Conditions The humidity sensing capacitor is shown in Figure 2; it comprises of two electrodes and a dielectric substrate that may trap moisture between them. Humidity has an effect on the value of capacitance. The IC tracks the resistance and translates the data into a digital format as it fluctuates. A thermistor with a negative temperature coefficient is used to measure temperatures using the DHT11 sensor. The resistance of this thermistor drops as its temperature increases. The sensor's semiconductor ceramics or polymer construction enables it to measure resistance changes across a broad dynamic range.

MQ-135 Gas sensor Module: Ammonia, nitrogen oxides, sulphur dioxide, benzene, smoke, and carbon dioxide are just some of the gases that may be detected by the MQ-135 gas sensor module.

The idea is based on the observation that the resistance changes when the target gas is present. The module's analogue output corresponds to the observed concentration of gas. Among the various applications it has found are in security systems, air quality monitoring, and pollution management.

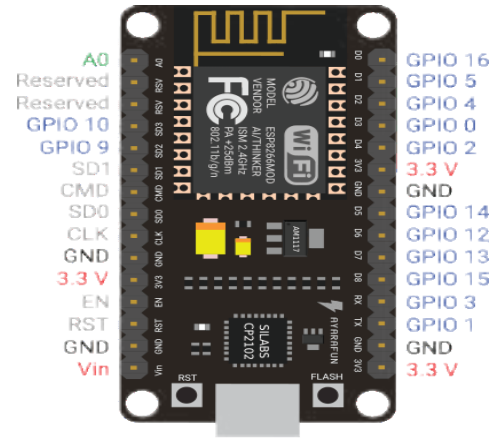


Fig. 2: Node MCU V3



Fig. 3: DHT11 Sensor Module

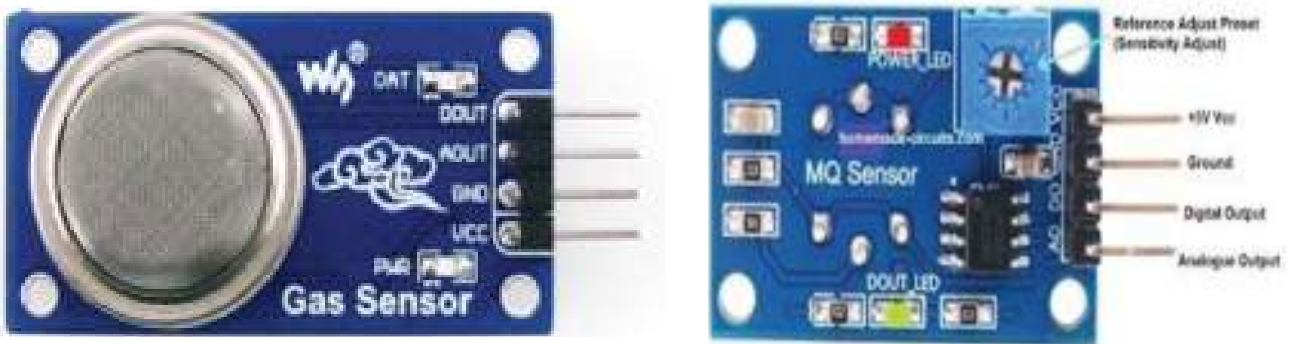


Fig. 4: MQ-135 Gas Sensor Module

Veroboard: Veroboard (KS100) is a kind of PCB used for electrical circuit prototyping. Connections may be made by trimming the copper strips that separate the rows of copper pads. Because of how easily it can be tailored to meet a variety of aesthetic needs, it is often used for quick jobs.

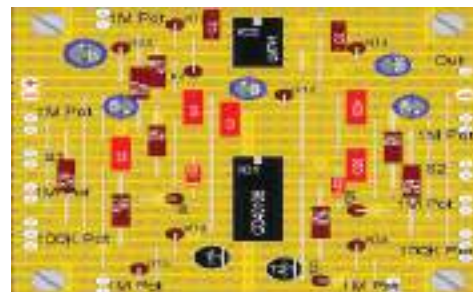


Fig. 5: Veroboard



Fig. 6: Breadboard

Breadboard: A breadboard is a tool used to prototype electrical circuits without solder. The board's slotted shape makes it easy to connect the different electrical pieces by providing a snug fit for the component leads. Breadboards are useful for quick development and testing of circuits since they do not need soldering or other permanent connections.

AC-DC Adapters: A breadboard, a solderless tool, is used to prototype electrical circuits. The electrical components may be connected quickly and easily by simply inserting the component leads into the appropriate holes on the board. Because they don't need solder or other permanent connections, breadboards are ideal for quickly prototyping and testing circuits.



Fig. 8: LED light



Fig. 9: Resistor

LEDs Emitting green, yellow and red colors Green, yellow, and red LEDs are often used as status indicators in electronics, with each colour serving a somewhat different purpose. In many cases, a green light indicates that everything is running well, whereas a yellow light serves as a warning or indicates that there may be a problem. Indicators of electricity and traffic utilise these hues often as visual status indicators.

Resistor: In an electrical circuit, a resistor limits how much current can pass. Its major function is to protect electrical components from being damaged by electrical current. The ohm is a universal unit of resistance measurement. Electrical circuits often use voltage dividers, current limits, and signal conditioners..



Fig. 7: AC-DC Adapters

Arduino IDE: This open-source software may be used to programme the Arduino board. For building and uploading programmers to the board, it provides a user interface. The IDE supports a simplified version of C++ and includes a library of pre-written scripts for commonly performed tasks. A serial monitor is also provided, which may be used to investigate data sent by the board and troubleshoot the code.

Thing Speak Cloud: With the help of the open-source, cost-free application Thing Speak, gadgets may communicate with one another online. Developers used Ruby to construct it. It offers an application programming interface (API) that mobile devices and social networking sites may utilise to access, retrieve, and record data more easily. Thing Speak was made available by io Bridge in 2010 to assist with IoT applications. Customers may analyse and display data by using Thing Speak integrated within MathWorks' C++ without purchasing a separate copy of C++.

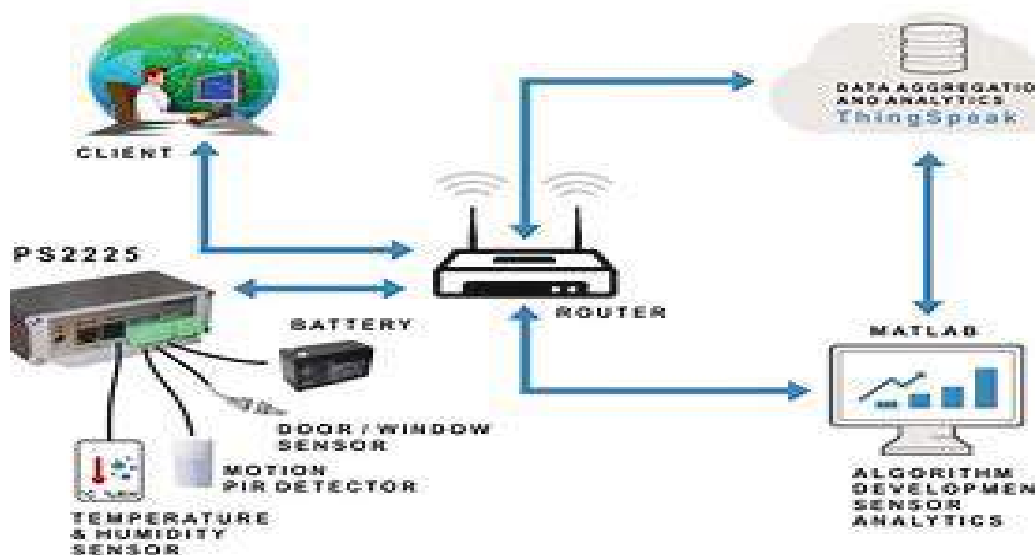


Fig. 9: Thing Speak Cloud

Working Procedure Sensor data is read by the system's central controller, a Node MCU, and then displayed through LEDs. The MQ-135 is a part-per-million air quality sensor, while the DHT11 is a meteorological station. LEDs indicate the current security status and data is sent to the Thing Speak server. After the MQ-135 is calibrated for 24 minutes, the DHT11 is heated for 10 minutes. When the complete working code for the Node MCU is available, the hardware circuit may be constructed from the necessary components.

HARDWARE MODEL

The DHT11 and MQ-135 gas sensor modules are calibrated and warmed up with the help of the hardware model. After powering the Node MCU with 12V DC for 20 minutes, the DHT11 sensor is preheated by connecting its Vcc and Gnd pins to the VU and Gnd pins of the Node MCU, respectively. Connect the MQ-135 gas sensor module's Vcc, Gnd, and analogue DATA wires to Node MCU's VU, GND, and A0 pins, then run Node MCU on 12V DC for a day to bring it up to temperature and calibrate it. Both modules have their Vcc pins connected to the 5V adaptor on the Veroboard, and their LED indication cathodes connected to the Node MCU's D2, D3, and D4 pins, as well as the MQ-135's analogue DATA line's A0 pin, the DHT11's DATA pin, and the Node MCU's Gnd pin. An AC-DC converter supplies the required 9V DC, and the Node MCU is pre-loaded with the necessary instructions..

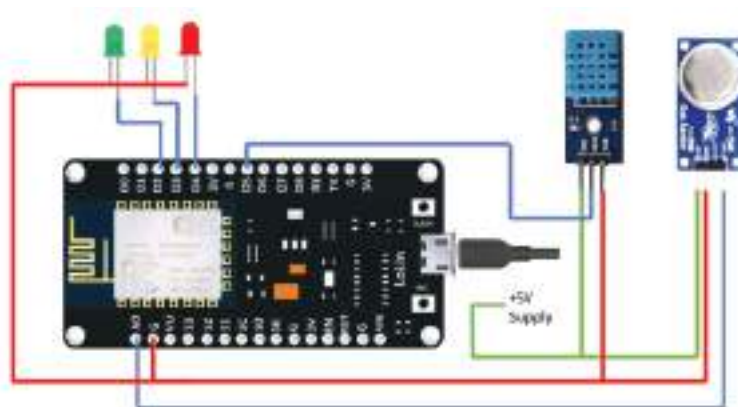


Fig. 10 : Hardware Model

SOFTWARE IMPLEMENTATION

Algorithms

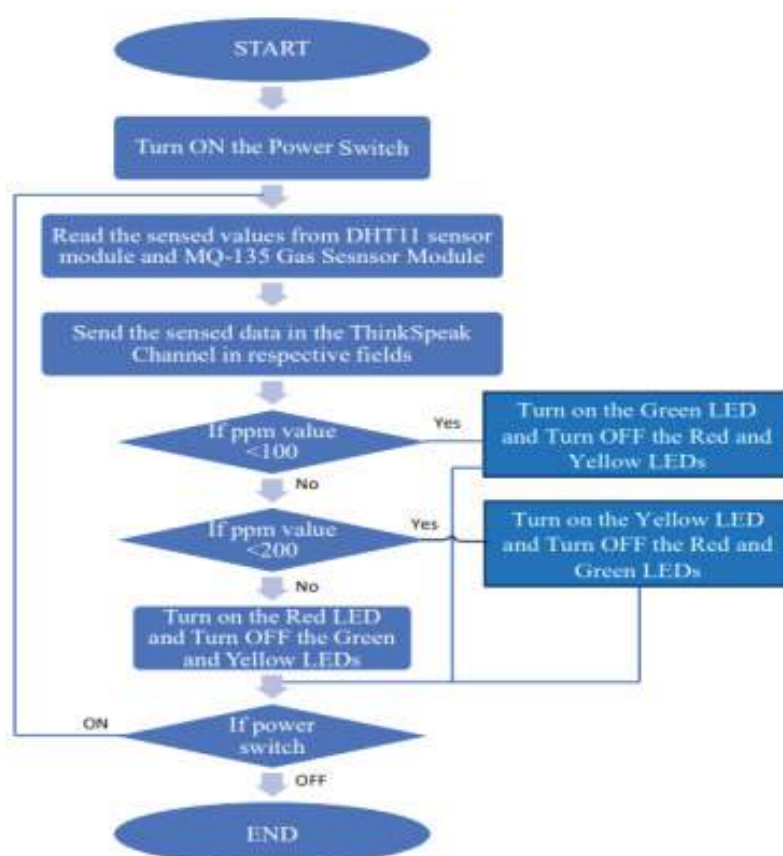


Fig. 11: Flow Chart of Software Implementation

Calibration of MQ-135 Gas Sensor Module Calibration theory states that exposing the sensor to a clean air environment is crucial. Develop a formula to reduce the sensor's voltage reading to microvolts (parts per million). The following conclusion may be drawn from these data points: In theory, the most important step is to calibrate the sensor in ambient air. Determine a percentage value (ppm) for the sensor's voltage measurement (parts per million). With these figures, we may learn:

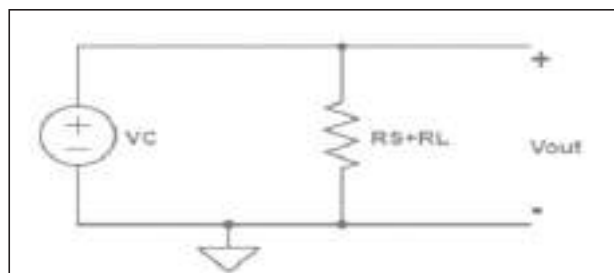


Fig. 12 : Calibration of MQ-135 Gas Sensor Module

From Ohm's Law, at a constant temperature, we can derive I as follows:

$$I = V/R \quad \dots(1)$$

From Fig 11, eqn. 1 is equivalent to

$$I = Vc/RS+RL \quad \dots(2)$$

From Fig 10, we can obtain the output voltage at the load resistor using the value obtained for I and Ohm's Law at a constant temperature

$$V = I \times R.$$

$$VRL = [VC/ (RS + RL)] \times RL \quad \dots(3)$$

$$VRL = [(VC \times RL)/(RS + RL)] \quad \dots(4)$$

So now we solve for RS:

$$VRL \times (RS + RL) = VC \times RL \quad \dots(5)$$

$$(VRL \times RS) + (VRL \times RL) = VC \times RL \quad \dots(6)$$

$$VRL \times RS = (VC \times RL) - (VRL \times RL) \quad \dots(7)$$

$$RS = \{(VC \times RL - (VRL \times RL))\} / VRL \quad \dots(8)$$

$$RS = \{(VC \times RL) / VRL\} - RL \quad \dots(9)$$

Eqn. 9 helps us to find the internal sensor resistance for fresh air.

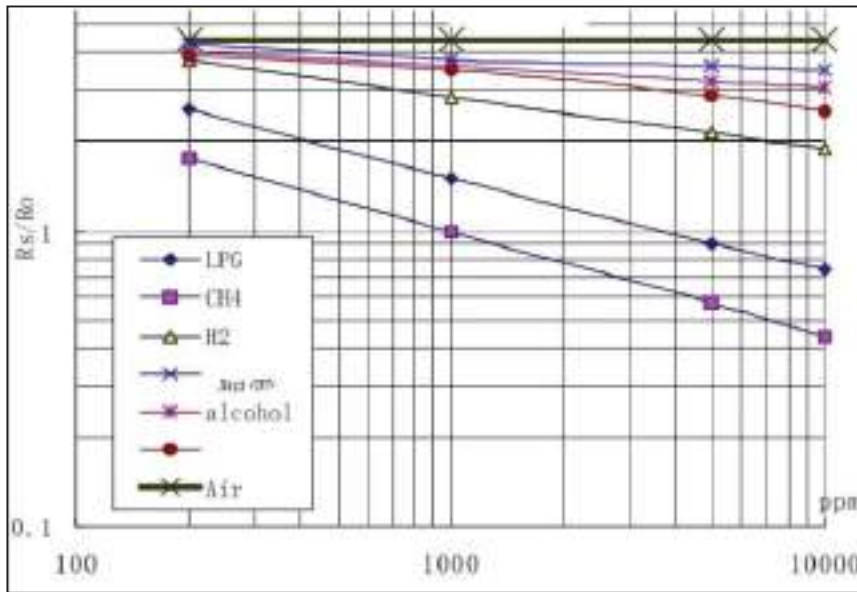


Fig. 11: Graph Representing Ratio vs PPM Variations

From the graph shown in fig 11. we can see that the resistance ratio in fresh air is a constant:

$$RS / R0 = 3.6 \quad \dots(10)$$

Fig. 11 The result of Equation (Eq.) 3.6 is shown in the datasheet. The RS measurement taken in free space is used as a baseline from which R0 is determined. The average analogue reading from the sensor will be converted into a voltage digitally. The RS formula will then be used to determine R0. Assume for the moment that all lines are straight. Because of this linear connection, the formula for both the ratio and the concentration may be combined into a single expression. This allows you to determine the concentration of a gas at any ratio, regardless of whether or not that ratio is shown on the graph. We'll utilise the line equation, but this time using logarithms instead of degrees. Using the data in Figure 11, we attempt to get the following values.

$$y = mx + b \quad \dots(11)$$

For a log-log scale, the formula looks like this:

$$\log_{10}y = m \times \log_{10}x + b \quad \dots(12)$$

Let's find the slope. To do so, we need to choose 2 points from the graph. In our case, we chose the points (200,2.6) and (10000,0.75). The formula to calculate slope m(here) is the following:

$$m = \{\log(y) - \log(y0)\} / \{\log(x) - \log(x0)\} \quad \dots(13)$$

If we apply the logarithmic quotient rule, we get the following:

Now we substitute the values for x, x0, y, and y0:

$$m = \log(0.75/2.6) / \log(10000/200) \quad \dots(14)$$

$$m = -0.318... \quad (15)$$

We can compute the y-intercept now that we know m. In order to achieve this, we must choose one point from the graph (once again from the CO₂ line). As for us, we went with (5000,0.9)

$$\log(y) = m \times \log(x) + b \quad \dots(16)$$

$$b = \log(0.9) - (-0.318) \times \log(5000) \quad \dots(17)$$

$$b = 1.13 \quad \dots(18)$$

Now that we have m and b, we can find the gas concentration for any ratio with the following formula:

$$\log(x) = \{\log(y) - b\} / m \quad \dots(19)$$

However, in order to get the real value of the gas concentration according to the log-log plot we need to find the inverse log of x:

$$x = 10^{\{\log(y) - b\} / m} \quad \dots(20)$$

We will be able to convert the sensor output numbers into PPM using equations 9 and 20. (Parts per Million). Now, we created the code and properly connected the Node MCU after flashing it.

SOFTWARE CODE FOR CALIBRATION OF MQ135 SENSOR

```
#include <iostream>

using namespace std;

void setup() {
  Serial.begin(9600);
  pinMode(A0, INPUT);
}

void loop() {
  float sensor_volt;
  float RS_air;
  float R0;
  float sensorValue = 0.0;
  Serial.print("Sensor Reading = ");
  Serial.println(analogRead(A0));

  for (int x = 0; x < 500; x++) {
    sensorValue = sensorValue + analogRead(A0);
  }

  sensorValue = sensorValue / 500.0;
  sensor_volt = sensorValue * (5.0 / 1023.0);
  RS_air = ((5.0 * 1.0) / sensor_volt) - 1.0;
  R0 = RS_air / 3.7;

  Serial.print("R0 = ");
  Serial.println(R0);
  delay(1000);
}
```

```

#include <ESP8266WiFi.h>
#include <DHT.h>
#include <ThingSpeak.h>

DHT dht(D5, DHT11);
#define LED_GREEN D2
#define LED_YELLOW D3
#define LED_RED D4
#define MQ_135 A0

int ppm=0;
float m = -0.3376;
float b = 0.7165;
float R0 = 3.12;

WiFiClient client;
long myChannelNumber = 123456;
const char myWriteAPIKey[] = "API_Key";

void setup() {
  Serial.begin(9600);
  pinMode(LED_GREEN,OUTPUT);
  pinMode(LED_YELLOW,OUTPUT);
  pinMode(LED_RED,OUTPUT);
  pinMode(MQ_135, INPUT);

  WiFi.begin("WiFi_Name", "WiFi_Password");
  while(WiFi.status() != WL_CONNECTED) {
    delay(200);
    Serial.print(".");
  }
  Serial.println();
  Serial.println("NodeMCU is connected!");
  Serial.println(WiFi.localIP());

  dht.begin();
  ThingSpeak.begin(client);
}

```

```

void loop() {
  float sensor_volt;
  float RS_gas;
  float ratio;
  int sensorValue;
  float h;
  float t;
  float ppm_log;
  float ppm;

  h = dht.readHumidity();
  delay(4000);
  t = dht.readTemperature();
  delay(4000);
  sensorValue = analogRead(gas_sensor);
  sensor_volt = sensorValue*(5.0/1023.0);
  RS_gas = ((5.0*1.0)/sensor_volt)-1.0;
  ratio = RS_gas/R0;
  ppm_log = (log10(ratio)-b)/m;
  ppm = pow(10, ppm_log);

  Serial.println("Temperature: " + (String) t);
  Serial.println("Humidity: " + (String) h);
  Serial.println("Our desired PPM = " + (String) ppm);

  ThingSpeak.writeField(myChannelNumber, 1, t, myWriteAPIKey);
  delay(20000);
  ThingSpeak.writeField(myChannelNumber, 2, h, myWriteAPIKey);
  delay(20000);
  ThingSpeak.writeField(myChannelNumber, 3, ppm, myWriteAPIKey);
  delay(20000);
}

```



```

if(ppm<=100) {
digitalWrite(LED_GREEN,HIGH);
digitalWrite(LED_YELLOW,LOW);
digitalWrite(LED_RED,LOW);
}
else if(ppm<=200) {
digitalWrite(LED_GREEN,LOW);
digitalWrite(LED_YELLOW,HIGH);
digitalWrite(LED_RED,LOW);
}
else {
digitalWrite(LED_GREEN,LOW);
digitalWrite(LED_YELLOW,LOW);
digitalWrite(LED_RED,HIGH);
}
delay(2000);
}
    
```

RESULTS

The MQ135 sensor measures temperature, humidity, and air quality for the project. When the data was compared to that from a mobile weather app, it was found to be inaccurate by a total of 0.06 degrees, 2.0 percent, and 0.03 ppm for temperature, humidity, and air quality, respectively. The system's accurate readings of ambient temperature and humidity provide evidence of this.

Table 1: Representing MQ135 Sensor to Detect the Temperature, Humidity and Air Quality

Expt. No.	Temperature (in celsius)			Humidity (in %)			Air Quality (in ppm)		
	Project Reading	App Reading	Error	Project Reading	App Reading	Error	Project Reading	App Reading	Error
1	31.2	33	1.2	70	65	5	8.61	8.5	0.11
2	33.3	32	1.3	70	65	5	42.25	42	0.25
3	33.8	32	1.8	74	70	4	52.3	53	-0.7
4	34.2	33	1.2	74	69	5	4.26	4.34	-0.08
5	22.6	22	0.6	59	57	2	0.67	0.7	-0.03

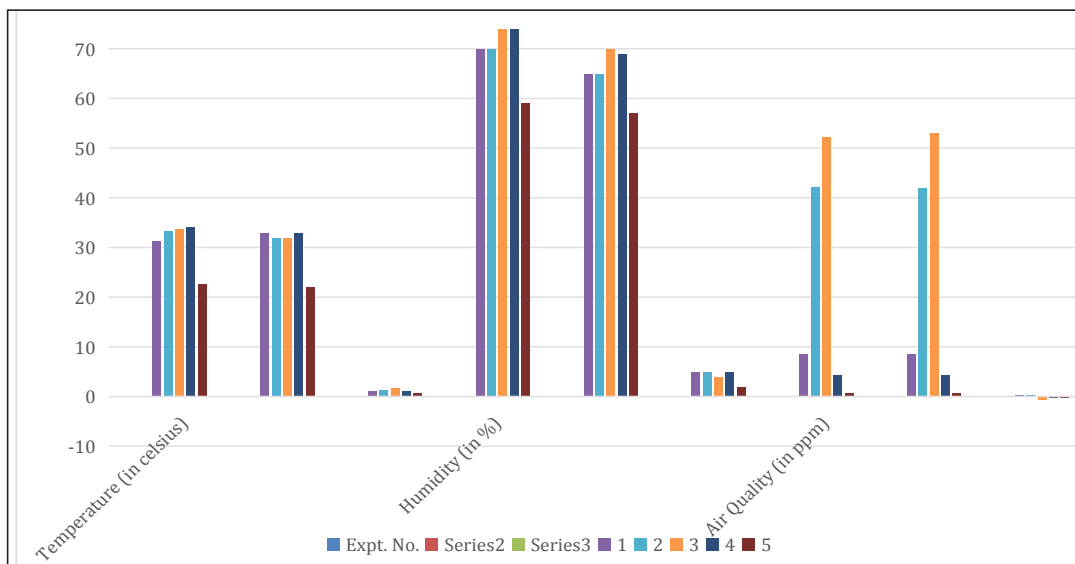


Fig. 12: Representing MQ135 Sensor to Detect the Temperature, Humidity and Air Quality

CONCLUSION

The current temperature, humidity, and Air Quality Index are just some of the metrics that this IoT gadget monitors and displays (AQI). The system uses a MQ135 sensor to detect and measure airborne pollutants such as smoke, CO, CO₂, NH₄, and others in parts per million (ppm). The instrument provides very accurate readings of both temperature and relative humidity (in Celsius). LED lights on the gadget display the air quality around the setup, with Google data providing further confirmation. By including gas sensors for various pollutants, the system would be able to track the ppm concentrations of each pollutant separately. The sensor does a great job monitoring the local environment for things like temperature, humidity, and air quality, but it needs a constant internet connection to upload its findings to the Thing Speak cloud. In sum, the system offers a reliable and low-cost means of monitoring environmental factors including temperature, humidity, and air quality.

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IoT Based Smart Agriculture Solution

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▶ ABSTRACT ◀

This paper aims to create an agriculture monitoring system that provides farmers with real-time data on their crops and the environment they grow in. The system uses a range of sensors to collect data on various parameters such as temperature, humidity, soil moisture, nutrient levels, fire alarms, and plant diseases. The data is processed using an API that generates suggestions for the farmers based on the collected data. The suggestions may include which crops are best suited for the current conditions, whether the soil needs more water or nutrients, when and where to apply pesticides or fertilizers, and whether there are any potential risks to the crops due to fire or disease. The data is also displayed in real-time on an app that can be accessed by the farmers at any time. The system has many benefits for agriculture, providing farmers with valuable data to help them make informed decisions and take action when necessary.

Keyword: *Transmitters, Real Time, Systems Sensors, Hardware, Monitoring, Receivers.*

INTRODUCTION

Agriculture is the backbone of many economies worldwide, providing a significant source of income and sustenance for countless communities. However, it is also a highly unpredictable and challenging industry, with farmers having to constantly contend with a range of environmental factors, such as weather patterns, pests, and diseases, that can significantly impact their crop yields and quality. To mitigate these challenges, many farmers have turned to technology, with the development of agriculture monitoring systems being one such example [1].

An agriculture monitoring system is a technology-driven approach to agriculture that aims to provide farmers with real-time data on their crops and the environment in which they grow. These systems typically utilize a range of sensors to measure parameters such as temperature, humidity, soil moisture, nutrient levels, fire alarms, and plant diseases, among others. The data collected by these sensors is then processed using an API, which generates suggestions and recommendations for farmers based on the collected data. These suggestions can include advice on which crops are best suited for the current conditions, whether the soil needs more water or nutrients, when and where to apply pesticides or fertilizers, and whether there are any potential risks to the crops due to fire or disease[5].

The real-time data display on an app that can be accessed by the farmers at any time, making it easier for them to make informed decisions quickly, potentially minimizing the risk of crop losses due to adverse weather conditions, pests, and diseases. This paper aims to explore the various components required to develop an effective agriculture monitoring system, from identifying appropriate sensors to developing the API and app. By doing so, we hope to contribute to the ongoing efforts to revolutionize the agriculture industry and provide farmers with the tools they need to succeed in an increasingly challenging environment[2].

RELATED WORK

Several studies have been conducted on the use of IoT technology in Agriculture. One such study by J. Herrera et al. (2019): This paper describes the design and development of an agriculture monitoring system that utilizes a combination of sensors and machine learning algorithms to optimize crop growth. The system measures parameters such as temperature, humidity, and soil moisture, and uses this data to predict crop growth patterns and make recommendations for farmers.

"Smart farming: agriculture monitoring system" by J. Herrera et al. (2019): <https://doi.org/10.1007/s00521-018-3807-8>

Another study by S. H. Kim et al. (2019): This study proposes an agriculture monitoring system that utilizes an IoT-based approach. The system uses a range of sensors to measure parameters such as temperature, humidity, and soil moisture, and sends this data to a central server for processing. The processed data is then displayed in real-time on an app that can be accessed by farmers.

"Real-time monitoring system for agriculture based on IoT" by S. H. Kim et al. (2019): <https://doi.org/10.3390/s19183890>

"A review of smart agriculture monitoring systems based on IoT technologies" by M. A. Khan et al. (2020): This paper provides a comprehensive review of existing smart agriculture monitoring systems based on IoT technologies. The authors analyze the various components of these systems, such as sensors, data processing algorithms, and data visualization tools, and highlight the challenges and opportunities associated with their implementation.

"A review of smart agriculture monitoring systems based on IoT technologies" by M. A. Khan et al. (2020): <https://doi.org/10.1016/j.compeleceng.2020.106953>

"Design and development of an intelligent irrigation monitoring and control system using IoT" by S. R. Suresh and S. Kumaravel (2021): This study proposes an intelligent irrigation monitoring and control system that utilizes IoT technologies to optimize water usage in agriculture. The system measures parameters such as soil moisture, temperature, and humidity, and uses this data to control the irrigation system automatically.

"Design and development of an intelligent irrigation monitoring and control system using IoT" by S. R. Suresh and SKumaravel(2021): <https://doi.org/10.1016/j.compeleceng.2021.107670>

PROPOSED WORK

The agriculture monitoring system, incorporating various sensors including fire detection, waterflow, humidity and temperature, soil moisture, nutrient, and plant disease detection sensors, was successfully implemented using the ESP32 microcontroller and Arduino IDE. The sensors collected data on key parameters related to crop health, environmental conditions, and potential risks.

The collected sensor data was transmitted to an API hosted on a website. The website's backend processed the incoming data and generated real-time suggestions to aid farmers in making informed decisions. These

suggestions encompassed various aspects such as optimal crop selection, irrigation requirements, fire alarms, fertilizer quantities, pesticide application locations, and the arrival status of irrigation water[3].

The integration of the ESP32 microcontroller, sensors, and API resulted in a seamless flow of data from the field to the website. The website's processing capabilities effectively analyzed the incoming data, allowing for accurate and timely suggestions to be provided to farmers. The data was also visually displayed on an accompanying mobile application in real-time, enabling farmers to monitor their fields remotely.

During the testing phase, the system demonstrated reliable performance and responsiveness. The fire detection sensor promptly detected potential fire hazards and triggered appropriate alarms, helping to mitigate the risk of crop loss due to fire incidents. The waterflow sensor accurately determined whether irrigation water had arrived, providing farmers with crucial information for efficient irrigation management[4].

The humidity and temperature sensor effectively monitored environmental conditions, aiding farmers in adjusting growing practices as per crop requirements. The soil moisture sensor provided accurate and timely information on soil moisture levels, enabling farmers to optimize irrigation schedules and avoid overwatering or under watering.

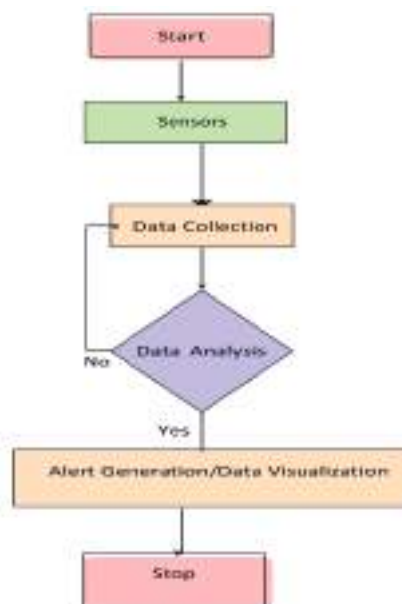
The nutrient sensor successfully measured nutrient levels in the soil, allowing farmers to tailor their fertilization practices accordingly. The plant disease detection sensor accurately identified signs of diseases, enabling early detection and prompt action to mitigate the spread and impact of plant diseases.

The system's API and website effectively processed the collected sensor data, generating relevant and actionable suggestions for farmers. The suggestions were based on the data analysis and predefined rules, assisting farmers in making informed decisions regarding crop selection, irrigation, fertilizer application, pesticide usage, and overall field management[7].

In conclusion, the implementation of the agriculture monitoring system, utilizing the ESP32 microcontroller and Arduino IDE, successfully integrated various sensors to collect data and transmit it to a website-based API. The system demonstrated reliable performance in terms of accurately detecting potential fire hazards, monitoring environmental conditions, soil moisture levels, nutrient levels, and detecting plant diseases. The generated suggestions and real-time data display on the mobile application provided valuable information for farmers to optimize crop production, resource utilization, and risk mitigation[6].

Further research and development in this field could focus on enhancing the system's capabilities by incorporating additional sensors, refining the data processing algorithms, and expanding the range of suggestions provided to farmers[8].

Flow Chart



RESULT

Agriculture monitoring system can provide farmers with real-time data and insights that help them make informed decisions about their crops, leading to increased yields and improved crop quality. With the use of sensors to measure parameters such as temperature, humidity, soil moisture, and nutrient levels, the system can generate recommendations and suggestions for farmers on crop management practices, such as irrigation, fertilization, and pest management. This can lead to more efficient use of resources, such as water and fertilizers, reducing waste and potentially increasing profits[10].

Moreover, agriculture monitoring systems can also help identify potential risks to crops, such as pests, diseases, and extreme weather events, enabling farmers to take proactive measures to mitigate them. The system can provide real-time alerts and notifications to farmers in case of potential risks, allowing them to respond quickly and minimize the impact on their crops[11].

Additionally, agriculture monitoring systems can provide valuable data for research purposes, enabling researchers to gain insights into crop growth patterns and environmental factors affecting crop yields. This data can be used to develop more effective crop management strategies, potentially leading to improved agricultural practices and increased food production[9].

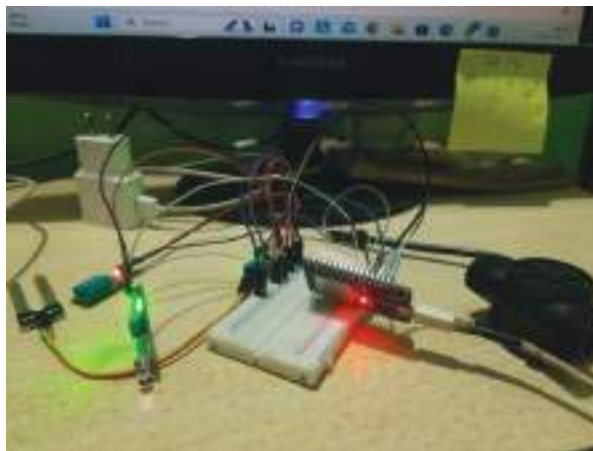


Fig. 1: System Architecture



Fig. 2: Real Time Dashboard

CONCLUSION

In conclusion, the implementation of an agriculture monitoring system utilizing sensors, a microcontroller (ESP32), an API, and a website has shown promising results for enhancing farming practices. The integration of fire detection, waterflow, humidity and temperature sensing, soil moisture sensing, nutrient sensing, and plant disease detection sensors provides comprehensive and real-time data on crucial aspects of crop cultivation[12]. The use of the ESP32 microcontroller enables seamless communication between the sensors and the API, facilitating the collection and transmission of data. The website, powered by the API, processes the data and generates valuable suggestions for farmers to optimize their agricultural practices. These suggestions include

guidance on crop selection for optimal results, soil moisture management, fire alarm alerts, fertilizer requirements, pesticide application recommendations, and irrigation water status.

Moreover, the real-time display of data on the accompanying app empowers farmers with immediate access to critical information, allowing them to make timely decisions and take necessary actions to ensure crop health and productivity.

The feasibility of this system has been established through its technical viability, affordability, and ease of operation. The sensors and microcontroller technology are readily available and can be implemented on a wide scale. The cost-effectiveness of the system makes it accessible to farmers of varying scales and economic backgrounds. The operational simplicity and user-friendly interface enable efficient utilization even by farmers with limited technical expertise.

The benefits of this agriculture monitoring system extend beyond individual farmers. By promoting precision agriculture, it contributes to resource optimization, reducing water usage, fertilizers, and pesticides, thus supporting sustainable farming practices. Furthermore, the system aids in mitigating risks associated with fire outbreaks, diseases, and suboptimal environmental conditions, thereby enhancing overall crop resilience and farm profitability.

Future research in this field should focus on refining the algorithms used by the API to provide more accurate and customized recommendations. Additionally, further integration of emerging technologies such as machine learning and remote sensing could enhance the system's capabilities, enabling more precise and automated decision-making processes.

Overall, the agriculture monitoring system presented in this research paper showcases its potential to revolutionize farming practices by leveraging sensor technology, data processing, and mobile applications. By empowering farmers with timely information and actionable insights, it holds promise for increased productivity, reduced environmental impact, and improved livelihoods in the agricultural sector.

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▶ ABSTRACT ◀

The increasing demand for energy due to rapid economic development and growth has led to a need for sustainable energy production. Solar energy has become a popular alternative, but the large space requirements for solar panels have hindered practical usage. Transparent solar cells (TSCs) have been developed to address that any piece of glass can be made into a photovoltaic solar cell, solving the problem. This makes it possible to utilize architectural space effectively. by using unused light energy coming from windows in cars and buildings. There are currently nine transparent photovoltaic (TPV) technologies under development, aiming for high transparency and electrical performance suitable for solar panels available on the market. This review paper aims to provide an overview of the latest developments in TSCs since 2007, including the materials and methods used in each technology, as well as their advantages and disadvantages from a performance, aesthetic, and financial perspective. Building integrated photovoltaics (BIPV) have also been developed, which integrate transparent solar cells with existing window panes. While These cells absorb all infrared and ultraviolet rays while allowing visible photons to flow through, making them a promising technology for sustainable energy production.

Keywords: — Solar energy, Transparent solar cells, Photovoltaic (PV), Building integrated photovoltaics (BIPV), Electricity, alternative energy sources.

INTRODUCTION

Solar energy has become an important focus for researchers. Because it has the potential to be a clean, renewable energy source, solar energy has drawn significant attention from researchers. The most advanced solar energy applications use photovoltaic (PV) technology, which use semiconductor materials to turn sunlight into electricity.

By 2020 and 2030, PV technologies are expected to produce about 345 GW and 1081 GW, respectively. There are over 24 different solar cell technology models available, produced using various techniques and materials. Photovoltaic cells encounter difficulties with cost, effectiveness, and operating lifetime. Monocrystalline PV cells, which are at least 6% more efficient than polycrystalline PV cells but also more expensive, are made of silicon, the first material to demonstrate good efficiency. Now, scientists are concentrating on discovering materials that will overcome these difficulties. Amorphous solar cells are produced using less semiconductor material thanks to thin film PV cells (TFPV), which results in a cost reduction of greater than 50%. Another type of solar cell is the third-generation solar cell, which also makes use of concentrators and organic solar cells like dye- sensitized solar cells (DSSC). One of the crucial factors is the quantity of surface area needed for the solar panel to produce an adequate amount of electrical output. issues that most solar cell applications encounter. Transparent photovoltaic (TPV) cells were developed as a solution to this problem of efficient space utilization. To address this issue, transparent solar cells (TSC) are being studied. TSC technologies are made to permit the transmission of visible light while also permitting the absorption of sunlight. With the incorporation of this technology, windows and other surfaces might serve double duty as an energy source and a source of natural light. Since solar energy has the potential to be a clean, renewable energy source, it is a key area of research for scientists. With numerous solar cell models on the market, PV technologies are at the forefront of solar energy applications. The issue of efficiently using space for solar energy applications is being addressed by research on transparent solar cells (TSC). TSC technology might be applied to windows and other surfaces, giving them the ability to serve as both an energy source and a source of light.

LITERATURE REVIEW

The acronym AFB Braga This research paper focuses on the many technologies used in transparent solar panels, as well as the generation of electricity using transparent solar cells. Bacchin, JMG, and PR Mei This study's procedure entails transforming glass into solar cells.

Thin film deposition and cells are examples of technology. S. Rehman, S.A. Al-Moallem, and M.A. Bader This study also looks at how photons may be used to turn solar cells into a potentially sustainable energy source using the Simple Room Temperature Method and the Ultraviolet Rays Method in this paper. H.W. Lin, M. Der Ger, C.P. Chang, and W.H. Hwu Additionally, this essay analyses the commercial demand for and application of transparent solar panels.

Photovoltaic Cell

Photovoltaic glass (PV glass) is a technique that uses semiconductor- based photovoltaic cells, sometimes referred to as solar cells, placed between two sheets of glass to convert light into electricity. It's not completely transparent, but it does let some light through while making electricity. By producing their own power via their windows, buildings that make extensive use of PV glass can lower their energy expenditures and carbon footprints. Variations in PV glass products, including slitted solar glass and glass with varied color s, gradients, patterns, and double or triple-glazed alternatives, have been developed by companies like Sharp and Onyx Solar, offering a variety of architectural design options. The PV cell operates on a similar concept as a semiconducting diode. When light is absorbed by the semiconductor material, electrons and holes are displaced, forming pairs that produce a current.

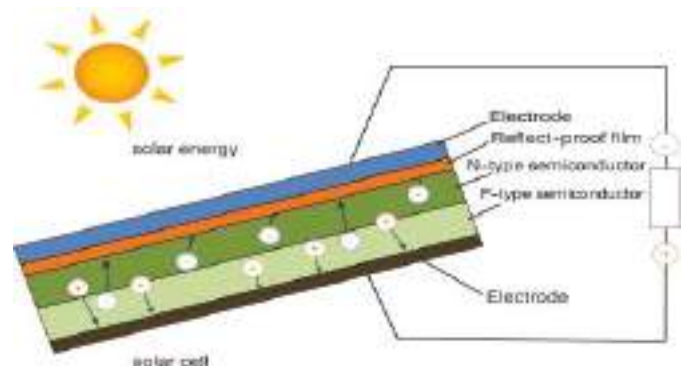


Fig. 1: Photovoltaic Cell

Solar Cell

Dye-sensitized solar cells (DSSC) are a promising energy-generating device due to their convenience of fabrication, low cost, and high power-to-conversion efficiency. The main components of DSSC include a semiconductor film made of titanium dioxide, zinc oxide, tin dioxide, or niobium pentoxide, a dye-sensitized transparent conducting substrate, electrolyte, and counter electrode. The mesoporous oxide, which contains TiO₂ nanoparticles providing a path for electrons to travel from the cathode to the anode, is the brain of the DSSC. The film is about 10 m thick, the particles' diameters range from 10 to 30 nm, and it is doped with a dye to increase absorption of photons. The substrate of a thin film panel is often standard glass, while the superstrate Low reflection, high transmissivity, and high strength are requirements for cover glass. The usual thickness of solar glass is 3.2 mm, which has a rough surface to ensure adherence to the EVA during the lamination process. Solar glass has a direct impact on how much solar radiation is transmitted, hence solar panel manufacture normally uses glass with low iron oxide levels to assure good solar energy transmission. Tempered glass, which is used to make solar panels, stronger and considered safety glass in case it breaks. Tempered glass is four times stronger than standard plate glass and is used to offer long-term defense against the elements. Every essential component of a solar panel needs to be built and placed with the goal of ensuring at least 25 years of electricity generation while withstanding harsh temperatures, dirt, and water particles. In summary, DSSC is a promising energy-generating device due to its low cost, convenience of fabrication, and high power-to-conversion efficiency. The main components of DSSC include a dye-sensitized transparent conducting substrate, semiconductor film, electrolyte, and counter electrode. Solar panels are made of tempered glass developed and installed to endure severe temperatures, filth, and water particles while ensuring a minimum of 25 years of power output, to give long-term protection from the elements.

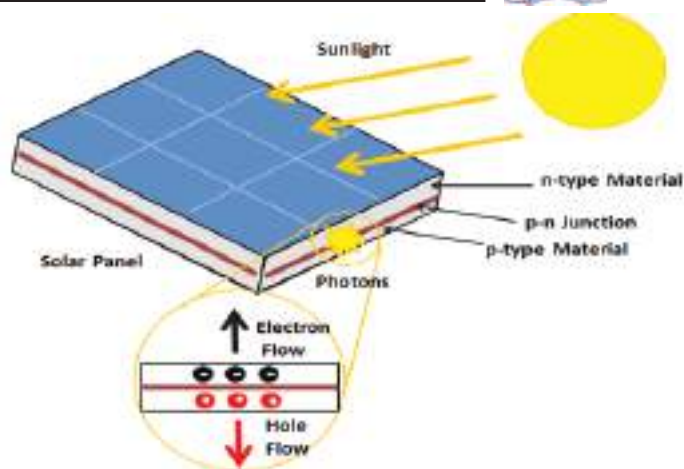


Fig. 2: Solar Cell

Electrolyte & Dye

An electrolyte is a material that conducts electricity and creates ions in a solution. It must have ions that can move freely and it can either be a liquid or a solid. An electrolyte's ions dissociate and become encircled by the solvent molecules when it dissolves in a solvent, such as water. Then, with an electrical charge on them, these ions are free to move about in the solution. Numerous biological processes, such as nerve and muscle activity, fluid balance, and acid-base control, depend on electrolytes. In several industrial operations, like the manufacture of batteries and electroplating, they are also crucial. Common electrolytes include calcium chloride, potassium chloride, and sodium chloride (table salt). Salts, bases, and other electrolytes are also crucial. The term "dye" refers to a colored substance that is used to color paper, textiles, and other things. Selectively absorbing some

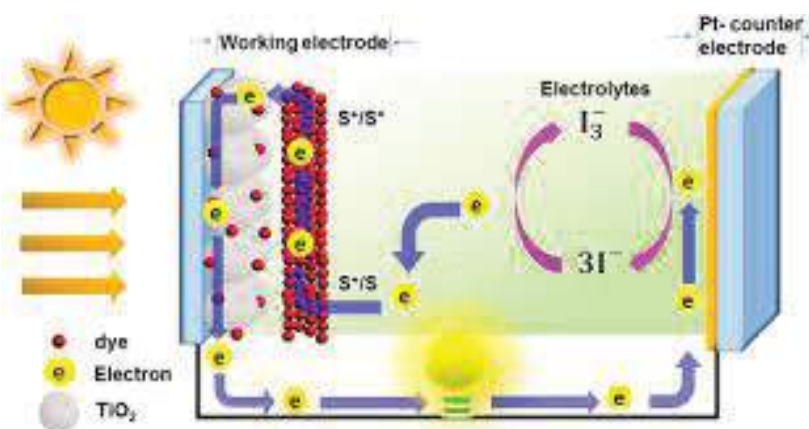


Fig. 3: Dye – Synthesized Solar Cell

Common electrolytes include calcium chloride, potassium chloride, and sodium chloride (table salt). Salts, bases, and other electrolytes are also crucial. The term "dye" refers to a colored substance that is used to color paper, textiles, and other things. Selectively absorbing some

light wave lengths while reflecting others, dyes function. The chemical makeup of a dye's molecules and how they interact with light produce the dye's color. There are many different kinds of dyes, including reactive, synthetic, and natural dyes. Natural dyes have been used for thousands of years and come from either plant or animal sources. On the other hand, synthetic dyes are created in a lab from chemicals and are frequently more vivid and colorfast than natural dyes. Synthetic dyes, known as re-active dyes, form a chemical bond with the substrate to which they are applied.

Near Infrared Transparent Solar Cells

Solar cells are machines that use light to create electricity. The fact that the majority of solar cells are opaque restricts their employment in situations when both transparency and the conversion of energy are necessary. Solar cells that are both transparent and effective have been the focus of research. 2011 saw the creation of a transparent solar cell by a team of scientists under the direction of Richard Lunt. Instead of merely concentrating on the visible spectrum, the new dye was able to absorb ultraviolet and near-infrared wavelengths as well. This made it possible to develop a heterojunction organic PV (OPV) with a transmission of over 65% that is transparent to visible light. Chlorine aluminum, a molecular organic donor, is present in the OPV.

Polymer Solar Cell

A flexible PV solar cell known as a polymer solar cell uses the photovoltaic effect to generate an electric current from sunlight. Large compounds called polymers have enduring structural constituents. A schematic of a polymer-based solar cell is shown. The commonly available solar cells are made from polished and pure silicon crystals, which are also used to build the chips for computers and integrated circuits. Due to the uneconomical nature of alternative technologies and their complicated manufacturing process, interest in alternative means of production has increased. Because they are lightweight, such solar cells can be used in autonomous sensors.

Comparisons Between Different TPV Based on Process

Thermophotovoltaics (TPV) is a technique that uses photons to change heat into electricity. Based on their process—i.e., how they produce the heat that is transformed into electricity—different TPV systems can be grouped. Here are some comparisons of various TPV systems based on how they operate:

Table 1: Comparison Between Different TPV

Combustion-based TPV	Electrically-heated TPV	Solar TPV	Radioisotope TVP
In this system, fuel is burned to produce heat. The heat is then used to create photons, which are then absorbed by a photovoltaic (PV) cell to produce electricity. High temperatures can be operated at by combustion-based TPV systems, which can result in high efficiency. They do, however, need a constant fuel source, and the combustion process can produce pollutants	In this system, a resistive heating element is utilized to produce heat, which is then used to create photons, which are then absorbed by a PV cell to produce electricity. Although they require a constant supply of electricity, electrically heated TPV systems can operate at lower temperatures than combustion-based systems.	In this system, light from the sun is focused onto a TPV system to produce heat. This heat is then used to make photons, which are then absorbed by PV cell to produce electricity. Solar TPV systems don't need a constant supply of fuel or energy and may function at relatively low temperatures. However, they need direct sunlight and might perform worse in dim lightning	In the radioisotope TPV system, heat produced by the radioactive material's decay is used to create photons, which are then absorbed by a PV cell to produce electricity. Although radioisotope TPV systems can function for many years without requiring re-fueling or maintenance, they are still constrained by the scarcity of radioactive materials and the associated safety issues

Advantages and disadvantages of Transparent solar cell

Table 2: Advantages and Disadvantages of TSC

Advantages	Disadvantages
<p>They don't hinder views or natural lighting when incorporated into building facades, windows, and skylights.</p> <p>They can produce electricity in places where conventional solar panels cannot be placed owing to aesthetic or space restrictions.</p> <p>By reducing the amount of electricity required to run lighting and cooling systems, they can aid in lowering energy usage.</p> <p>Because they are shielded by the glass or plastic layer, they can endure longer than conventional solar panels.</p>	<p>They produce less electricity for a given surface area than conventional opaque solar panels because they have a lower energy conversion efficiency.</p> <p>Due to the specialized materials and procedures necessary to make them transparent, they are typically more expensive to create than conventional solar panels.</p> <p>They might not function as effectively in hot areas since the translucent layer may become less efficient from the heat.</p> <p>Because the glass or plastic covering is so delicate, they are more likely to crack or sustain other types of damage</p>

TYPES OF TRANSPARENT SOLAR PANELS

Thin-Film Transparent Solar Panels :- These are constructed of thin, transparent solar panels. Although flexible or stiff, thin-film TPVs are notable for their slender shapes.

These translucent solar panels can be deployed as ready-made solar collectors on the target surface and incorporated into the glass structure during the production process.

Plastic Transparent Solar Panels:- We can now create transparent plastic solar panels that are just as effective as glass modules by mixing the correct polymers, photosensitive components, and additives.

Tiny organic fluorescent particles inserted in transparent plastic solar panels capture energy from intangible radiations.

These solar panels will be more environmentally friendly than standard modules since plastic is recyclable.

Organic Transparent Solar Panel :- We can now create transparent plastic solar panels that are just as effective as glass modules by mixing the correct polymers, photosensitive components, and additives.

Tiny organic fluorescent particles inserted in transparent plastic solar panels capture energy from intangible radiations.

These solar panels will be more environmentally friendly than standard modules since plastic is recyclable.

CONCLUSION

Transparent solar panels have long been problematic because they go against the idea of photonic absorption, which is necessary for solar cells to function. While letting visible light to flow through, the translucent luminescent solar concentrator (TLSC), which was developed by researchers, selectively harnesses a portion of the solar spectrum that is invisible to the human eye. The TLSC, which absorbs specific invisible UV and infrared light wavelengths, is composed of organic salts. Then, these unseen wavelengths shine (luminesce), becoming another wavelength, which is then converted into electricity by thin PV solar cell strips. Solar panels that are transparent might be either partially transparent or completely transparent. Solar panels that are partially transparent have an efficiency of 7.2% and can absorb around 60% of the sunlight that hits them. Researchers at Michigan State University have created fully transparent solar panels with an estimated 10% efficiency. While the panel's efficiency is crucial, a less effective solar window Only solar panels will inevitably be offset by the potential size of their deployment if they are integrated into enormous windows in buildings. They should be able to produce transparent solar panels in large quantities with an efficiency of roughly 10%, according to researchers. This non-intrusive technology is particularly cost-effective and can be scaled from handheld consumer devices to commercial and industrial applications.

ACKNOWLEDGEMENT

For transparent solar panels to become a reality, several technological advancements need to be made. One of the main challenges is developing a material that can efficiently convert sunlight into electricity while remaining transparent. Researchers are exploring different materials, such as perovskites and quantum dots, that could potentially achieve this goal. Another challenge is improving the durability and longevity of transparent solar panels. Currently, most solar panels have a lifespan of around 25 years, but transparent panels would need to last much longer since they would also serve as windows or building facades. Finally, there is the issue of cost. Transparent solar panels are still more expensive than traditional opaque panels, so reducing production costs will be crucial for their widespread adoption. Despite these challenges, the potential benefits of transparent solar panels are significant. They could revolutionize building design by turning windows and facades into energy-generating surfaces, reducing our reliance on fossil fuels, and lowering carbon emissions.

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Performance Analysis of Internet of Things Enabled WSN for Agriculture

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▶ ABSTRACT ◀

An increasing number of sensors and other intelligent devices are making the Internet of Things (IoT) a topic of interest in the abstract for the simplicity with which information and communication may be obtained. In the Internet of Things, wireless sensor networks play a pivotal role due to their low power consumption and high capacity for data exchange among its many nodes. This is why the main focus of agricultural precision systems is the development of novel methods for agricultural monitoring and actuation that are more effective, affordable, and reliable. To do this, it makes use of several different technologies, including wireless sensor networks, sensor devices, the Internet of Things, and data analysis. The proposed study integrates a wide range of technologies to prototype a precision agriculture system for medium and small agricultural plants, with an emphasis on two main benefits: efficient energy management with self-charging capabilities, and a low-cost strategy. A sensor network composed of many nodes is built and integrated into an autonomous system that is linked to the cloud. Forecasting, sensor management, and decision-making may all benefit greatly from smart data processing and analysis, which is why it is so important. Using wireless sensor networks and the Internet of Things, the suggested system monitors soil moisture, humidity, and temperature in the impacted areas and relays that information back to the user.

Keywords: *Internet of Things, Power Consumptions, Precision Agriculture, Energy Management, Wireless Sensor Networks.*

INTRODUCTION

Precision agriculture has inspired numerous ideas, including the use of cutting-edge technology to construct more robust and efficient foundations upon which agricultural businesses might be operated. Nowadays, a lot of gear has fancy sensors built in, so you can talk to it and engage with it right away. Massive amounts of data may be gathered and analyzed using surprisingly simple and inexpensive hardware with the aid of these technologies and infrastructures. The Internet of Things aims to connect these devices so that they may be utilized in novel ways to accomplish extraordinary feats. The Internet of Things (IoT) idea, when applied to already existing technology, allows for a wide range of applications in the field of agricultural monitoring. Wireless sensor networks (WSNs), broad node-to-node communication, constant monitoring of the environment, effective use of energy and water in building an autonomous system, and limiting the cost of the system all fall under this category.

Figure The WSN's design and construction are shown in great detail in Figure 1. The sensor node incorporates connectivity and processing power. During the linking process, a short-range wireless network may be set up as a multi-hop network. Wireless sensor networks are used in precision agriculture to monitor crop growth, learn more about the agricultural environment, and advance the state of the art. Further, WSNs are low-cost, simple to set up, and power-efficient. It continues to function to a high quality for a long time and is versatile enough to accommodate different farming methods. There is potential for the development of a wide range of data acquisition algorithms that share aspects with modern agriculture, allowing for the continuous expansion of precision agricultural operations and substantially reducing the time spent on data collecting. Outside of its basic function of improving precision agriculture and increasing agricultural production, the WSN has numerous other applications in agriculture, as shown in Figure 2. Soil nutrient data might be used to make predictions about crop health and the quality of agricultural output. Monitoring weather conditions (including temperature and humidity) and soil moisture levels may also help with future irrigation scheduling.[5]

Recent WSN studies have targeted agriculture intending to improve upon established farming practices. The miniaturization and decreasing cost of MEMS technology has made previously inaccessible sensors practical. Due to their scalability, compact nodes, and inherent benefits of self-organization, WSNs are a great alternative for automating agricultural procedures. The development of WSN-based applications for smart agriculture has considerable obstacles due to the limitations of WSNs in processing power, memory, and battery life. Using wireless sensor network (WSN) based agricultural solutions shouldn't need consumers to take on more debt. In multi-hop WSNs, energy usage might differ across nodes. The fraction of nodes transferring packets to those near the base station is much greater in regions where the nodes are situated due to the nodes' role as routers. The greater packet throughput requires more power at the node level. Because of its powerlessness, the node can no longer communicate with the rest of the network. When a node is eliminated, all of the other nodes that were relaying for it are also shut off. Because of these energy-saving measures, the WSN application continues to operate under these conditions. Finding the root reasons for growing energy consumption is a prerequisite for developing effective remedies.[2]

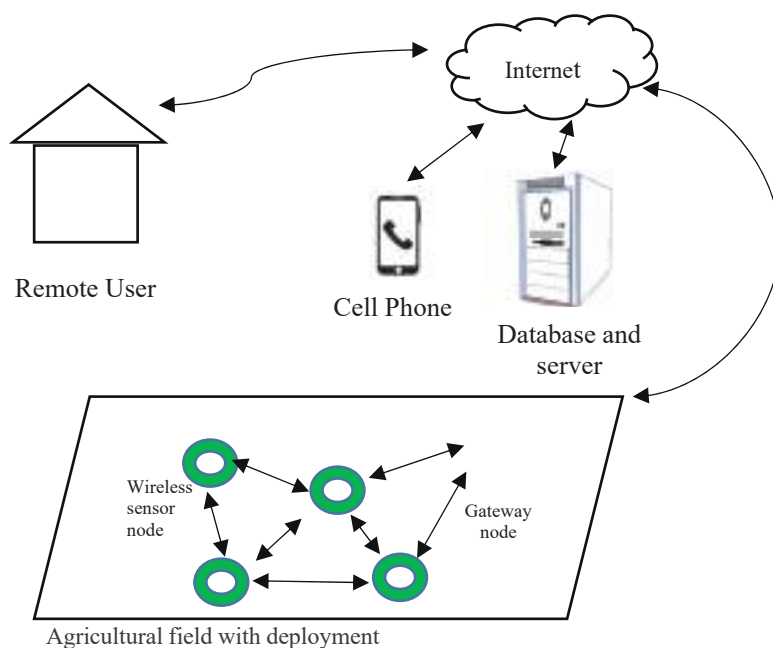


Fig. 1: Prototype of a smart farm [7]

The capabilities of wireless sensor networks and their integration into industrial workflows are complementary. Flexible deployment, a wide range, cheap cost, high stability, mobile support, and other qualities are largely determined by how a wireless sensor network is built to compensate for the drawbacks of the conventional cable system [6]. By fusing the roles of farming and vacationing, "leisure agriculture" has emerged as a novel transdisciplinary field. Today, leisure agriculture occurs in the shape of farmhouses and ecological gardens. Tourists may take in the sights and sounds of the area, but they can also engage with it firsthand, providing them with mental and physical relaxation. With WSN's multiple dedicated sensor nodes' sensing and computing capabilities, real-time fine sensing of the monitoring object's physical parameters, and multihop relay mode to send data to the data center for researchers to apply, crop growth information sensing has its own set of technical advantages in the context of a single person, multi-parameter, fine-grained farmland environment. The bigger the network (the more nodes), the more accurate the aggregate data, which may reduce the requirements for the accuracy of a single node; nevertheless, the deployment of a large number of nodes also raises concerns about the security and reliability of the network as a whole [7]. An enhancement in the system network's ability to withstand disruptions is achieved. Secondly, the network may be self-organized, which lowers line cost and is versatile compared with wired networks. Finally, data-centric WSNs may provide multi-level and multi-faceted access to data due to the dynamic nature of the flexible network. These benefits explain why WSNs are increasingly being employed for data gathering across a broad variety of monitoring domains, from hydrology and industry to the military and the smart home, and why they hold great promise for the intelligent capture of data needed for precision agriculture.[1]

Intelligent Farming IoT Applications

Smarter and more intelligent production, household life, public transportation, and city planning have all been made possible by IOTs. Precision agriculture, also known as smart farming, has emerged as a result of the increased use of IoT devices in the agricultural sector. It's also possible to do this. Industry, the home, transportation, and city planning are just a few of the areas that have benefited from IOTs' widespread use. Precision agriculture, also known as smart farming, was developed as a result of the broad use of IoT devices in the agricultural sector. There's also this alternative.[2]

1. IOT crop management The Crop Management System monitors fields for things like weed development, pest infestations, soil moisture, and diseases that affect the leaf tissue. The demands of crops may now be properly identified and predicted by farmers. These farms are a showcase of several environmental parameters, such as soil type, climate, temperature, and humidity. Assessing and keeping tabs on crop conditions is referred to as "crop surveillance." Using sensors and RFID chips connected to the Internet of Things, we can determine the health of a plant or a plant disease. [6].
2. Smart Irrigation System Watering requirements of a plant or field may be determined by using either intelligent irrigation or automated irrigation. Effectively and creatively, it determines how much water each plant in the field needs. The ultimate goal of intelligent irrigation is to equip farmers with a self-sustaining watering system that minimizes their reliance on municipal services and optimizes resource efficiency.

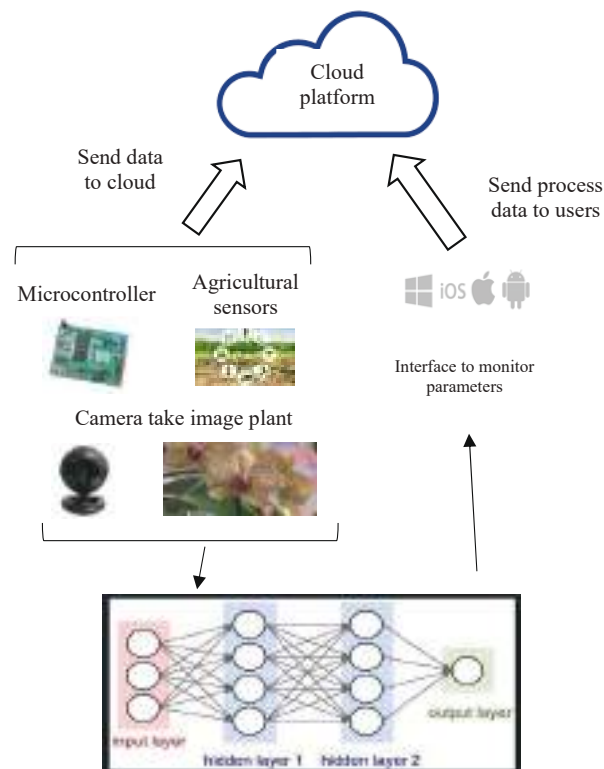


Fig. 2: The Neural Network to Process Images [6]

Maintaining conventional irrigation methods is crucial. This self-sustaining watering system may eventually need less human intervention. Soil moisture, temperature, and other factors are measured using sensors like thermometers and hygrometers to determine when and how much water should be applied.[7]

Goals

1. To create a low-cost smart power auto irrigation system that can be used in irrigation.
2. To develop and implement a system that comprises a variety of sensors to determine the field's real-time state both online and offline.
3. To create a system that uses the least amount of electricity to run a WSN node.[7]

LITERATURE REVIEW

Here, we compare and contrast the perspectives of several writers on the use of a WSN-based Internet of Things for real-world precision agriculture. An area, such as an agricultural field, may be categorized into a plethora of heterogeneous agriculture and farm areas, and Hamouda et al.11 have presented an optimum heterogeneous irrigation system based on a WSN that is deployed for irrigation. The system's current location and the agricultural data it has collected are sent into an extended Kalman filter (EKF). EKF may be used to filter the sensed data, resulting in a filtered reading of the data collected by all wireless sensors; this filtered data can then be sent to the IoT.

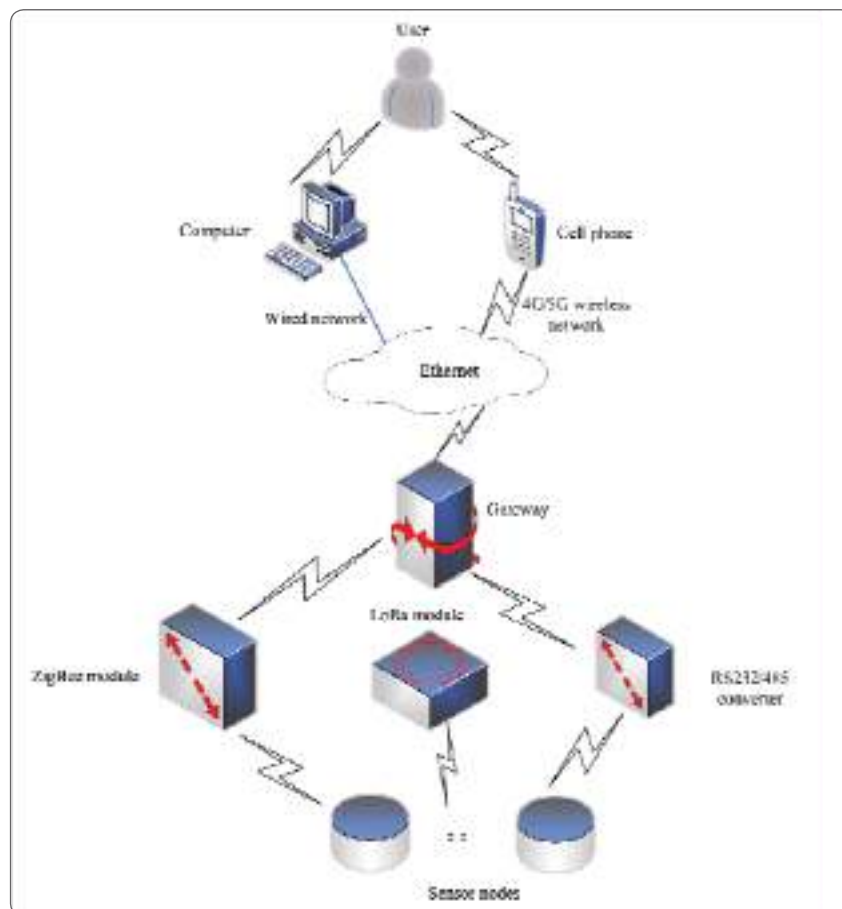


Fig. 3: WSN-based Internet of Things

To maximize productivity while reducing costs, the agricultural sector needs a cloud-based decision-making and support system. Predictions of weather and environmental conditions are made with the help of a decision-

making and supporting system, and related data is saved in the cloud with the help of the Internet of Things.13-23 Using the Internet of Things (IoT), the proposed decision-making and supporting system may access all sensor data collected, resulting in more accurate weather forecasts. Rama Krushna Das et al.²⁴ proposed an Internet of Things (IoT)-based smart agricultural farming system, with the Indian government providing around 73% of the money and the system directly employing the workforce. Many factors contribute to a decline in crop and post-crop output, which in turn generates severe financial hardship for farmers and national and local governments. Precision agricultural technology employing the Internet of Things is presented as a means to lessen the amount of crop output that is lost during harvest. Information gathered by a wireless sensor network is managed with the help of Raspberry Pi technology and a wide range of field sensors.[4]

S. B. Saraf and D. H. Gawali [2] have suggested a technique for data aggregation via the use of a duty cycling algorithm, intending to boost agricultural output through real-time monitoring and management of plant field measurements. Drones may collect data in the field by carrying wireless sensors that detect things like temperature, soil, humidity, and air quality. Drones can also be equipped with surveillance cameras. Every wireless sensor's readings might be gathered at the BS and sent to the access data center. It is possible to reduce power usage under unusual circumstances, such as weather, by using a duty-cycling strategy.[2]

Nikos Petrellis [4] due to a lack of irrigation resources worldwide has developed a precise and efficient water management approach to maximize irrigation availability. Dry conditions may make it hard for plants to breathe, which can cause their leaves to become yellow and eventually fall to the ground in clumps. Plant death is the result of this condition, and the rest of the farm will have the same issue soon enough. To determine the degree of plant thirstiness in PAF, one must focus on and watch the yellowing leaves and sprinkling on the ground utilizing wireless sensor equipment.[4]

Prasad J. P., Mohan S. C. [7] have proposed WSN technology as a means of aiding farmers in addressing the dual problems of excessive and insufficient watering of agricultural fields. For these problems, there is automation technology based on WSNs that aims to improve energy management, efficiency, and latency. The suggested approach is used to optimize irrigation infrastructure throughout the farm, ensuring that all crops are watered by the irrigation system. With the help of GSM cellular technology, the farmer receives updates on agricultural operations in the field of the crop through text messages. To maximize irrigation efficiency in crop management, Joaquin Gutiérrez et al.²⁸ suggest a smart irrigation system. The suggested system incorporates a wireless sensor network (WSN) to monitor conditions at the plant's roots, such as soil, moisture, and temperature. Through the use of cloud computing and big data analysis, information gathered by wireless sensors and activated by actuators will be communicated to a web application. In a 136-day study conducted in a sage crop field, the suggested approach was shown to reduce irrigation needs by 90 percent compared to the status quo of water management in agricultural plants.[7]

Maniyath S.R., Ram H. [10] have established a network model that employs various numerous cloud systems employing different service providers to achieve redundant and economic efficiency in storing agricultural sensor information. To optimize sensor data in real-time on a worldwide scale, the cloud is fed the data through the Internet of Things, and here is where the optimization approach comes into play.[10]

Prakash Kanade, JP Prasad [16] have suggested using a deficit drip irrigation technique to make better use of water supplies. The sensor's data might be sent to the cloud for further analysis depending on the estimated amount of water needed by each plant species in the field. The data is used to provide recommendations for improving irrigation practices across agricultural sectors, helping farmers provide enough water for all their crops.[16]

D. Rommer [22] proposes a method of operating wireless sensor nodes that relies on static clustering strategies is described; this method ensures that the whole agricultural area is exposed to light in the most effective and precise manner possible. A more effective way to address the coverage-hole issue is to use a mix of node types in different locations, depending on the task at hand and the available resources. The networked sensor nodes are constantly gathering data about the surrounding environment. The sensed data received about the environmental

element in the agricultural area is only communicated to the BS if the value of the user-defined periodic timer (PT) or detected characteristics exceeds the desired limit.[22]

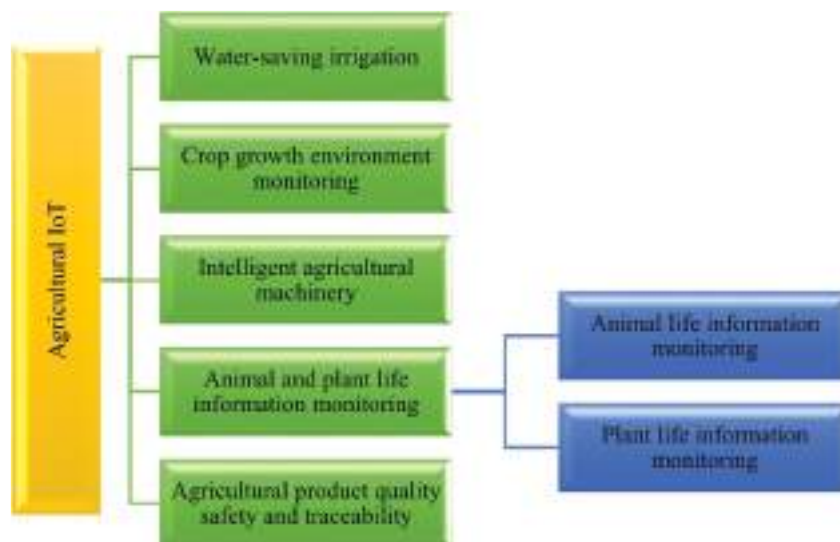


Fig. 4: Agricultural IoT[5]

PROBLEM STATEMENT

Recent WSN studies have targeted agriculture intending to improve upon established farming practices. The miniaturization and decreasing cost of MEMS technology has made previously inaccessible sensors practical. Due to their scalability, compact nodes, and inherent benefits of self-organization, WSNs are a great alternative for automating agricultural procedures. The development of WSN-based applications for smart agriculture has considerable obstacles due to the limitations of WSNs in processing power, memory, and battery life. Using wireless sensor network (WSN) based agricultural solutions shouldn't need consumers to take on more debt. In multi-hop WSNs, energy usage might differ across nodes. The fraction of nodes transferring packets to those near the base station is much greater in regions where the nodes are situated due to the nodes' role as routers. The greater packet throughput requires more power at the node level. Because of its powerlessness, the node can no longer communicate with the rest of the network. When a node is eliminated, all of the other nodes that were relying for it are also shut off. Because of these energy-saving measures, the WSN application continues to operate under these conditions. Finding the root reasons for growing energy consumption is a prerequisite for developing effective remedies.[20]

OBJECTIVES

- Predicting future crop temperatures, humidity, and soil moisture by analyzing sensor data.
- To keep an eye on crop quality, we use sensor data (both historical and real-time) to accurately predict the occurrence of pests and diseases.
- An automated smart power irrigation system at a reasonable price is the target.
- Conceive, design, and implement a multi-sensor system to ascertain the field's online and offline status in real time.
- Our goal is to provide a solution that significantly reduces the power consumption of a WSN node.

CURRENT STATUS OF THE RESEARCH

With the help of the Internet of Things, Israel has created a world-class agricultural system in an otherwise unproductive region. By utilizing big data's direction of users during fertilization, irrigation, after-sales, and

other key operations, Israeli farmers have been able to achieve precise watering, environmental information collection, and anger control for farming with the help of QR codes, radio frequency technology, network monitors, and various types of environmental sensor devices [8]. Using Africa's abundant sunshine, the solar panel array generates power; water is drawn from various sources (rivers, wells, groundwater, etc.) and stored in tanks on the farm; and the drip irrigation system meticulously satisfies the needs of the crops [9]. Cost-effective and widely used throughout Africa's orchards and gardens, the Sun Culture technique helps farmers cut down on production expenses while simultaneously boosting efficiency. There has been a lot of recognition and help for the company as well [10]. The agricultural sector may be split down into four primary subfields: agroforestry parks; food and culture; rural landscape decorative and mountain-dwelling; and continuous education. The model's incorporation of IoT technology has paved the way for innovative approaches to farming, and the results of a pilot program to install wireless LAN in agricultural land and use it to map plant growth and enable remote control of greenhouses to boost productivity and reduce labor costs have been encouraging [11]. Potential applications of self-organizing wireless sensor network technology in animal experiments were investigated by studying the effect of the environment on animal body temperature [12].

Several findings have been made in the fields of fine crop cultivation, animal breeding, and agricultural product traceability. Bansal et al. developed a cutting-edge greenhouse control system that can remotely gather data and operate using computer technology and wireless technologies. The greenhouse's temperature and CO₂ content can be kept stable with the help of this method [13]. For the features of recreational agriculture, Nicolescu et al. developed the idea of recreational farming, in which users may know the development of land plants in real-time through the network; in addition, it offers a platform for farm owners to trade experiences and share their delight [14]. There is no uniform industry standard, and a large number of closed-loop IoT goods are created and manufactured [15], but traditional industrial IoT technology applications are tailored to the specific demands of their customers, and IoT technology is also finding new uses in leisure agriculture. Many sensors, including those for air and soil temperatures and humidity, must be placed in the field to use the Internet of Things (IoT) in recreational agriculture.

Agriculture Prototype

To effectively schedule watering operations, the prototype farm shown in Figure 3 uses real-time, distributed wireless sensor technology to detect and quantify environmental data such as soil moisture and temperature. The device may be used to monitor the weather as it happens, but it can also help with water and energy management, among other ecologically responsible choices. The information stored in local and remote databases is made available through an intuitive mobile app. Customers will be able to keep an eye on or even manage their farms from the palm of their hand using their cell phones. The overall system is intended to be energy-efficient, cost-effective, and low-maintenance to assist farmers and customers maintain their farms or gardens with as little effort as possible. This setup consists of a gateway, six WSNs, and a meteorological control unit.

Nodes of Sensors

The basic functionality of the wireless sensor nodes is implemented by modules housed on the microcontroller-based Arduino boards, and the nodes' connectivity to other sensors is handled by additional interface boards. Soil moisture, pH, leaf wetness, ambient temperature, humidity, solar radiation, air

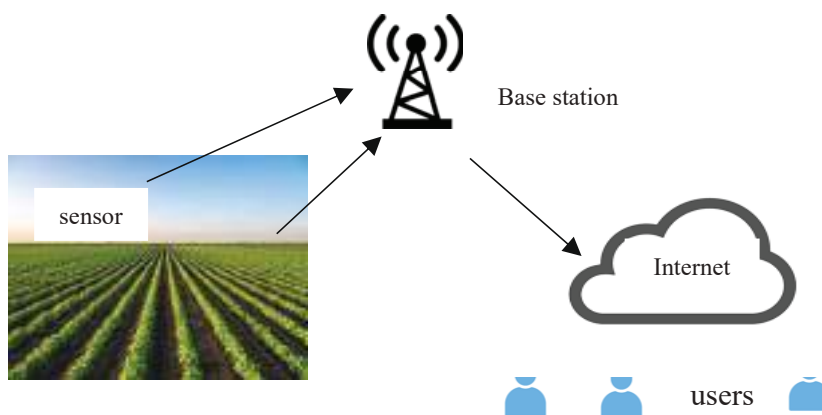


Fig. 5: Prototype Farm[20]

pressure, soil temperature, and meteorological parameters like wind direction, precipitation, and wind speed may all be read by the sensor board. Nodes can talk to one another and send sensor data to the gateway at the 2.4 GHz frequency using the ZigBee protocol and the XBee PRO S2. Sensors may be integrated and programmed using the Integrated Development Environment (IDE). Each WSN has a 3.7 V, 1150 mAh lithium-ion battery fitted to remedy power issues.[21]

Gateway for IoT

A Linux-powered mesh router that works as a gateway to the Internet of Things stores the gathered sensor data in a MySQL database. While the gateway may communicate with sensor nodes using a wide number of wireless protocols, the ZigBee standard is being used in this implementation. And since it supports both Wi-Fi and Ethernet connections, syncing data between local and remote databases via a cellular or wireless connection is a breeze. The gateway might also transmit sensor data to a cloud-based database. Recent data may be accessed using the gateway's user interface app, as shown in Fig. 3.[20]

The Cloud and Services

The gateway sends collected sensor data to commercial cloud service platforms with limited storage space, such as Microsoft Azure and Google Firebase. The cloud makes it simple and flexible for users to get to their data. This opens the door for future uses including remote access to farm data, data analytics, and agricultural guidance. This "smart farm" technology collects data that can then be accessed through the web and mobile devices.[25]

Application

Using a mobile application, we will transmit sensor data in real time to the cloud, which will help us achieve our project goals. Users of the mobile application platform may keep tabs on more than just the health of their farm by keeping tabs on things like energy use, irrigation schedules, and weather conditions in real time.

Analysis of Data

In this research, we concentrate on using high-resolution sensor data to make accurate predictions about agricultural productivity, weather, and crop quality. By reducing the amount of chance that crops are exposed to in the field, the Internet of Things has the potential to increase agricultural yields and production. Farmers may gain an understanding of energy production, water usage, water recycling, and crop quality via the application of the data-driven physical model. Long-term weather data monitoring may be used to create a time-series prediction model that can accurately forecast the weather a day in advance, allowing farmers to plan irrigation systems. The mobile app's dashboard will alert the user when it's time to irrigate. Sensors' potential for collecting large volumes of data poses problems for data management and storage, but it might lead to the identification of useful predictive patterns in agricultural datasets. The project's data analysis is only getting started; further data processing and mapping are required. Research activities for data analysis are listed in Fig. 3, left, below.

1. Acquiring, organizing, and analyzing information from various systems, such as those dealing with agricultural production, power generation, and water distribution. This is a pivotal phase since the scale of this effort covers several ages and regions.
2. Several types of machine learning simulations are implemented.
 - You may be able to determine what influences agricultural production, FEW interactions, and the quality of your crops by using the classification and regression trees (CART) method.
 - Blending deep neural network-collected WSN data with information gathered from external sensors.
 - Model testing and analysis.
3. Projected values are being added to a mobile and online app that is now undergoing maintenance and updating.

PROBLEMS

As can be seen from the aforementioned examples of agricultural IoT system design, technology, and application, agricultural IoT has made tremendous strides in recent years. However, some challenges can only be conquered through constant, resolute effort.

1. There are now three main categories for IoT: "perception," "transportation," and "application." Research on individual layers is extensive, but work on the overall structure of the IoT system is weak. The timeliness of IoT data transmission suffers as a consequence of the resulting instability in data transfer, challenges in data sharing, possible safety dangers in transmission, and poor positioning precision and stability.
2. There are numerous varieties of sensors, each with its unique communication interface and incompatible communication protocols, all of which need a great deal of software and hardware and make future expansion challenging. Embedded gateway middleware is essential to the IoT, although its study and implementation are still in their infancy and mostly limited to lab settings at this point.
3. Data collecting and single-machine processing have received the bulk of attention in studies of the monitoring and perception of agricultural IoT, but studies of entire application systems have been notably under-researched. Intelligent agricultural equipment IoT research and implementation have mostly focused on the improvement of a small number of individual technologies.
4. High-speed wireless WAN is essential for agrarian IoT. However, high-speed data transfer is difficult to achieve in the rural agricultural setting due to the poor wireless connection signal. Therefore, improving the data coding efficiency is the only method to ensure the system's real-time performance.

NEED

1. There is a need for research on the construction of agricultural IoT systems and the deployment and management of perception nodes. The design must be decentralized, accessible, and capable of sharing both resources and services. This allows for more specificity and depth in agricultural data collection, as well as the integration of many heterogeneous systems and the sharing of resources.
2. It is necessary to build comprehensive information perception standards, do further research on embedded gateways, and create multi-protocol conversion gateways. The goal is to standardize device interfaces and protocols so that devices may be connected in ways that are both more user-friendly and better equipped to analyze and handle large amounts of data.
3. The digital twin of the entire production process can be realized with the help of virtual reality technology, 5G communication technology, and augmented reality technology; this, in turn, paves the way for intelligent process monitoring, decision-making, and multi-factor intelligent tracing by connecting agronomy, crops, agricultural machinery, and farmers under a single network system.[34]

METHODOLOGY

The data analysis for this project is only getting started; further data processing and mapping are required. The researchers that pursue the data analysis path are responsible for the following types of work:

- Systematic data collection and analysis of plant, electrical, and water processes.
- The term "data pre-processing" refers to the steps used to clean, prepare, and make ready raw data for further analysis. This stage is essential because of the temporal and spatial complexity of the project.
- Deep neural networks were trained using remote sensing data and then used to the WSN data to enhance it.
- An app accessible on both smartphones and computers displays predicted outcomes.

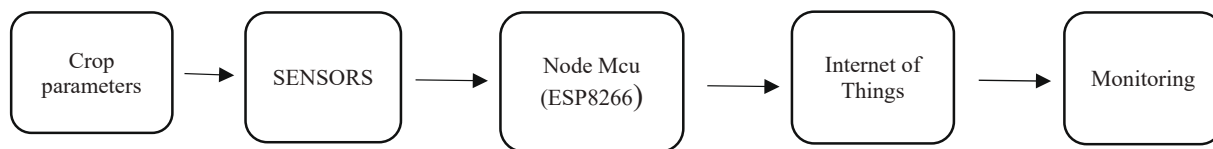


Fig. 6: Monitoring flow

The challenge of monitoring large and small regions is highlighted, and a strategy for doing so at ground level is presented. With the use of sensors and an IoT platform, we have developed a system to keep an eye on farmland. Figure 4 depicts the three architectural layers—deployment, service, and application—that contribute to the total processing. For monitoring fields of varying sizes, the suggested system employs three distinct operational levels. The software could collect data on soil and climate conditions, then store it, process it, analyze it, and provide the results to the user. The suggested technique provides rapid access to visual representations of acquired field and meteorological data for farmers. When an event happens, the system will send an alert message to each user by email or text message. Using WSNs and IoT technologies in agriculture aims to provide real-time crop monitoring and the most efficient and effective solutions to issues in the agricultural sector.[22]

Sample Size

The dataset including 2500 samples is taken and then they are evaluated on various parameters step by step. Hardware Details and Description Sensors for light, ultrasonic, LCD, voice, Arduino, soil moisture, soil temperature, soil pH, and Raspberry Pi were all employed in this investigation.

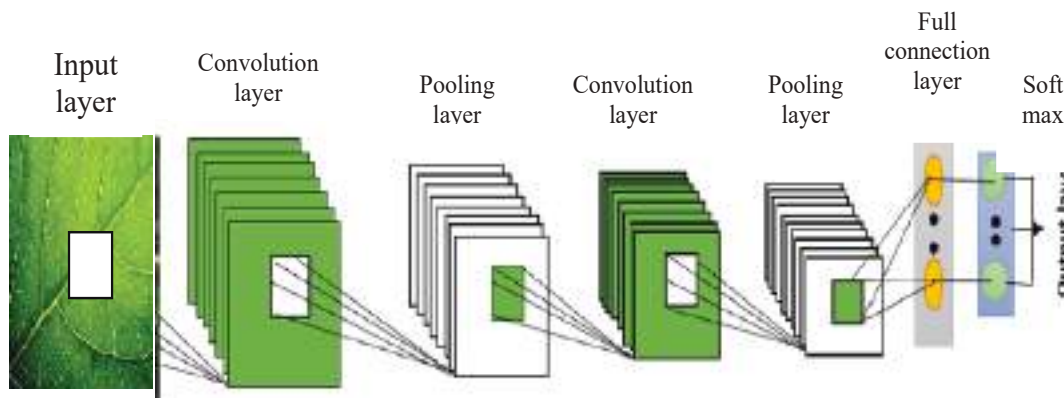


Fig. 7: Details and Description[23]

Wireless Sensors Materials

Wireless sensors provide the way for future wirelessly networked applications like the Internet of Things in the cloud, mobile networks, and more. When designing wireless sensors, engineers must take into account a wide range of factors, including the materials' resistance to loss and interference, their conductivity, and their ability to detect and correct errors. Sustainable materials, low-cost materials, recycled goods, materials for the next generation, conductive polymers, Nanotubes, energy-conservation materials, and specialized electronic components are only a few of the categories that have been added to the development model since then. These parts serve a crucial purpose because of the efficient production process and structural modification of their base materials. electronic tools for building Making devices begin with processing materials like gallium (Ga) and arsenic (As). Semiconductive cubes of gallium arsenide (GaAs) and a conductive polymer round out the ingredients.[23]

Rainfall Sensor

With the use of the rain gauge, meteorologists can accurately anticipate precipitation levels. The rainfall sensor pad, with its network of exposed copper traces, functions as a variable resistor (for example, it seems to be a potentiometer) whose resistance varies with the height of the water above and below the pad. It has been theorized that lower resistance occurs at higher water levels. The wireless sensor, which consists of a detecting pad with rows of exposed copper traces, is designed to be deployed in an outdoor environment, either over a protective covering or in some other position highly susceptible to damage from rain.[20]

Air Quality Sensor

Instrumentation for analyzing and purifying air after contaminants have been removed. Particulate matter (PM) in the air may be measured using an alpha sensor. It's possible to connect the sensor to an Arduino board running pollution-sensing software. Any changes in impurity levels may be saved to a USB device and retrieved at a later time. The Internet of Things allows for the remote monitoring of air quality (IoT). When particle matter (PM) emissions reach an unsafe level, the filtration system kicks in to clean the air. The air purification chamber should include built-in electronics and mechanical support. After PM is discovered in the air using a quality sensor, it must be removed using the recommended methodological equipment.[19]

Soil Moisture and Humidity Sensor

There, on the soil's surface, are the devices used to monitor the environment's temperature and moisture. To attain the target average air temperature and humidity, it was determined to position the nodes at the level of the crops' margins. The moisture and temperature sensors were placed at intervals of 5 meters, with about 5 centimeters between each pair. When the sensors were ready, they were planted at a shallow depth. Specifically, the FC-28 soil moisture sensor is used in our setup. Input voltages of 3.3V to 5V are supported by this sensor. The range of the possible output voltage is 0V to 4.2V.



Fig. 8: Humidity sensor

The LM393 comparator is vital to the operation of this sensor. The outputs are available in both analog and digital formats for your convenience. The digital output from the sensor is read by an Arduino Uno. Whether or whether the ground is damp affects the value produced.[24]

Temperature Sensor

It was determined by the use of an LM 35 temperature sensor. The linear scaling factor of this sensor is +10 mV/°C. This instrument gives an accurate measurement to within 0.5 degrees. This sensor may be relied upon when used in non-invasive situations. In a temperature range from -55 to 150 degrees, the gadget continues to function normally.

Soil pH Sensor

The pH of the soil is an indication of its nutrient quality. Our work with soil necessitates the use of a Labman pH meter to measure the acidity of the ground. In general, soil pH ranges from 1 to 14. Soil pH values between 6 and 7 are acidic, 7 and 8 are neutral, and 8 and above are basic. The Labman pH meter has an operating temperature of between 0 and 100 degrees Celsius. The pH scale is accurate to within 0.01 pH.

Light Sensor

The LM393 light-sensing microcontroller was used extensively throughout our investigations. As a sensor, this light-sensitive resistor is used (LDR). It requires a power supply between 3.3 V and 5 V to function. One

may use a potentiometer to modify the intensity of the lights on/off switch. A digital signal is produced based on this threshold value.

Ultrasonic Sensor

An ultrasonic sensor with the model number HC-SR04 was used in this study. This device requires a minimum input voltage of 5V. The accuracy is within 3 millimeters. It operates at a frequency of about 40 Hz. It may be used to measure anything from 2 centimeters to 450 centimeters.

Liquid Crystal Display (LCD)

In this experiment, we utilize an Arduino with a Liquid Crystal Display to display both input and output parameters (ALCD).

Arduino Uno

The microcontroller used here is an Arduino UNO. There are four digital I/O pins available for use. There are six analog inputs in all. There is no need for more than 5V for the device to work. With 32 kilobytes of flash memory and 16 megahertz of processing power, it's a very capable device.

Raspberry Pi

We include a Raspberry Pi 3 model B in our system. You can store one gigabyte of data in the available RAM. Constructed using the same protocol as Ethernet 100 Base. This portable gadget is both inexpensive and practical. One may insert a microSD card to increase the device's storage capacity. Adding it to our system is a breeze.

IoT Module

IoT sensor nodes are battery-operated, portable, and wireless. Multiple such small sensors would typically be used in an IoT application system to continually monitor the weather over a large area. The paper provides an energy-efficient idea for IoT-enabled PA that is based on the architecture of solar power systems. Using environmental data, solar power models attempt to foretell future solar power output. The foundation for Microsoft's Solar Model of Electricity came from an existing model. After considering the proposed layout, adjustments are made to the original plan. Two different approaches are used while studying the past. To address this issue, the authors offer a novel approach: training to quantify the base station's massive resource needs. The authors suggest a unique product density approach to determining the base station's power requirements (low power, medium power, and high power specs) from the devices in communication with it. Quite a few communication networks have used the material density approach to calculate ON and OFF timings. The article generally advises adopting a strategy of Enhanced Duty Cycling.[25]



Fig. 9: IoT Module

Relay Network

Relay nodes are required to ensure and implement fault tolerance in WSNs. Router-based sensor cluster header fusion and outbound transmission to target/sink in a remote wireless sensing device Due to low-power, resource-intensive routing approaches, nodes contemplate multi-hop wireless routes involving numerous nodes.

Data Preparation Cum Generation

Our experimental investigation used a dataset taken from the publicly available Kaggle database [33]. Seven characteristics, including pH, rainfall, temperature, humidity, nitrogen, potassium, and phosphorus, are provided

in Table 2 as the lookup format for the crop-recommended dataset. All sorts of crops may be made by combining these seven traits in different ways. The proposed crops and numerical values for each of the seven parameters are presented in a lookup table.

The lookup table indicates that there are 22,200 examples inside the Kaggle data set. Through the use of comma-separated lists containing the desired functions and rule-based classifiers, the most effective model is developed using supervised learning methods.[29]

IX.HARDWARE IMPLEMENTATION

These schemes aim to better organize agricultural land and expand the reach of a centralized monitoring system. This can be controlled remotely from just about anywhere with a mobile phone and some wireless capability. Irrigation, environmental, soil moisture, and fertilizer data collection are all operations that may be managed by software users without the need for a person to be present. Each farm that uses the app may benefit from an in-depth analysis of crop performance, tailored harvest recommendations, and accurate crop forecasts. Figures 5 and 6 depict the sensor node's prototype and subsequent deployment.

The environmental elements that the sensor network is designed to detect include temperature, soil moisture, humidity, and light. This model is used to determine which farming practices will be used on each piece of land. A collection of these nodes' data is then uploaded to the cloud. The data obtained is kept in a database hosted in the cloud. Sending information to a cloud database makes sense for long-term storage. Farmers may log in to their accounts to examine their nodes' complete historical data as well as the most up-to-date readings.

Automated, Intelligent Irrigation System for High-precision Farming

The recommended approach for precision agriculture is the SIS-PAF, which is provided to get rid of the disadvantages of several current implementation systems. This technique is an attempt to address the global water crisis by reducing the amount of water wasted for irrigation. Utilizing cloud computing data that may be recorded on the website, the proposed solution has employed Internet of Things (IoT) technology to organize and control to keep the farmers updated on the status of it. The suggested system includes the Arduino Uno microcontroller board, a moisture sensor, and a GSM modem for wireless communication. To get the data from Arduino to farmers in outlying locations, we employ a GSM modem and a Hypertext Preprocessor-created website that displays all relevant parameters for easy viewing. The website is built online and maintains a database of data collected from a variety of wireless sensors that are given data through hardware peripherals. An irrigation system's threshold value is adjusted to regulate sprinklers for diverse crops. By adopting this system, just the necessary amount of irrigation water has to be given. To increase agricultural yield productivity via more efficient use of agriculture resources, the use of IoT-based agriculture platforms is a game-changer for the agriculture sector as it now stands. More benefits may be gained by large-scale farmers by remotely monitoring and manipulating numerous aspects. IoT-based technologies may be made more accessible to farmers with the aid of a system administrator.

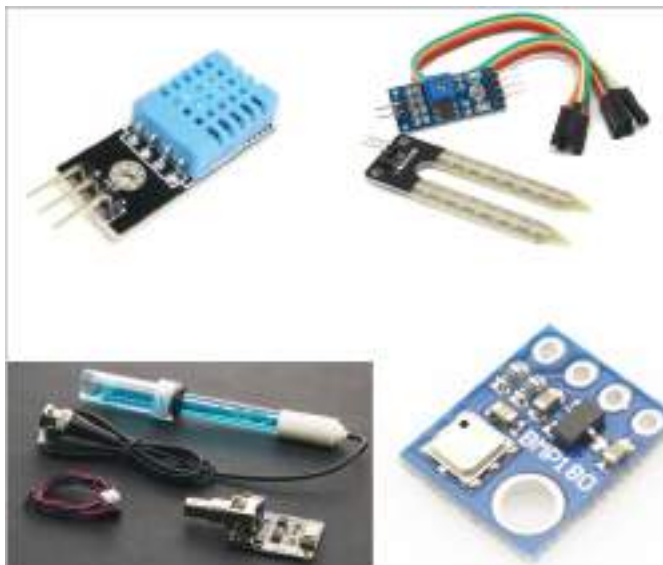


Fig. 10: Four-pin DHT11 for Arduino; B, Hygrometer Sensor; C, PH Meter Sensor; D, Air Pressure Sensor

The DHT11 Arduino sensor, shown in Figure 1A, is capable of monitoring both temperature and humidity. Agricultural soil moisture may be measured using a hygrometer sensor, as shown in Figure 1B. The PH meter's probe is seen in Fig. 1C. The hydrogen ion acidity of a water solution may be estimated using the pH meter's sensor. A device for measuring atmospheric pressure in an agricultural setting is seen in Figure 1D.[30]

B.DC Geared Motor

We can divide a DC motor into its transmitter and receiver halves. We monitor environmental factors like humidity and temperature by keeping the wireless sensor's transmitter out in the field (Figure 12).

All of the settings and configurations are stored in one convenient location. The irrigation pumps are kept in different parts of the agricultural field so that water can be delivered to a crop area as needed after researchers examine the various information of various measures that have been preserved in the central server at various times since the agricultural field status.



Fig. 11: DC Motor



Fig. 12: Wireless Sensor's Transmitter

RESULTS AND DISCUSSION

After the necessary hardware and software have been established, tests must be carried out to determine whether or not the proposed remote control device satisfies the requirement of collecting field data. The coordinating part receives the first data from the wireless sensor in the experimental portion through the simplest wireless network. The coordinator then disseminates the data across the wireless communication network using the wireless information packet network module. The third phase involves sending the data to the user's gadget.

A variety of tasks are completed and information is shared here. Wireless sensors have become more common in agricultural settings, although just three typical sensors were used for this study. taking humidity and temperature measurements of farms Since temperatures will likely fluctuate as the experiment progresses, keeping tabs on a broad upward or downward trend is unnecessary. There is a temperature and humidity sensor that reports the current climatic conditions in real time. Maintaining a maximum daily temperature and humidity level conducive to agricultural growth is all that has to be done. It also shows that the ideal temperature and humidity for farming are opposites. Figure 7 shows that, despite the anomalous data values recorded by some sensor nodes at a particular time, the rule of change in temperature and humidity data received by sensor nodes is generally the same.

Project Result Description Here, we present the results of an experiment in which home plants were used to determine how precise a moisture meter might be. After analyzing weather patterns and field data, the best watering schedule is created. One may either manually or automatically manage a motor pump. If it rains on or around the scheduled irrigation day, watering may be postponed for a few days until the system has recovered from the deluge. The capability of soils to hold water is also investigated in this research. This intelligent technology evaluates the soil moisture forecast figure for four consecutive days to make sure it is accurate. In a few days, the encrypted soil moisture data will be accurate and reliable enough for this purpose. In cases when the MSE is low, kernel-based support vector regression (SVR) is used.[11]

Evapotranspiration

Table 1: Evapotranspiration Values for Upcoming Days

Day	Evapotranspiration
1.	166.63
2.	229.2
3.	218.76
4.	217.08

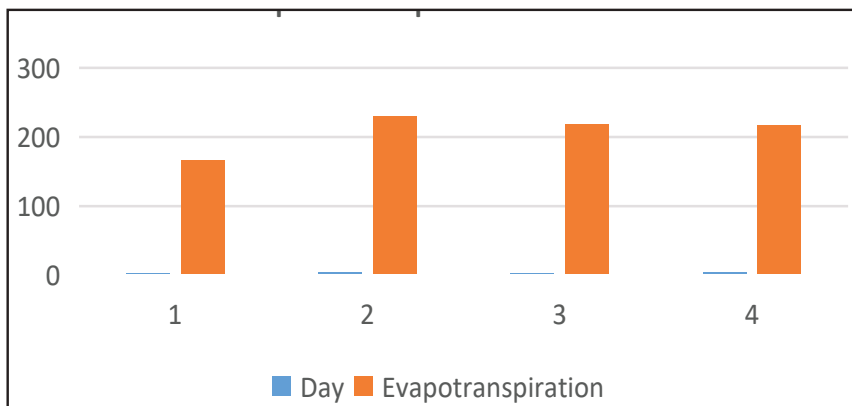


Fig 13. Evapotranspiration Chart

Soil Retaining Capacity

Table 2: Evapotranspiration, Precipitation and Humidity Values

Day	Evapotranspiration	Precipitation	Humidity
1.	33.32	0	79
2.	45.84	11	70
3.	43.75	0	72
4.	43.41	3.35	76

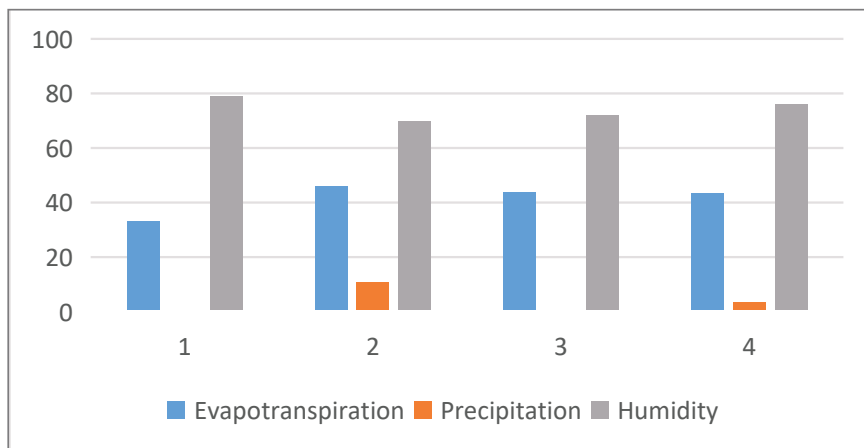


Fig.14: Soil Retaining Chart

Temperature and Humidity

Table 3: Temperature and Humidity

Day	Temperature	Humidity
1.	83	29.45
2.	70	29.81
3.	72	29.85
4.	76	29.9

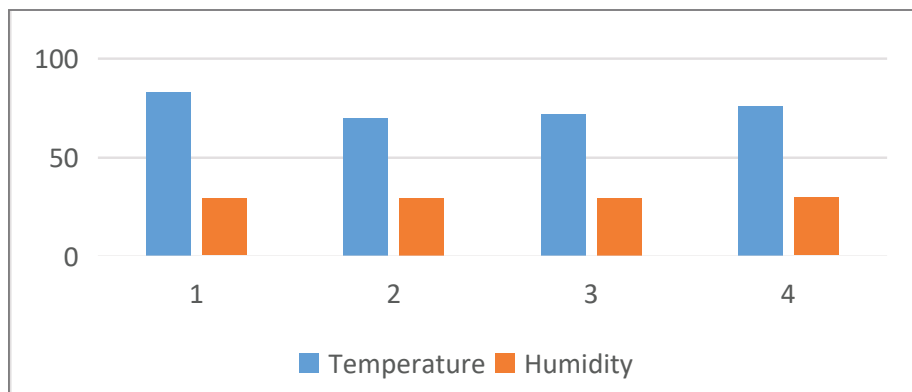


Fig. 15: Temperature and Humidity Chart

Prediction Model

Table 4. Moisture Content and Irrigation Requirement

Day	Moisture Content	Irrigation Requirement
1.	56	1
2.	36	1
3.	29	1
4.	36	1

SIMULATION PERFORMANCE ANALYSIS

The technology is tested in a simulated environment to determine its efficacy.

Simulation Analysis The proposed framework's performance is evaluated in two ways: I separately for the WSN and WiLD networks, and (ii) overall, depending on the results of the first stage. We used a Skymote gadget based on the CC2420 platform in the Contiki Cooja simulator to mimic 6LoWPAN. To ensure a large number of hops, 50 nodes are placed in a network with a fixed distance from the sink.

Increasing the network's node count results in a decrease in throughput. This is due to numerous packet losses brought on by intense channel congestion and frequent channel checks. The recommended technique outperforms the alternatives. When nodes

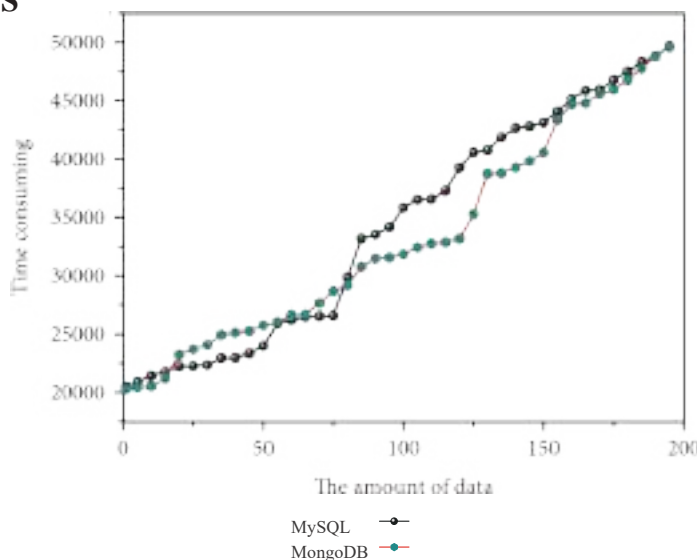


Fig. 16: Time-Consuming Comparison of the Item-by-item Operations[22]

in the middle of the hierarchy attempt to become accessible, it shortens the amount of time the queue is at rest. Since it prioritizes downstream traffic to reduce latency, the suggested protocol outperforms competing methods. The energy module in Contiki is what is used to determine how much power each node needs every second. When comparing the constant duty cycle MAC technique to the LPL length, there is a substantial difference in power usage. The WSN-IoT example demonstrates a common flowchart for machine learning, machine testing, and WSN action processes.[35]

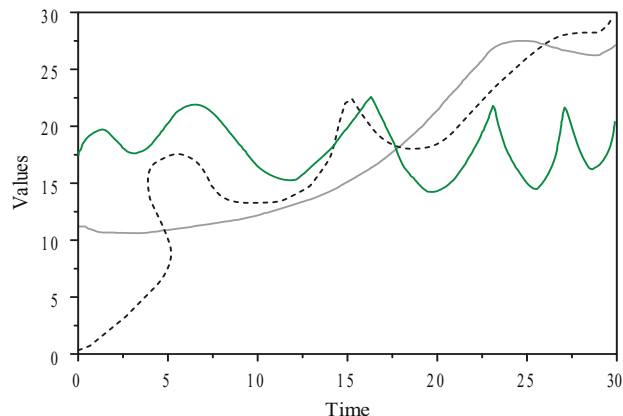


Fig. 17: Data Statistics Analysis Interface.
[Temperature, Humidity, PPM]

TYPICAL APPLICATIONS OF AGRICULTURAL IOT

Since agricultural IoT has been steadily improving over the years, it has seen extensive usage in the study and implementation of agricultural technologies. Brief descriptions of a few common examples of this are provided below.

Water-saving Irrigation

Water is becoming a more and more precious commodity in the modern world. Water is essential for plant growth and development, thus it naturally has a major effect on crop yields. Varying plants have various water needs since they have different growth cycles. The old flood irrigation system may be swapped out for something more efficient with the use of Internet of Things technology, which also helps with the issue of water scarcity. Increased crop yields and improved crop lodging resistance are two additional benefits. In their investigation, Yang et al. used a neural network as the backbone of an efficient irrigation system that used less water (Yang et al., 2020). This approach safeguarded ecological agriculture while increasing irrigation efficiency, decreasing the need for human involvement, and decreasing waste produced by excessive drainage.

Animal and Plant Life Information Monitoring

Data monitoring of livestock and crops is crucial for the success of any farming operation. It has the potential to vastly enhance the effectiveness and quality of agricultural output.

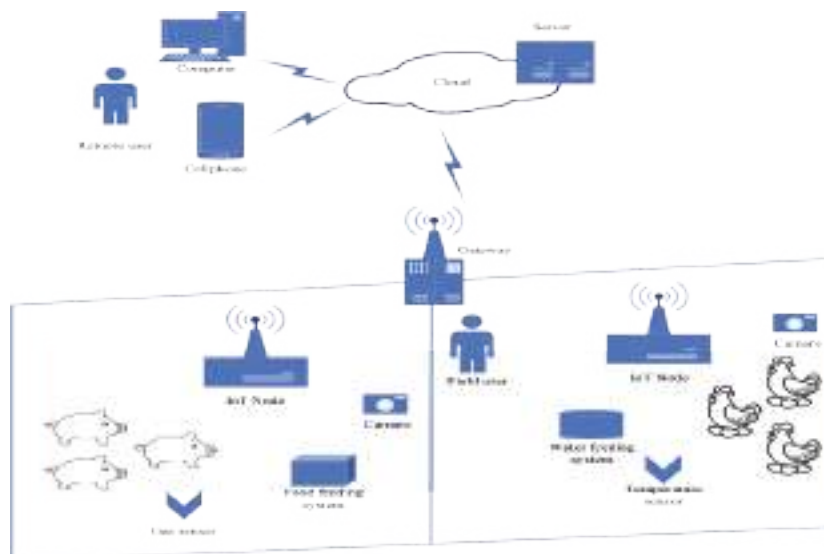


Fig. 18: Typical Animal Information Monitoring System.[34]

Intelligent Agricultural Machinery

Intelligent farm equipment allows for consistent, ergonomic, and communicative use in the field. It's capable of doing things like planting seeds, transplanting seedlings, fertilizing, pesticide spraying, feeding, irrigating, picking, and harvesting by itself. Soil, water quality, crop, and aquatic product data may also be gathered, lending technical assistance for the introduction of precision farming and disease-free breeding (Ma and Sun, 2020). Incorporating the Internet of Things Integrating the Internet of Things (IoT) into agritech applications through the use of sensing, positioning, and wireless network technologies to develop a vehicle-mounted intelligent terminal and a remote service platform for agritech equipment paves the way for the timely, accurate, and comprehensive delivery of service information.[31]

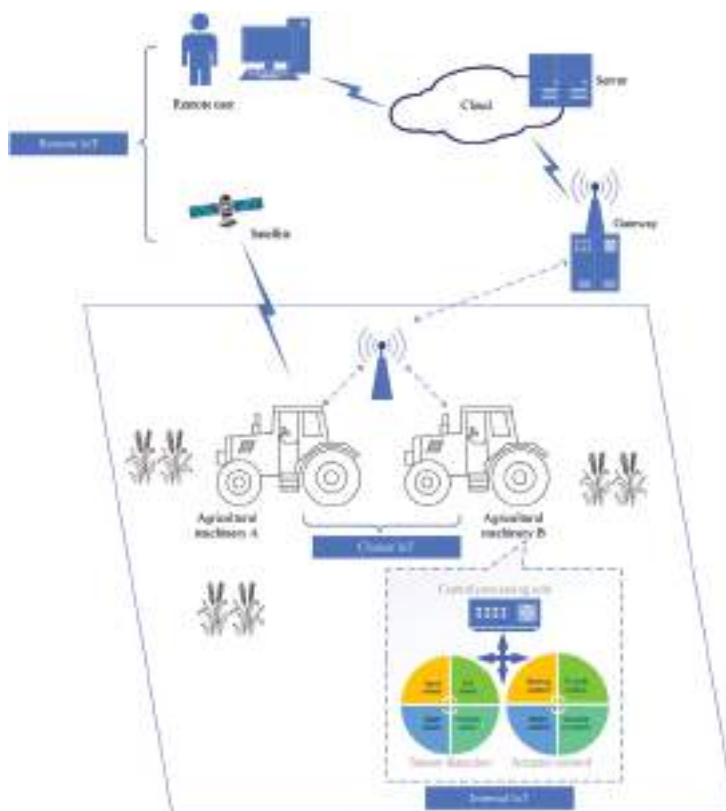


Fig. 19: Structure of Intelligent Agricultural Machinery IoT. [18]

Connectivity options for agricultural machines that use the Internet of Things (IoT) range from local to global. The term "internal IoT" is used to describe the networking and management of sensors, actuators, and the machine's brain. The term "Cluster IoT" is used to describe the coordination and management of similar or dissimilar farm machines in the same geographic region. The phrase "remote IoT" describes the coordination and management of devices located away from the main hub of operations. Fig. 8 depicts the IoT architecture of smart farm equipment.

Agricultural Product Quality Safety and Traceability

Warehouses, distribution centers, and the supply chain are where agricultural IoT is most often put to use to ensure the quality, security, and traceability of agricultural goods. Automatic identification and the entry and outflow of warehouse items are made possible by the use of electronic data interchange, bar codes, and RFID electronic tags, among other technologies. To track where the primary agricultural goods come from and travel to, WSNs can keep tabs on warehouses and delivery trucks in real-time. American agricultural product traceability, Swedish agricultural traceability, Japanese food traceability, European beef traceability, and Australian livestock

traceability are only a few examples of industrialized nations' well-established agricultural product traceability systems. Pinto et al. uses TIC controllable techniques for food sector traceability to address the demands of modernization, intelligence, and informatization of agricultural products (Pinto et al., 2006). The complete agricultural product safety traceability platform built by Jiang et al. Realizes real-time automated collecting, processing, and presentation of agricultural product data; Enhances product traceability; Decreases the cost of tracking and monitoring agricultural goods (Jiang and Sun, 2017).[35]

Figure 28 shows a tally of how many times certain keywords appeared in research publications that were part of this study between 2011 and 2021. According to the survey results, "Animal and plant life information monitoring" is more popular than any other category.

CONCLUSION AND FUTURE WORK

The agricultural industry is experiencing a digital transition similar to that of other industries. There's been a remarkable increase in the quantity and quality of data we've been able to get from farmers. Interest in emerging technologies including the Internet of Things, robotics, drones, wireless sensor networks, and artificial intelligence has skyrocketed in recent years. Machine learning algorithms can sift through massive amounts of data to extract useful information and insights. Throughout the precision agriculture ecosystem, researchers have employed machine learning models for a wide range of tasks, such as yield estimate and weed and disease identification. Using ML to examine sensor data, farm management systems are developing into complete AI systems that deliver trustworthy insights to decision-makers. Concerns about deploying an app and the infrastructure required to handle data gathered from it are addressed, as are challenges associated with tracking crop quality, output, and weather forecasts. It's possible that in the next years, state-of-the-art techniques like distributed (or edge) deep learning will become more widely used. Artificial intelligence (AI) has the potential to improve agriculture in many ways, including the productivity of farms and the efficiency of farm labor, while also helping to preserve our limited natural resources.

To further the field of agriculture via the use of Internet of Things technology and wireless sensor networks, we have performed an extensive study into the application of such networks in the sector and offered a strategy and set of concepts to achieve this goal. To create a video, the screenshot operation module's screenshot files are merged with the video synthesis module. The recording operation module, in conjunction with the camera access module, records audio and video depending on the recording operation information stored in the database.

Analyzing the sensor data with the help of a typical agricultural sensor network architecture, a distributed database cluster is created to achieve large-scale and real-time data storage functions. Sensor data and non-sensor data must each have their collections, documents, and fields; bulk write, read, and delete operations must be implemented; an automatically scalable database cluster framework must be built using auto-sharding technology, and a database operation script must be drafted.

An IoT-based system for recreational farming is developed and put into practice; this system naturally marries recreational farming with contemporary computer technology, allowing for the real-time online management of actual farms via the web. It also serves as a platform from which to conduct studies and experiments into the development of a cutting-edge approach to agricultural enterprise. Object-oriented principles were used in the design of the system's essential components, and the abstract factory pattern was introduced in the user self-customization module before being thoroughly examined and expanded upon to make the system more flexible and scalable.[33]

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Cost Analysis of Installing Photovoltaic System for Battery Swapping charging Station using RET-Screen Expert

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▶ ABSTRACT ◀

Electric vehicles are changing the whole automobile sector very tremendously. After the United Nations Climate Change Conference, India is significantly boosting the EV adoption. But still due to the lack of charging infrastructure in India People are afraid to buy electric vehicle. The running cost of EV compare to the IC engine is low but people have the anxiety of battery run out. So in this Paper we want to attract the attention of Private sector as well toward Revolution of clean energy. This paper will estimate the cost or financial analysis of establishing the electric vehicle charging station. The total initial cost for this plant will be Rs 526,800 which will be compensated within 8.3 Years.

Keywords: *RETScreen Expert, Solar Photovoltaic, Electric Vehicle, Feasibility analysis, Greenhouse gas, Emission Reduction, Payback Period.*

INTRODUCTION

The New age of world is looking for an alternative which can provide safe and pollution free Transportation. Presently our transportation is mainly consist of the Internal combustion engines (ICE) which emit harmful gases each time when they used. IC engine use petrol, diesel as a fuel and when they burn produce toxic gas like carbon-mono-oxide, carbon-di-oxide which causes Global warming. Therefore we start to use Electric vehicle (EV), they use electricity for traction the motor. They donot emit any harmful gases means they are eco-friendly.

In the meanwhile government is also encouraging people in general to use EVs by giving subsidy on buying new electric vehicle. India is aiming to have 30% of Electric vehicle in 2030. But the biggest hurdle in this path is the charging infrastructure. The lack of availability of the charging infrastructure make it tough for people to buy electric vehicle. Therefore timely implementation of EV charging stations/EV charging infrastructure is necessary. Electric vehicle (EV) can be charged either way using the AC or DC power. In AC power an internal converter into the car is required to convert AC to DC while in the DC power can be directly fed into the Battery bypassing the converter. In India, 2kw to 22kw AC or 2kw to 200kw DC is used for charging. The Battery capacity of 2 wheeler vehicle (2-W) is 1.2 – 3.3kwh, 3 wheeler vehicle (3-W) is 3.6 – 8kwh, Electric car (E-car) is 21kwh with average voltages 48 – 72V are commercially used. Charging the batteries of 2-W and 3-W at the same location where the other vehicle E-car or Heavy duty vehicle are being charging will required more space and more power as charging of EVs are not spontaneous, they required time. So we want to encourage the Private sector as well on the topic of EV charging infrastructure. In Battery Swapping the battery of 2-W or 3-W can be divided into two or three smaller batteries which can be handle by one or two person easily. When these batteries get discharged they can exchanged with the charged one. This exchanging of discharged battery with the charged one is called Battery Swapping. The Grid connected Photovoltaic System is installed at Station for charge the discharged batteries. At time of all batteries get fully charged, the extra generating power can be send to the grid and when the PV is not capable of delivering required power, extra power can be withdraw from the grid which makes this system more reliable. Having these types of numbers of battery swapping station will resolve the problem of range anxiety as swapping will only take 1-2 minutes only to exchange the battery while plug in charging takes time. Battery Swapping is getting famous in outer countries as well due to the minimum time requirement. In this research paper we will going to calculate the predictable cost of installing the Photovoltaic Module for this type of Battery swapping charging station using the RETScreen Expert – Professional – 6.0.7.55

A Review on RET Screen Expert

RET Screen Expert is an international software developed by the Natural Resource Canada. It's a tool which provides decision support to model and analyze clean energy project. It is used in 222 countries, available in 35 languages and having more than 420,000 users. It provide appropriate Workflow to the users Start from the location or site selection. It provide site location climate data appropriately using the Ground Data or by NASA Satellite which help to make an estimation about the site geographical and climate condition for project. According to the site selection it also provide the power generation cost called Benchmark. In the facility section it allow to enter the facility type and details of the client. Technology type, fuel selection lie under the page of Energy, In this page allow user to select the technology want to use for example in case of PV selection we can select the type of PVs like polycrystalline or monocrystalline, slope, Azimuth angle, number of PV required, solar collector area, Miscellaneous losses, Import and Export rate of electricity and many more. Cost page have the three main section Initial cost, Annual Cost and annual saving. RETScreen provide the different level of analyses in cost page it has three different level of analyses. According to levels it become more practical. RETScreen also have Emission Analysis page which help to calculate that how much we are reducing the Green House Gas (GHG). It provide the Base case which is estimated GHG Emission from conventional technology and proposed case which means how much GHG reduction from the new technology. Financial viability is taken care in Financial page, it has a cumulative cash flows, financial parameters like inflation rate, project life, debt ratio etc. RETScreen Expert also calculate Risk of the project.

PHOTOVOLTAIC MODELING

Photovoltaic (PV) is a device that uses to convert sunlight to electricity. Sunlight consist of small energy packets called photons, when these packet falls on the layer of semiconductor, that causes electric field across the layer which makes electrons to flow, this process is called photovoltaic effect. The smallest unit of PV Modeling

is called Cell. These cells are combined together in parallel and in series called Panels to produce enough electricity. When these Panels further connected together either in parallel or in series called the PV Array. These Photovoltaic cell produce Direct current (DC) it can be converted using the converter DC to AC and fed to the Grid or it can be store directly to the battery using charge controller.

PV Components

PV Modeling consist of other components than photovoltaic are include Battery bank, solar charge controller Inverter, loads and auxiliary energy source.

Solar Panel

Panels are made of a large no of individual cells connected in series and parallel to generate required amount of electricity. These cell are made up of silicon material. When the sunlight strike the PV Panel, electron carrying negative charge got displaced from their position, now can flow freely in semiconductor flow toward the front surface of cell, creating imbalance in charge between front and rear. This imbalance create voltage potential, when this cell connected to the load electricity start to flow. This electricity can be Stored in batteries for future use.

Inverter

Inverter are the device that convert Direct current (DC) to Alternating current (AC). It is one of the most important component in PV system. Conversion of DC to AC is required because our all home appliances are of AC and Battery only store DC. Whenever PV generate electricity it will generate only DC which means for home application it need to convert. Inverter also consist of Safety equipment in case offault occurrence.

Battery Pack

Batteries are used to store Energy. They convert the electrical energy into chemical energy and chemical energy to electrical energy at the time of discharging. When electricity is generated by the PV in more than required amount it can be stored into the batteries. There are different types of batteries are available in market most common are lead-acid batteries, but these days lithium ion battery is catching everyone's attention. Lithium ion battery have more energy density 260-270 wh/kg, while lead-acid batteries have 50-100 wh/kg

Charge Controller

Solar charge controller manages the power Flow, it ensures that energy is being safely provide to the batter from PV module. It ensure that Reverse current is not flow to the PV module. It also have function to prevent the overcharging current, Low voltage disconnect. It manages the Deep cycle charging of battery and limit the power so that battery do not drain the power during night.

Supporting structure and electric cables are also the important component of the Solar PV Module

Types of Photovoltaic System

Photovoltaic System can be of Three Types namely,

- Grid connected or utility-interactive system
- Stand-alone system
- Hybrid System

Grid Connected or Utility-interactive System

Grid Connected system are those system in which battery storage system is not required. In these type of system, PV Module is connected with the Grid using the inverter. The additional energy which are not consumed by

the consumer can be fed to the Grid, Net metering allows consumer to pay only for the difference in power that they use. It is less expensive than other solar power system. It can further be classified as Battery connected or without battery. When the system is battery connected it makes the system more independent from the Grid. It can be advantageous as it will only draw the power from grid when system is not producing enough electricity to meet the load.

Standalone System

Standalone system also known as Off-Grid solar system, it has no interaction with the Grid. That means battery storage system is required to meet the demand when sun is not available. Standalone system can be useful wherever Grid is not available such as rural area. This type of system are little more costly and required continuous maintenance. These system are more preferred for powering application such as ventilation, water pump, fans and solar thermal heating system.

Hybrid PV System

Hybrid PV system are the system which uses multiple sources of energy to enhance the availability of Power usage. Hybrid PV system can be consist of sources of energy like sun, wind or hydrocarbon. They often integrated with Battery bank to maximize the availability of power. Hybrid PV system is the best method for the place which are isolated with the Grid. As it can be consist of multiple sources to generate electricity for example when there is clear sunny day PV can be used to charge the battery and whenever there is cloudy day have enough wind, wind turbine can be used to address the battery. Battery Bank can used during those hours when there is neither wind nor sun. But it makes the system more complex and costly as it require more equipment.

Lithiumion Battery

In 1970 M. Stanley Whittingham, a British-American chemist developed a concept of rechargeable batteries. Lithium-ion battery is the most famous one. He were also awarded with the Nobel Prize in chemistry for their work. A Lithium-ion battery is a type of rechargeable battery that make use of charged particles of the lithium to convert chemical energy into electrical energy. These batteries were classified into two categories, namely Primary and secondary. Primary batteries are those batteries which cannot be charged again after being discharged. Whereas Secondary batteries are those batteries which can be recharged again and again after being discharged.

Lithium-ion battery is made up of an anode, cathode, electrolyte, separator and two current collectors (positive and negative). The cathode is mainly consist of lithium compound, while the anode is made of Graphite. When the battery is charging the lithium ion tends to move from the cathode to the anode and vice versa. During the discharging lithium ions moves from anode to cathode. Thus the movement of ions from positive electrode to negative electrode produce electricity, it get transmitted to the attached load.

Currently discovery of lithium found in reserves of India in the district of Jammu and Kashmir is boosting the aspiration of India to becoming a green energy produce. It is estimating that it have 5.9 million-ton of lithium. India is setting its target to reduce the carbon emission by 40% in decade. India's transportation sector has ambition to replace the 30% of conventional vehicle with the electric vehicle. Battery Swapping will be now more convenient and feasible for the EVs.

Battery Swapping

Battery Swapping is a simple and feasible idea which stand on exchanging the discharged batteries with charged one. Battery swapping takes hardly 2-3 minutes to interchange the batteries whereas charging the EV with cable takes 6-7 hour. At Present, battery Swapping is understood a feasible solution for EVs like 2-W, 3-W. Battery

Swapping has some advantages over the plug in charging but also tackle with some challenges in its growth as mainstream charging method [5]

Advantages of Battery Swapping

EV Charging is Completed in Minute: As Discussed Battery Swapping is an idea of switching the discharged batteries with the charged one, it hardly takes a minutes to do which is highly feasible for Vehicle. It will reduce the concern of people of time taken in charging the E.

Reducing in Upfront Cost of EV: According to the Ministry of Road Transport and Highways (MoRTH) has permitted the sale and registration of EV without batteries, which gives a huge boost to battery Swapping Solution

Increased Predictability of Battery Life due to Controlled Charging Condition: At Battery Swapping station, Batteries can be charged using the standard voltages and current which in term can increase the life period of the Batteries.

Favorable Temperature: When battery undergo charging under controlled temperature its predictable life likely to extend. Which favors the battery state of charging and depth of discharging.

Challenges in Battery Swapping

Lack of Standard in EV Batteries: There is still lack of standardization among the EV batteries. Different EV Producer use the different battery/motor specification for vehicle which the biggest hinder the establishing the Battery Swapping Stations.

Greater Battery Needed to Power same Number of EV's: As per Battery Swapping is done by manually or by some machinery, it is important to make battery lighter in weight so a human or machine can easily able to change. Due to this sometime double or even triple battery are used in place of single battery.

Higher GST on Separate Battery vs Battery Sold with EV's: Govt. of India imposed higher taxes on the separate battery sales (18%), but the batteries sold with EV imposed less tax (5%)

Shorter Commercial Life of Battery Pack due to Customer Preference for the New Batteries with Higher Range: As with time the power delivering capacity of batteries got reduced which reduces the range of EV. As a result of this customers prefer to use new batteries with higher range capacity because of this batteries have less commercial life.

Site or Location Selection

India is a country which is enrich with lots of minerals and sources. Each and every site of India is enrich with special characteristics. It also blessed with the huge resources of renewable energy sources. India receives 1600 to 2200 kwh/m² radiation annually. India experienced 250 to 300 clear sunny days in most part of it. And it is a tropical country which receives sunshine longer hours per day with great intensity according to The National Action Plan on Climate Change. Therefore India has a great future to the Renewable energy sources. [4]

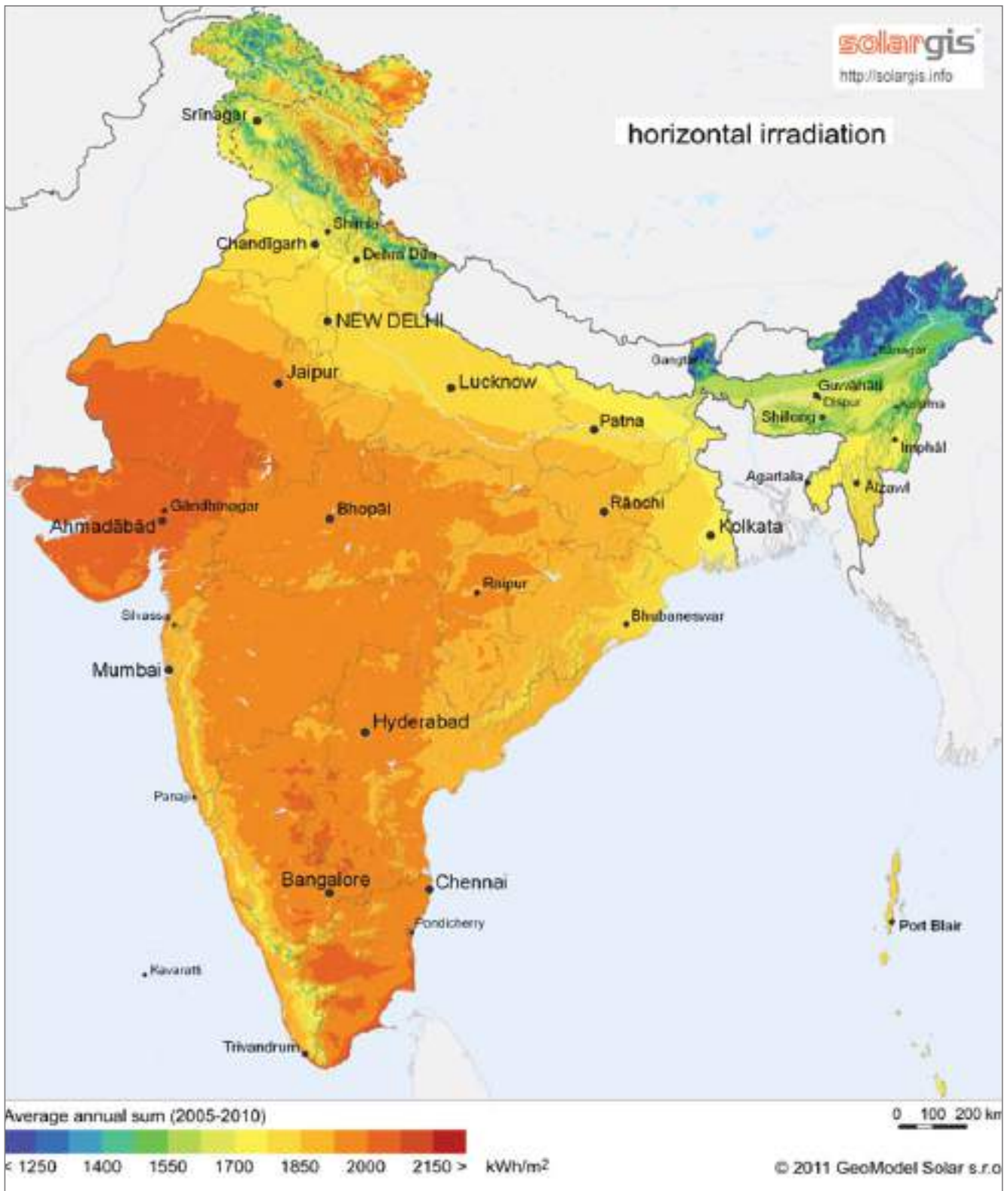


Fig. 1: Annual Solar Radiation Received in India

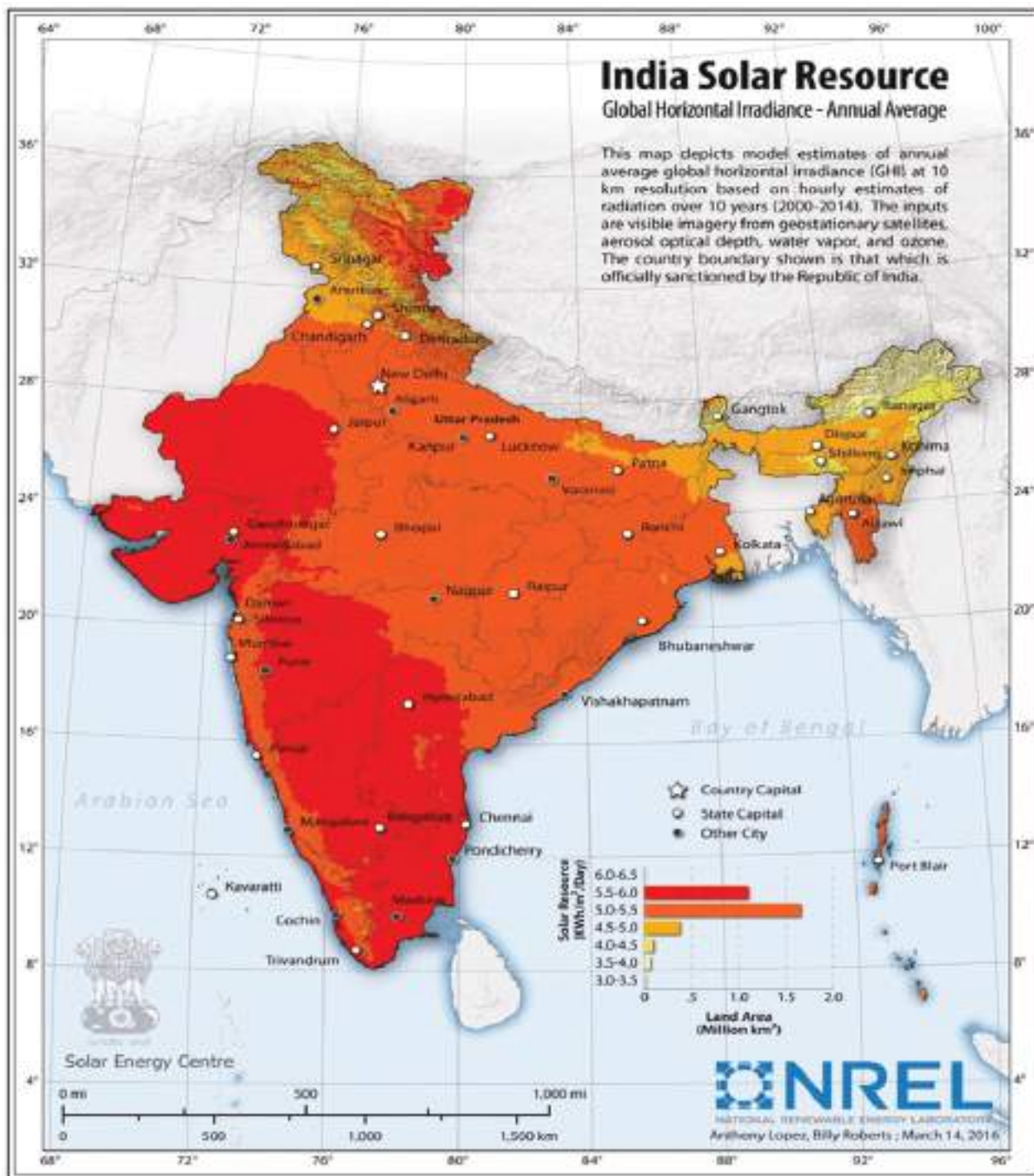


Fig. 2: Daily Solar Radiation Per Meter Cube in India

Battery Swapping station can be installed wherever is required and feasible. For this research purpose we will going to calculate all the parameter for the location of Madhya Pradesh (M.P.). Madhya Pradesh’s capital is Bhopal and it have some major cities like Indore, Jabalpur, Gwalior, Sagar, Ujjain, Rewa etc. For this research paper we will going to select Indore for installing Battery Swapping Station with Photovoltaic system. Indore is a Big and Populated city, it is also rank 1st six times for cleanest city in India, in subject of waste management and Recycling of waste. Indore receive around 5 kwh/m² - 5.5 kwh/m² radiation daily.

RETScreen can help us to estimate monthly/daily solar radiation of Indore using the NASA Satellite Data. It can also provide the Air temperature, Relative humidity, Atmospheric Pressure, Wind Speed, Earth temperature by using the Ground Data or by NASA Satellite estimated Data. As for just Demonstrative Purpose of Research Paper, we will select a place on the Agar-Bombay road at Vijay Nagar Square, Indore. Its Latitude is 22.7°N and Longitude is 75.8°E. It has Elevation of 567 m above sea level.

Month	Air temperature	Relative humidity	Precipitation	Daily solar radiation - horizontal	Atmospheric pressure	Wind speed	Earth temperature	Heating degree-days 18 °C	Cooling degree-days 10 °C
	°C	%	mm	kWh/m ² /d	kPa	m/s	°C	°C-d	°C-d
January	18.2	48.9%	3.38	4.61	972	2.6	23.6	0	254
February	20.8	38.7%	6.76	5.35	970	3.1	27.6	0	302
March	26.0	27.2%	4.16	6.20	968	3.8	34.4	0	496
April	30.2	23.7%	4.50	6.65	965	4.7	38.4	0	606
May	32.5	32.3%	14.72	6.75	962	5.8	37.4	0	698
June	29.5	59.8%	146.89	5.54	960	6.1	32.4	0	585
July	26.1	80.0%	307.69	4.27	960	6.0	28.4	0	499
August	24.8	86.9%	230.76	3.88	962	5.4	27.6	0	459
September	25.3	77.3%	187.75	4.72	964	3.8	28.6	0	465
October	25.1	55.9%	31.16	5.17	968	2.2	28.9	0	468
November	22.0	48.1%	8.55	4.68	971	1.7	26.5	0	380
December	18.8	48.7%	5.34	4.32	973	2.1	23.2	0	276
Annual	25.0	52.3%	951.56	5.17	96.6	3.9	29.7	0	5,468
Source	Ground	Ground	NASA	NASA	NASA	Ground	NASA	Ground	Ground
Measured at						m	10	0	

Fig. 3: Climate data of Indore City

DESIGNING OF PHOTOVOLTAIC SYSTEM

In this chapter we will discuss the technical specification, parameters and methodology used for designing the Grid connected Photovoltaic system for our battery swapping station located at Indore near Vijay Nagar Square. Battery Swapping can be done by human effort if the size of battery is small. Battery used in 2-W is 1.2-3.3 kwh battery having weight 15kg to 18kg which are considered heavy for general people. Therefore the Battery size and capacity can be divided into smaller batteries so that it can be handle easily. For this Research paper we are considering the Battery capacity as 1.2 kWh which have nominal voltage and current as 48V and 25Ah respectively and other specifications are given in below table.

Table 1. The Technical Specification of Batteries

Parameter	Values
Dimension	L 165mm, W 165mm, H 245mm
Battery capacity	1.2 kWh
Nominal capacity	25Ah, 48V
Nominal voltage	48V
Maximum Charging current	10 A

Required Power Demand

Each battery required 48V and 10A which means 4kw of power is needed to charge the battery. If the battery swapping station is consisting of 15 similar battery pack so the total power required to charge the battery at a time is 6 kw. Charging of those batteries with PV module can have multiples cases.

CASE 1 : If all the battery is fully charged the power generating at the station can be exported to the Grid.

CASE 2: Some of the battery is discharged, if generating power is able to meet the demand then PV will charge the batteries.

CASE 3: If all the batteries are discharged and PV generation is meet the demand then PV will charge the batteries.

CASE 4: If all the batteries are discharged and PV is not capable to meet the demand then power will be withdraw from the Grid. Using these cases we will undergo Financial and Power Analysis

Sizing of Photovoltaic panel

Total peak watt produced is required for finding the correct size of the PV module. The peak Watt rely on the size of the panel and location climate, Different PV panel produce different amount of power. For India, the panel generation factor is 5.56 [8]

$$\text{Total Watt Peak rating} = \frac{\text{Solar PV energy required}}{\text{Panel generation Feactor}}$$

After calculating the total watt-peak rating, calculation of the number of PV panels for the system is calculated by the ratio of the Total watt Peak rating required to the PV output power rating as revealed in below formula. This gives 18 PV module when we used Sunpower mono-Si-SPR-X21-345-COM with an output capacity per unit is 345W

$$\text{No. of PV panel} = \frac{\text{Total Watt Peak rating}}{\text{PV output Power rating}}$$

The technical details of Sunpower mono-Si-SPR-X21-345-COM is given below in table 2. The Sunpower is Company which developing record-breaking Solar-technology since 1970. Its Headquartered in Silicon valley since 1985. Sunpower is the only U.S.-based solar company that been around longer than our 25 year warranty. Solar panel are excellent, they produce more electricity over a smaller area and they are last long compare to the other panel in market. It is highly efficient and have excellent performance under low light condition. It provides 21% efficiency under favorable condition. These panel will be great for this project work because of small spacing and higher efficiency. [9]

S. number	PARAMETER	VALUE	UNIT
1)	Rated Voltage (V_{mpp})	57.3	V
2)	Rated Current (I_{mpp})	6.02	A
3)	Open-Circuit Voltage	68.2	V
4)	Short-Circuit Current	6.39	A
5)	Max. System Voltage	1000	V (UL/IEC)
6)	Maximum Series Fuse	15	A
7)	Power Tolerance	+5/-3	%
8)	Avg. Panel Efficiency	21.5	%
9)	Nominal Power	345	W
10)	Power Temp Coef.	-0.29	%/°C
11)	Voltage Temp Coef.	-167.4	mV/°C
12)	Current Temp Coef.	2.9	mA/°C

Note – All the data is calculated under Standard test condition (STC)

Fig. 3: The Technical Specification of Sunpower Mono-Si-SPR-X21-345-COM

Solar Inverter Selection

Inverter is a device used to convert DC power to AC power. The excess amount of power generated by the System can only be feed to the grid after conversion. Therefore Inverter will be required for conversion. The selection of inverter is done such that its input rating should never be lower than the total watt. It should have same nominal voltage as battery. For grid connected system, the input rating of the inverter should be same as PV array rating.

OUTCOME AND DISCUSSION

This Study will provide the viability of installing PV based Battery swapping station. The cost for installing Photovoltaic System for Battery Swapping station is be calculated in this paper. The Benchmark cost for Grid tide Photovoltaic system for 3 kW to 10 kW is to be 44,640 Rs/kW or for Special Category States/UTs (i.e. North-Eastern States including Sikkim, Himachal Pradesh, Uttarakhand, Jammu and Kashmir, Ladakh, Andaman and Nicobar and Lakshadweep islands) is 49,100 Rs/kW. This Benchmark Cost includes the cost of solar PV panels, inverter, balance of system e.g. cable/ Switches/ junction box/ mounting structure / applicable taxes, etc. This Benchmark Costs excludes the cost of net metering cost and battery pack- up costs.

Climate data for the location Agra-Bombay road vijaynagar square, this data includes the details of Air temperature, Humidity, Solar radiation, Atmospheric pressure, Wind speed, Earth temperature, Heating/Cooling degree-days are given in RETScreen from Ground analysis or by NASA Satellite. Daily solar radiation and Earth temperature of the selected location is given by the graph given below.



Fig. 4: Monthly Received Solar Radiation and Earth Temperature

Technical Viability

RETScreen Expert output depends on the technical expects like solar collector efficiency factor, solar technology, solar tracking mode etc. All these details are important in term of technical sustainability. For this project, we will select Fixed solar tracking mode as it's consider cheap and have less complex component. Slope angle is the angle at which solar panel is mounted. It is decided according to the path of sun such that solar panel receive the maximum solar radiation to the entire year. For the countries like India is varies from 28° to 30°. and Considering the Azimuth angle is 0°.

RETScreen Data is depend on the Number of clear days encounter, location of system and efficiency of the Module. The parametric data of the solar panel is given in table 3.

Month	Daily solar radiation - horizontal kWh/m ² /d	Daily solar radiation - tilted kWh/m ² /d	Electricity export rate Rs/kWh	Electricity exported to grid kWh
January	4.61	6.10	7	904.943
February	5.35	6.44	7	851.743
March	6.20	6.66	7	951.853
April	6.65	6.36	7	869.085
May	6.75	5.94	7	835.890
June	5.54	4.78	7	669.476
July	4.27	3.82	7	565.936
August	3.83	3.58	7	534.322
September	4.72	4.76	7	673.569
October	5.17	5.92	7	854.870
November	4.69	5.95	7	840.217
December	4.32	5.87	7	869.285
Annual	5.17	5.51	7	9,421.189

Fig. 5. Monthly Solar Radiation at Slope of 30° and Azimuth Angle 0°

Table 2: Parametric Characteristics of the Sunpower Mono-Si-SPR-X21-345-COM

Property	Value
Type of Technology	Mono-si
Power capacity	6.21 kW
Manufacturer	Sunpower
Model	Mono-si – SPR-X21-324-COM
Number of panels	18
Efficiency	21.5%
Nominal operating cell temperature	45°C
Temperature coefficient	0.4%/°C
Solar collector area	28.9 m ²
Miscellaneous losses	15%

Economic Sustainability

The Financial parameter make every proposal more practical. It consist such as inflation rate, Debt ratio, Debt, Equity, Debt interest rate these all parameters are count in the RETScreen Expert Financial Worksheet. The values are already calculated for most of the project but we can provide value manually either as shown in Table 4. Economic Analysis also includes the cost of transportation, infrastructure and labor cost all these parameter are taken care in consideration. Based on those values Internal Rate of Return, Net Present value, Benefit-Cost ratio, the annual life cycle of plant are provided. It also provide the Simple Payback period, it is the time required by system to generate the amount of money which being invested in initial period. RETScreen can calculate the Electricity export revenue if all the electricity is feed to the grid.

Costing/Saving/Revenue

The estimated costing for this project can be decided as the regular investment of planting a solar panel. This costing includes the study of Feasibility of pant at given location for this project it is supposed to be Rs 5000, it

has 0.95% of total costing. Development cost include the cost of material and labor required for installation and for ruff work, this supposed to be Rs 10,000 which is 1.9% of total initial cost. Technical team is also required for instrument set up and wiring of plant, it'saroung 1.9% of total initial cost Rs 10,000. According to the present market prize of the panel is supposed to be Rs 80,000 per panel, this includes 6 panels are required for operation, the total cost come out to be Rs 4,96,800 which is 94.3% of total initial coast. At last the Miscellaneous cost is supposed around Rs 5000 which is 0.95% of total initial cost. The total initial cost come out to be Rs 5,26,800.

Annual Costs are the cost which need to be pay annually, this costing include operation and management cost, as this system is fixed orientation based it required little maintenance it can be put Rs 2,174. Government or bank provide good subsidy on implement solar panels in India. If initial cost is taken charge under some subsidy, then debt term is consider for 10 years with Rs 60,839. Inverter Replacement is also considered in this research paper that required periodically replacement at every year, a typical normal inverter cost around Rs 30,000.

If all the electricity generated by our solar Module is feed to the grid the considered saving/revenue which is generated by exporting electricity is consider Rs 65,948.If this further conclude its simple payback period is only 8.3 Years and Equity payback is 8.5 year which is drawn only by exporting the electricity. The Net present value of this project is Rs 2, 57,500. Which has the annual life cycle saving of Rs 26,215 per year. Benefit-cost (B-C) ratio is 4.3.

Table 3: Financial Input Variable

Financial Parameters	Value	Unit
Inflation rate	3	%
Discount rate	9	%
Reinvestment rate	6	%
Project life	25	Year
Debt ratio	85	%
Debt interest rate	6	%
Debt term	10	Year
Debt payment	59,569	Rs
Electricity export rate	7	Rs/kWh
Electricity export escalation rate	2	%
Total Initial cost	5,15,800	Rs
Operation and Maintenance Cost	2,174	Rs
Total Annual cost	61,742	Rs

Emission Reduction Assessment

Since 1990, three sector namely Industrial sector, electricity and heating sector and transportation sector are the fastest growing source of GHG (Green House Gas) emission. In which transportation causes 12.6 % of total GHG emission. [11]. There was a temporary decrease in the average global CO₂ emission in year 2020 during epidemic world wide according to the Carbon emission data, which increased again in 20221 after the end of casualty.

The emission analysis worksheet is used to calculate the GHG emission reduction carrying out by the implementation of solar module. For Indian region GHG emission factor (excl. T&D) is 0.856 kgCO₂/kWh, which has Base case of 8.063 tCO₂/kWh. By following parameters software calculate the gross annual GHG emission reduction for the location. It only calculate the GHG emission during the project operational period

not during the life cycle. This project have the 8.1 tCO₂ reduction. According to Committee constituted by the Central Electricity Authority (CEA), India's plan is to install 500 GW (gigawatt) of renewable energy capacity by 2030. This project will help in achieving so. In RETScreen, GHG reduction revenue that is proposed to any investor in order to generate revenue by selling the GHG reduction emission that is called carbon trading. If the plant is at big scale it would reduce more carbon footprint which can be sell to any potential customer.

Table 4. Financial Output Variable

Financial Viability	Value	Unit
Internal rate of return		
Net Present Value	267,302	Rs
Annual life cycle saving	27,213	Rs/year
Benefit-cost (B-C) ratio	4.5	
Debt service charge	1.1	
Energy production Cost	5.52	Rs/kWh

Sensitivity Analysis

Sensitivity analysis is a study to determine what different values for an independent variable can do to affect a specific dependent variable. In other words, the uncertainty associated with the project during analysis is a measure of the level of uncertainty of the inputted variable which has effects on the level of uncertainty on the calculated financial variable.

The value of the initial cost is gotten to be Rs 5, 26,800 and with $\pm 30\%$. It will be Rs 6, 84,840 and Rs 3, 68,760 respectively. And the actual electricity export rate is Rs 526,800 but with $\pm 30\%$ it will be Rs 6,84,840 and Rs 3,68,760 respectively. It is observed that the project is to be financially profitable. The Net Present Value (NPV) is sensitive to the electricity export rate to the grid than to the initial investment and the debt interest rate.

Risk Analysis

Risk analysis is done before the implementing of solar energy project in such a way it will help to predict the level of uncertainty, its's just similar to the sensitivity analysis. It just different from sensitivity analysis in term of comparing the parameters, in sensitivity analysis uses two different parameters to come to a conclusion whereas in risk analysis all the parameters are allowed to vary with each other within a specific range. The RETScreen perform a Monte Carlo simulation technique for 5000 times for recalculating the energy production cost and the result gotten is displayed in impact graph and the distribution graph.

According to the impact graph, the variation on the energy production cost is as a result of the variation of the various parameters. The electricity exported to the grid and the electricity exportrate have a great impact on the project but they are in opposite direction to the initial cost. An increase in the initial cost increase the energy production cost while an increase in the electricity exported to the grid decreases the energy production cost. In distribution graph , the level of risk set at 20% by excluding the lower 10% and the upper 10% value expected from the energy production cost to exceed 90% confidence level. According to the energy production cost is Rs 4, 07,338 per kilo watt hour and this is closer to the Rs 2, 49,806 per kilo watt hour of the energy making the project bankable and realistic.

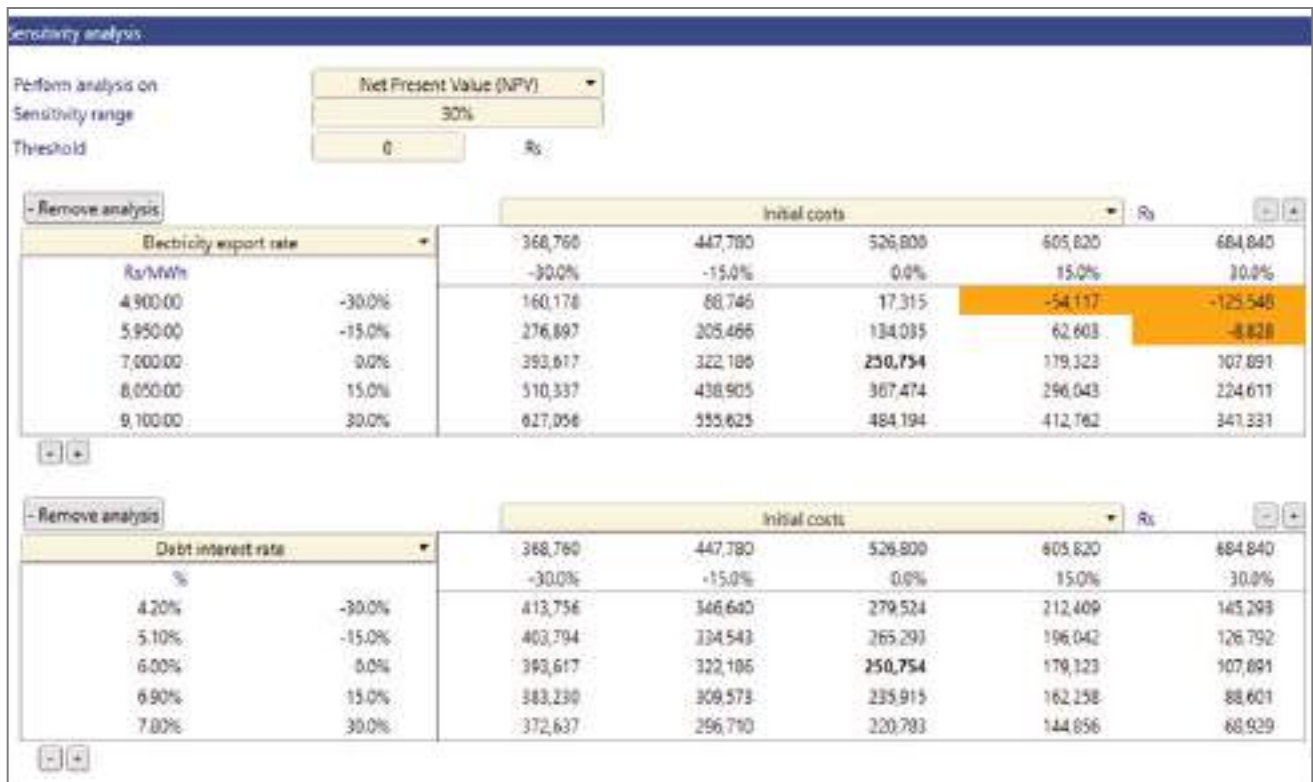


Fig. 6: Sensitive Analysis of Photovoltaic Module used for Battery Swapping

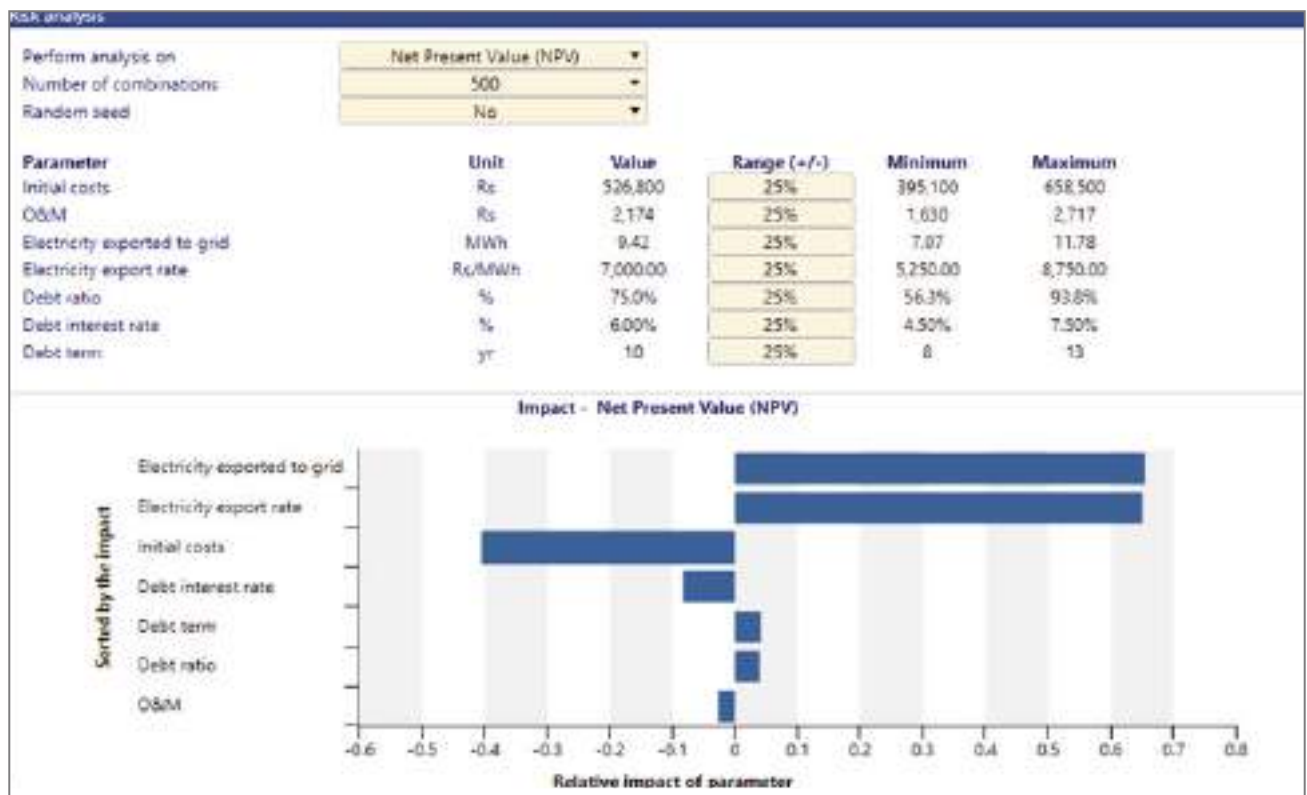


Fig. 7: Impact Graph of Risk Analysis of Photovoltaic Module used for Battery Swapping



Fig. 8: Distribution Graph of Risk analysis for Photovoltaic Module used for Battery Swapping

CONCLUSION

In this research we have conducted a feasibility analysis to understand the viability of installing Photovoltaic Module for the battery swapping station. This paper analysis the technical, financial, risk, sensitivity and environment impact of the project. This was done to attract attention of private sector on to the potential of EV (electrical vehicle) sector in upcoming years. It's also elaborate the idea of installing PV Module for charging the swappable batteries. This will help the people to understand the upcoming advancement in the technology. The Software called RETScreen Expert developed by the Natural Resource Canada. Provide all the required data for this assessment. It provide the climate data by a NASA satellite or by a ground data collected by the experts. And the Financial parameters which include the reinvestment rate, inflation rate, discount rate, and debt interest rate were used for the analysis as input data in the Software. Depending upon the selected location and solar panel wattage, the software calculate the total amount of energy generated by the panel and exported to the grid. The payback period of the system is assumed to be eight and half year which is understood to be good. From the sensitivity and risk analysis it is concluded that the electricity export rate has a major impact on the Net Present Value (NPV).

Finally, establishing such plant can reduce the rush on the EV charging station and can reduce the load on the main power generating stations.

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Techno-Economic Analysis of Hybrid Energy Systems for Sustainable Power Generation

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▶ ABSTRACT ◀

The need for electricity is rising as a result of economic and population expansion, which has increased the demand for renewable energy sources. Due to the limitations and deteriorating performance of conventional power generators powered by fossil fuels, the utilization of renewable energy sources has become more and more crucial. In remote and rural areas where the transmission chain of network extension is impractical or inefficient, hybrid renewable energy systems (HRES) offer a potential answer. In this study, the hybrid optimization model for electric renewables (HOMER) software to analyze the techno-economic performance of, off-grid solar PV, wind turbines, batteries, micro-hydropower, and converters are taken into consideration. The site chosen is Sitoka, a village located in the Khargone district of Madhya Pradesh. The latitude and longitude are 22.1814° N, and 75.8912° E respectively. The result of the simulation showed that adding solar PV, Micro-hydro, and wind turbines with Diesel Generators can supply up to 100% of the needed electricity, with the PV-WT-MH-BT-CT system achieving the lowest cost of energy (COE) of \$0.197/kWh in the off-grid scenario. Analysis was also done on the sensitivity of many parameters, including solar radiation, wind speed, NPC, COE, O&M, and renewable fraction. The studies highlight the significance of employing HOMER to examine the techno-economic performance of renewable energy systems for rural electrification and optimize the design of HRES.

Keywords: Techno-economic, Hybrid Renewable Energy Sources, Solar Energy, Wind Energy, Microgrid.

Abbreviations

PV: Photovoltaic kWh/yr: kilowatt-hour/year

MH: Micro-Hydro CT: Converter

CoE: Cost of Energy BT: Battery Storage

HES: Hybrid Energy System HRES: Hybrid renewable energy system

WT: Wind Turbine DG: Diesel Generator

INTRODUCTION

The ever-increasing electricity demand, driven by technological advancements and population growth, has led to a critical need for reliable and sustainable energy sources. Globally, renewable energy systems have advanced significantly due to the depletion of traditional energy sources and the necessity to cut CO₂ emissions to address environmental crises [1]. However, the investigation of hybrid energy systems that combine renewable and conventional resources is necessary due to the intermittent and unpredictable nature of renewable sources, as well as changing energy demands [2].

A contemporary alternative that provides cost savings and lower carbon emissions is microgrid technology. Microgrids assist the continued development of sustainable energy sources while providing reliable power output by mixing renewable sources including wind turbines, solar panels, and hydropower. Energy storage, commonly in the form of batteries, is essential for making up for the erratic nature of renewable energy sources. However, because of their longer lifespan, quicker reaction to load fluctuations, and reduced maintenance costs, other storage technologies like pumped-storage hydropower are gaining popularity.

Hybrid energy systems are especially pertinent in nations like India where rural electrification is still a problem. Techno-economic analyses can be carried out to optimize performance and analyze the financial viability of hybrid systems by looking at various system configurations using software like Homer Pro. These evaluations assist in locating affordable options that provide a steady supply of electricity while reducing their negative effects on the environment.

One of the most important steps in reducing global warming and lowering greenhouse gas emissions is the switch to renewable energy[3]. The use of renewable energy is crucial since the production of electricity using fossil fuels considerably contributes to climate change. Developing nations have a wealth of renewable energy resources, such as solar and wind. However, more public knowledge, financial support, and social involvement are required for them to reach their full potential.

In order to generate sustainable energy, this paper will analyze the techno-economics of hybrid energy systems. These systems address the problems caused by intermittent renewables and changing energy demands by combining renewable and conventional resources. Utilizing software like Homer Pro, system configurations and financial analyses may be optimized. This helps decision-makers make well-informed choices, facilitating the shift to a future powered by sustainable energy sources.

Novelties of the paper;

1. An innovative HRES design addresses scalability and cost issues in rural locations.
2. HRES achieves reduced expenses and enhanced performance metrics.
3. The proposed solution has a quicker payback period and benefits the environment.

The paper is organized as follows: Section 2 provides an overview of software description, Section 3 describes the methodology for techno-economic analysis, Section 4 provides an overview of hybrid energy systems and their components, Section 5 presents the results and findings, Section 6 Sensitivity Analysis, Section 7 Conclusion of the papers, and Section 6 acknowledgment

SOFTWARE DESCRIPTION

HOMER Pro is a powerful software tool for designing and analyzing hybrid power systems incorporating various renewable energy sources. With its extensive set of features, HOMER Pro enables users to evaluate techno-economic performance, optimize system settings, and make wise decisions. To develop effective and affordable energy solutions, the program enables the integration of solar photovoltaics (PV), wind turbines, batteries, cogeneration, fuel cells, biomass, and other inputs. HOMER Pro assists users in choosing the best combination of renewable energy technologies, reducing costs, and maximizing energy production for both grid-connected and off-grid applications by simulating and examining various system configurations.

METHODOLOGY

On-site location data must be analyzed using pertinent criteria, such as electric load demand, daily radiation, clearness index, and temperature, in order to come up with the best design for a hybrid renewable energy system (HRES). In order to evaluate the value of self-consumption, demand charge reduction, and energy arbitrage, HOMER software integrates engineering and economics data. This software is effective for modeling and analyzing HRES solutions. The approach uses HOMER to do techno-economic analysis, optimization, and sensitivity analysis to find the least expensive HRES design among various structures while also taking the financial risk, environmental laws, and readily available RES supplies into account. The goals include creating a stand-alone HRES that is appropriate for the given location based on economic and technical performance as well as giving statistics for upcoming investments, system planning, system extension, and policy decisions.

Site Location

Sitoka is a village located in the Khargone district of Madhya Pradesh. The latitude and longitude are 22.1814° N, and 75.8912° E respectively[4]. The settlement has a total land area of 204.03 hectares. Sitoka has a total population of 605 people, 313 of whom are male and 292 of them are female. The chosen location is located near the bank of the Narmada River providing huge availability of water sources that can be used for the generation of electricity.



Fig. 1: The Map of Sitoka Village [4]

Load Profile of the Site

The load selected is the community load. In the community load, the scaled annual average is 536.32 kWh/day and the peak demand is 70.93 kw. The load demand is low at the beginning of the day but during the midday 12 pm to 5 pm, the load demand is maximum, and then at night the demand is less. The daily load demand and seasonal load demand are depicted below in Figures 2(a), and 2(b).

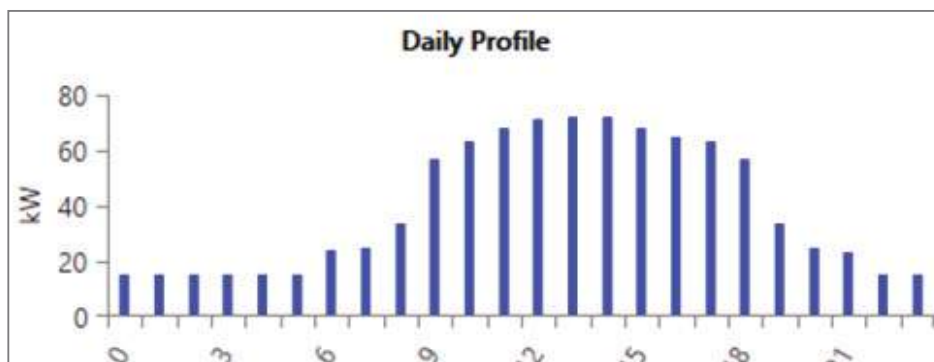
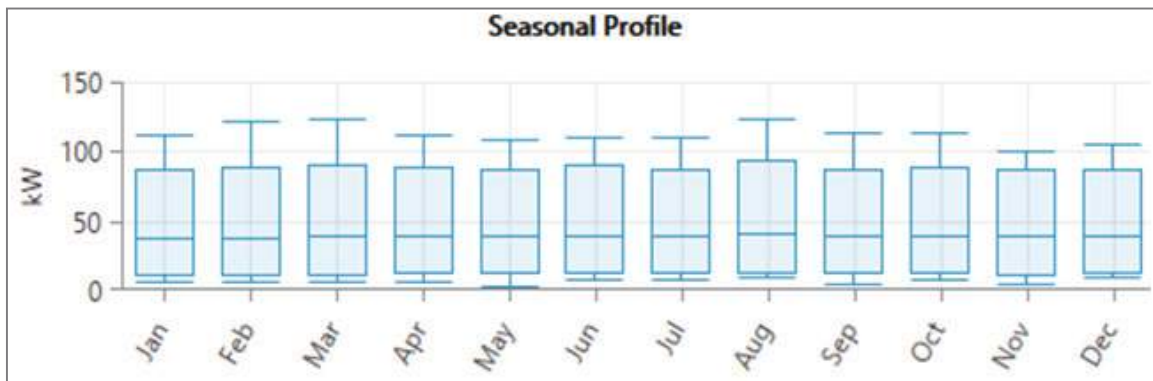


Figure 2(a): Daily Load Profile of the Village



2(b): Seasonal load profile of the village

SYSTEM DESIGN AND COMPONENTS

Solar Panel

Solar photovoltaic (PV) panels are essential for converting solar radiation into electricity. The performance of PV panels is influenced by factors such as incident global solar radiation, panel temperature, and the PV derating factor. The HOMER software was used to analyze the PV panel output, considering these factors. The data from the National Renewable Energy Laboratory (NREL) provided solar radiation and temperature measurements for a specific location (22.1814° N, 75.8912° E). The estimated yearly solar radiation was recorded as 5.27 kWh/m²/day, indicating a significant potential for solar energy utilization. Based on the recorded solar radiation and temperature, the PV panel performance was evaluated using the relevant equation. This analysis contributes to understanding the efficiency and suitability of PV panels for the given location, informing system design and performance optimization.

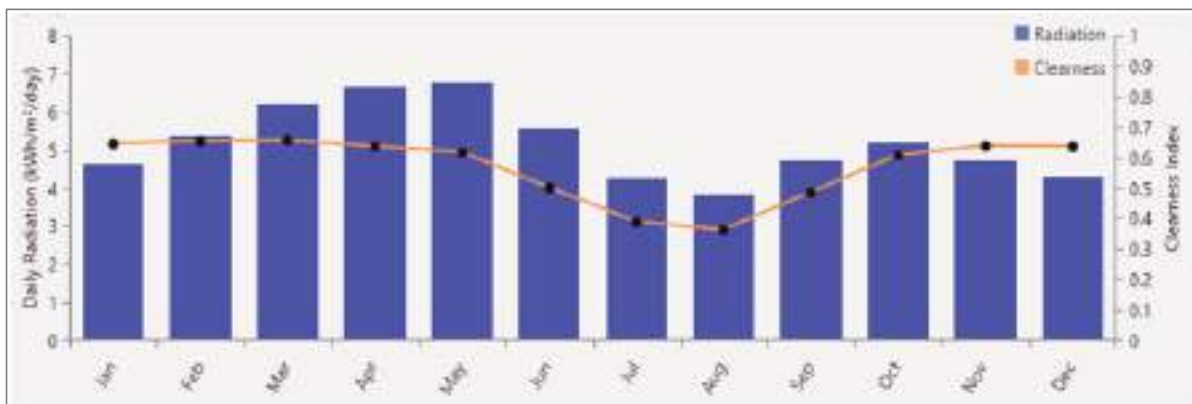


Figure 3: Graph of Daily Radiation vs Clearness Index [5]

Wind Turbine

Wind turbines are devices used to harness the kinetic energy of the wind and convert it into electrical energy. When the wind blows, it causes the rotor blades to spin. The rotational motion of the rotor is transferred to the generator through a gearbox, which increases the rotational speed to generate electricity. The electricity produced is then transmitted to the power grid for distribution to consumers. The measurement of wind for a particular place (22.1814° N, 75.8912° E) was provided by data from the NASA Prediction of Worldwide Energy Resource database. There is a substantial potential for using wind energy, as indicated by the estimated annual solar radiation measurement of 5.45kWh/m²/day.



Fig. 4: The Graph of Average Wind Speed [6]

Micro Hydro

Hydroelectricity, also known as hydroelectric power or hydropower, is a form of renewable energy that harnesses the energy of moving water to generate electricity. It is one of the most widely used sources of renewable energy. Karam Dam is located in the Dhar district which is located 97 km from the chosen site. As shown in the figure below, the monthly discharge requirement for energy generation is calculated using direct runoff output and rainfall distribution data. The annual average discharge is 223.08 L/sec [7].



Fig. 5: The Graph of Average Stream Flow [7]

Diesel Generator

A diesel generator is a type of generator that uses diesel fuel to produce electrical energy. It consists of a diesel engine and an electric generator that work together to generate power.

The capacity of the generator is 1KW and the minimum load ratio is 25% and the duration of the generator is 15000 hrs [5].

Converter

A converter always operates in the inverted or rectification modes. During the rectification phase, it converts AC to DC, and during the optimization stage, DC to AC. the capacity of the converter is 1 KW, its efficiency is 95% and its lifetime is 15 years.

Battery

A battery is a portable device that stores chemical energy and converts it into electrical energy. It consists of one or more electrochemical cells connected together to provide a steady flow of electricity. Its nominal voltage is 12 V and nominal capacity is 1KWh, its minimum state of charge is 40% and the lifetime of the battery is 10 years.

SYSTEM LAYOUT

The proposed system consists of a Generator, Battery, Micro-hydro, Solar PV, Wind turbine, and converter. The system layout is depicted in the figure below and the financial details of the system are shown below in Table 1.

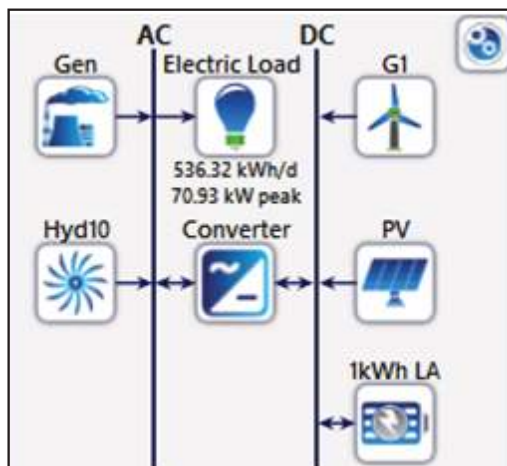


Fig. 6: System Layout of Microgrid

Table 1: System Component’s Economical Detailings [8]

Component	Capital cost (USD)	Operating and maintenance cost (USD)	Replacement cost (USD)	lifetime
PV System	1005 \$	10 \$/year	800 \$	25 years
Diesel Generator	1005 \$	0.300 \$/year	805 \$	15000 hrs
WT System	1205 \$	20 \$/year	855 \$	20 years
Battery	305 \$	10 \$/year	305 \$	10 years
Converter	305 \$	0	305 \$	15 years
MH System	80,000 \$	2,400 \$	40,000 \$	25 Years

RESULT AND DISCUSSION

The ideal off-grid HRES system, denoted in Table 2, is made up of the DG-PV-WT-BT-MH-CT components. Based on the system's NPC, COE, O&M, and RF characteristics, the NPC (\$498,242), lowest COE (\$0.197), and highest Renewable Fraction (99.0%), all while retaining high system performance. The system has little need for pricey DG, which suggests a focus on renewable energy sources. It is not recommended to utilize PV-WT-DG-BT-CT since it has a lower renewable fraction and higher NPC, COE, and O&M expenses. The cheapest system for meeting load demand comprises an 84.8 kW PV, a 24 kW windmill, a 79 kW DG, an 11 kW MH, a 58.6 kW CT, and a 191 kW battery.

Table 2: Details of the System Produced (Cost & Sizing)

System Configuration	Component Size						Cost			RF (%)
	PV(kW)	WT(kW)	DG(kW)	BT(kW)	MH(kW)	CT(kW)	NPC(\$)	COE(\$)	O&M(\$)	
PV-WT-MH-BT-CT-DG	84.8	24	79	191	11	58.6	498,242	0.197	11,589	99.0

Table 3 shows that the HRES system with negative operational and maintenance costs generates revenues as opposed to costs, in contrast to the HRES systems impacted by the grid factor. This can shorten the payback time. The most cost-effective parts of the HRES, PV, and WT have lower overall costs than MH, which has a higher total cost of \$111,026 as a result of its high capital and operational expenses.

Table 3: Financial Evaluation of the Connected Systems

Component	Capital	Replacement	O \$ M	Fuel	Salvage	Total
MH	\$80,000	\$0.00	\$31,026.02	\$0.00	\$0.00	\$111,026.02
DG	\$79,395	\$0.00	\$26,042.48	\$9,498.57	\$13,076.43	\$101,859.61
WT	\$79,395	\$6,541.93	\$6,205.61	\$0.00	\$3,686.80	\$37,980.34
BT	\$57,300	\$51,573.62	\$24,691.5	\$0.00	\$6,021.60	\$127,543.58
PV	\$85,222.9	\$0.00	\$10,962.40	\$0.00	\$0.00	\$96,185.39
CT	\$17,588.74	\$7,462.44	\$0.00	\$0.00	\$1,404.51	\$23,646.68
System	\$348,426.73	\$65,577.99	\$98,927.69	\$9,498.57	\$24,189.34	\$498,241.64

The table 4 shows that while wind power has a relatively lesser contribution because of the low wind speed at the selected location, PV and MH are the key contributors to satisfying the energy requirement. The minimum function of DG in the ideal HRES. The PV array produces 134,937 kWh of energy yearly and runs. The wind turbine produces 39,669 kWh with a COE of \$0.0757/kWh. The annual hydro energy output is 122,716 kWh. The converter runs for 4,427 hours a year, whereas the diesel generator generates 1,937 kWh.

Table 4: Total Energy creation by HES

Sources	kWh/yr	%
PV	134,937	45.1
DG	1,937	0.647
WT	39,669	13.3
MH	122,716	41.0
Total	299,259	100

The monthly average electric contribution by each renewable source for an ideal HRES approach is shown in Figure 7.

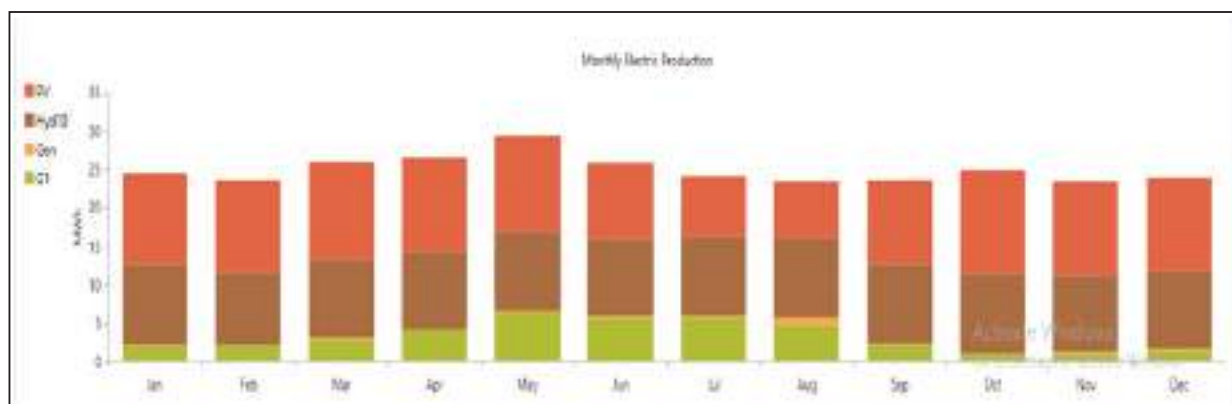


Fig. 7: Monthly Electric Production

Figure 8 provides an overview of the various components of the cash flow for HES.

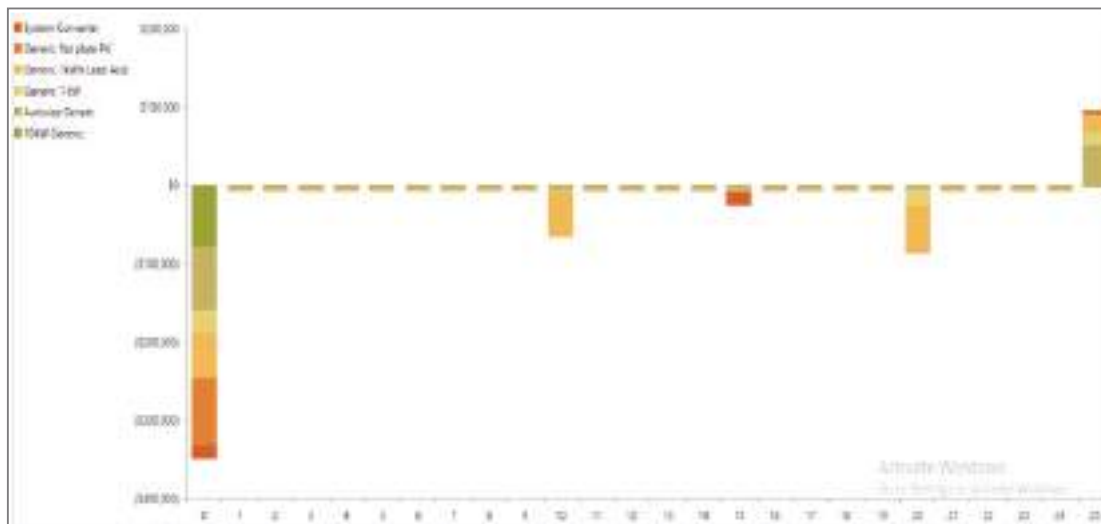


Fig. 8: Cash Flow by Different Systems

SENSITIVITY ANALYSIS

According to the study, on-grid energy systems have superior NPC, O&M, COEs, and RF than off-grid energy systems. The study included sensitivity parameters for global solar radiation and annual wind speed, with the true values (foundation case) either raised or lowered. The base case parameters for annual wind speed (m/sec) and worldwide solar radiation (kWh/m²/day) were 5.45 and 5.27 respectively. While varying the sensitivity parameters worldwide solar radiation (kWh/m²/day) from 5.05 to 5.45 and yearly wind speed (m/sec) from 5.30 to 5.60, the system shows the result in which NPC(\$)¹ and COE(\$)² are decreased and it shows the best result when the worldwide solar radiation is 5.45 kWh/m²/day, yearly wind speed is 5.60 m/sec that is CoE is reduced from 0.197\$ to 0.188\$.

Table 5: Result of Sensitivity Analysis

Sensitivity Elements		Evaluation Criterion			
Worldwide solar radiation (kWh/m ² /day)	Yearly wind speed (m/sec)	NPC (\$)	CoE (\$)	O&M (\$/yr)	R.F (%)
	5.30	498,242	0.197	11,589	99.0
5.05	5.45	491,232	0.194	12,016	100
	5.60	86,982	0.193	12,875	100
	5.30	493,189	0.195	11,423	99.0
	5.45	486,437	0.192	12,288	100
5.27	5.60	479,136	0.189	11,797	100
	5.30	490,226	0.194	12,019	100
	5.45	484,460	0.192	11,401	100
5.45	5..60	474,534	0.188	11,873	100

Fig. 9: Shows the Graph between CoE and RF, this Below Depicts the Sensitivity Analysis Result which Shows that COE has Improved as well as RF also Improved by doing Sensitivity Analysis.

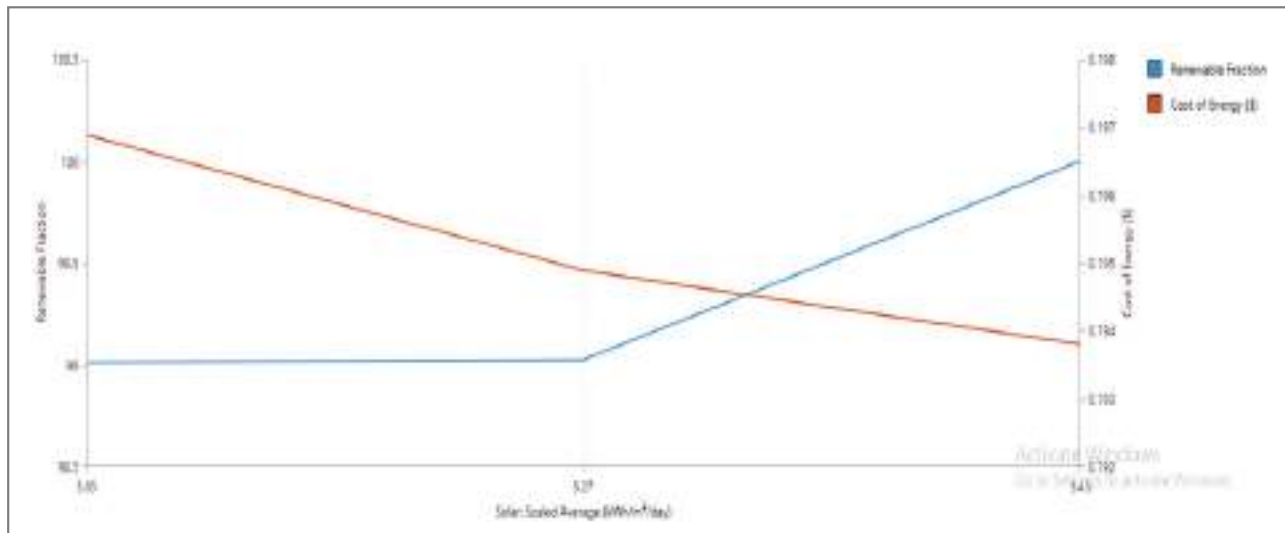


Fig. 9: Shows the Graph between Renewable Fraction vs CoE in Reference to Solar Scale Average

CONCLUSION

The findings of this study highlight the significant novelties and contributions of the proposed hybrid renewable energy system (HRES) design. Firstly, the innovative HRES design specifically addresses scalability and cost issues in rural locations, providing a viable solution to the energy crisis. By integrating renewable sources such as PV, wind, diesel generators, and hydro, the HRES achieves reduced expenses and enhanced performance metrics, ensuring a reliable and sustainable power supply to isolated populations. The simulation-based analysis reveals that the proposed HRES microgrid offers a cost of electricity (COE) of 0.197 Rs/kWh, which is considerably lower than conventional grid power prices. Furthermore, the system demonstrates a quicker payback period, indicating its financial feasibility, while also providing substantial environmental benefits through reduced pollution and greenhouse gas emissions.

According to the study's results, the proposed HRES microgrid proves to be a practical and cost-saving measure for rural communities. The net present cost (NPC) of the system is calculated to be 498,242 Rs, reflecting its economic viability and long-term cost-effectiveness. The HRES successfully satisfies the load requirements of Sitoka Village, ensuring a reliable and uninterrupted power supply. These statistics emphasize the positive impact of the HRES on rural electrification and demonstrate its potential to improve the lives of off-grid populations by providing sustainable and affordable energy solutions.

In conclusion, this research demonstrates the transformative potential of the proposed HRES design in addressing the energy crisis in rural and isolated areas. The achieved novelties of scalability, cost reduction, and enhanced performance metrics position the HRES as a promising solution for meeting the energy demands of off-grid communities. The study's findings underscore the economic viability of the HRES, as evidenced by its low COE and NPC while highlighting its environmental benefits and contribution to a cleaner and more sustainable future. By offering a reliable power supply, a shorter payback period, and reduced pollution, the HRES opens new avenues for rural development and improved quality of life.

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TRACK : 5



Solar-Powered Railway Track Crack Detection Robotic Vehicle

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▶ ABSTRACT ◀

In the present scenario, India has one of the widest railway networks in the world. In India railway is one of the most significant modes of transportation in the country. But as per safety parameters, we were still unable to reach global standards. That's why it's a matter of concern to ensure the safety and protection of the citizens using the service. The main cause of accidents and derailment of trains is the low maintenance of the railway track as many cracks can be found. And sometimes the staff is not aware of the problem which results in the loss of many innocent lives. Hence there is a necessity of developing incipient innovative technology which will be vigorous, fast, productive, and stable for object detection as well as crack detection. This research proposes a robotic device for detecting the crack on the railway track by using a GPS tracking system which is used to send an alert message to the railway control board so that effective measures can be taken on time. The microcontroller Arduino UNO is used to coordinate the activity of the device.

Keywords: *Identification of Cracks, GSM SIM800L, Global Positioning System (GPS) Module, Arduino UNO, HC-SR04 Ultra Sonic Sensor, Infrared Sensor, Supervision of the Railway.*

INTRODUCTION

Indian railway is an insignia of conviction and evolution spanning over a century. On Nov 30, 201, a train named Maha-Kaushal Express got derailed due to a crack on railway track, and near about 52 passengers got injured while one was in serious condition. In that case, inefficient way of crack detection may be one of the main causes of the accident. Through our proposed system we need to establish a more efficient and secure railway system. At present the system of crack detection and track maintenance is a manual system which are larger in size and require more time with man power so it needs to be modified so that more efficient results should be obtained. The proposed system has a robotic vehicle which runs on the railway track as commanded by the microcontroller. Whenever any crack gt detected it will stop automatically and then send an alert and location (via GPS) using GSM (Global System for Mobile Communication) module to the head office. Hence, the proposed system associated to reduce the railway accidents by using autonomous railway track crack detection robotic vehicle. The system can be used at any time to detect cracks and inspect the railway tracks. The system is based on solar energy so it will take less amount of external power and is eco-friendly.

OBJECTIVE

The main goal is to identify the gaps in the railroad and to figure out if there are any hazards in the tracks to elude and dissuade accidents. This type of system comes up with a cost-effective solution to the rail line detection issue by using a sonar or ultrasonic sensor and a infrared detector sensor that locate the exact position of the faulty track and along with transmit the information to the control room of railway via SMS, so that incidents can be halted.

SCHEMATIC

Fig. 3.1 demonstrates the schematic of “SOLAR POWERED RAILWAY TRACK CRACK DETECTION ROBOTIC VEHICLE”, there are one batch of infrared detector units assembled to the anterior side of the autonomous vehicle. Infrared (IR) transmitter and infrared receiver circuit is employed here to sense the crack. When the power is given to the robotic vehicle, it travels along the rail track. The Infrared (IR) sensors keep a check on the condition of the tracks.

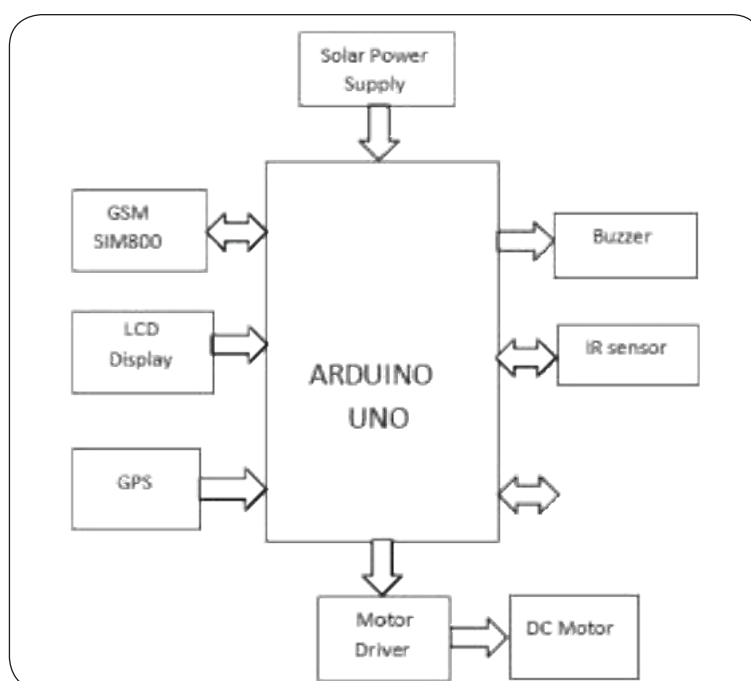


Fig. 3.1: Block Diagram Schematic

METHODOLOGY

1. **Arduino UNO:** An open-source microcontroller ATmega328P Arduino UNO is a programmable circuit with open-source H&S (hardware and software). It is easier to use. It consists of a USB interface, power jack, 14 digital input-output connectors, 6-analog outputs and a reset switch. By attaching USB cable, can able to provide the power that is needed to run the card.

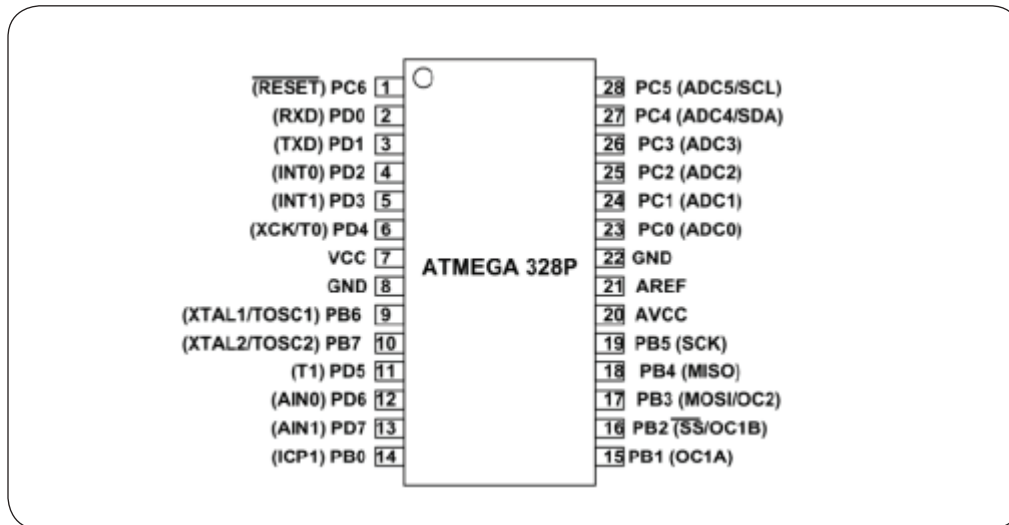


Fig. 1: Arduino UNO

2. **Ultra-Sonic Sensor:** HC-SR04 Sonar or ultrasonic sensor is an electronic contrivance which is utilised to detects the concrete object's distance by emitting ultrasonic sound waves and transforms the reflected sound into electrical signal waves. These waves peregrinate more expeditious than audible sound waves. The sensor has 4 pins that are: VCC, trigger, ground (GND) and echo.

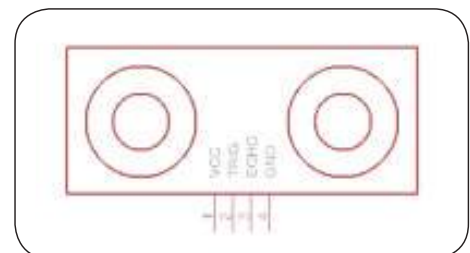


Fig. 2: HC-SR04 Ultrasonic Sensor

3. **Infra-Red Sensor:** The infrared radiation sensitive sensor is an electronic device that is furnished with consolidated infrared transmitter and infrared receiver which sends infrared energy and identify any obstacles in front of the model. The sensor does have a very reliable and fixed response.
4. **GSM SIM 800A Module:** The GSM (Ecumenical System for mobile communications) is a designated contrivance which includes USB, a serial link, Bluetooth or mobile phone that offers support for GSM modems. sanctions programs like Short Message Service (SMS) to transmit and receive messages over the Modulator Demodulator(modem) interface.

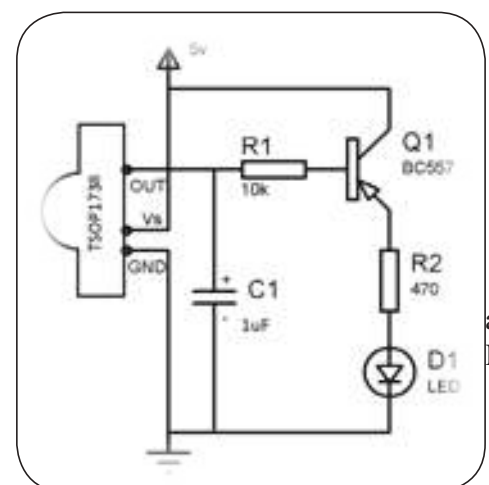


Fig. 3: Infra-Red Sensor

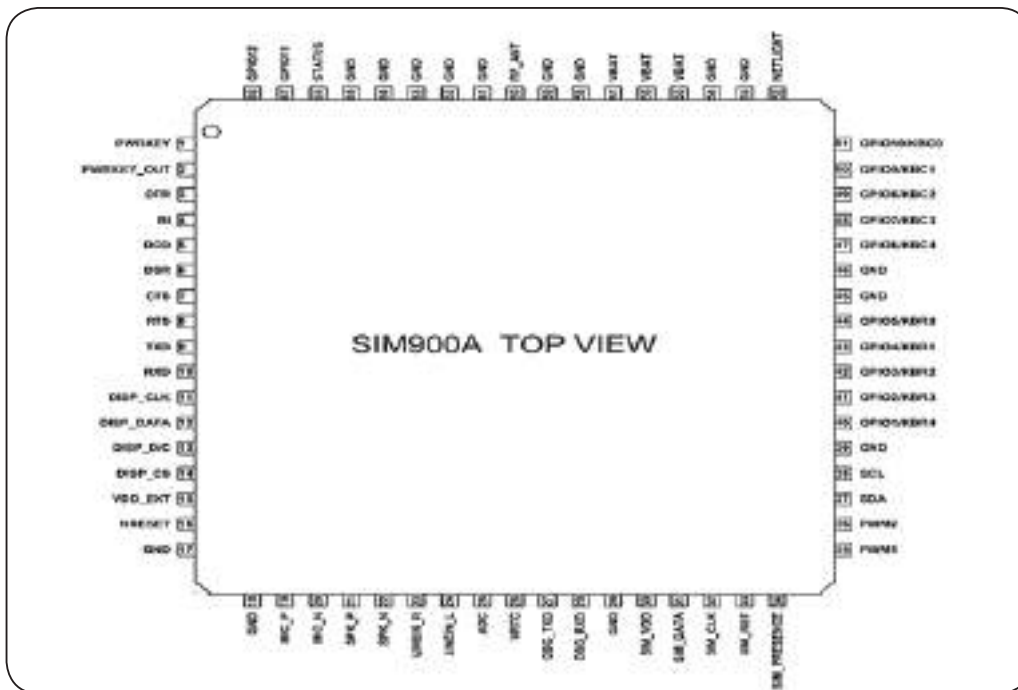


Fig. 4: GSM SIM 800A Module

- Neo 6M GPS Module:** The Satellite-based radio navigation Global Positioning system is utilized to identify a path of an object on the earth. The location is shown on a longitude and latitude view or map view. It consists of small processors and antennas that directly receive data sent by the satellites with the help of RF frequencies.

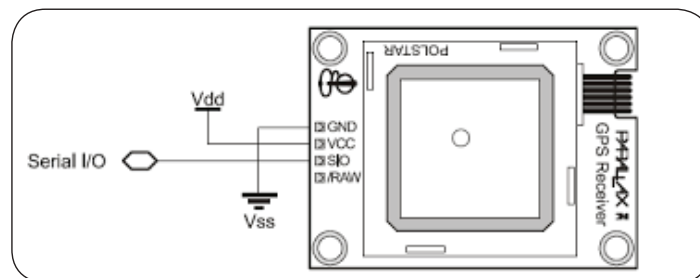


Fig. 5: Neo 6M GPS Module

- 4.6. Motor Driver L298N:** The motor driver is an electronic device which helps in converting electrical energy into mechanical energy. It is used for monitoring the movements as well as the speed of the engines.

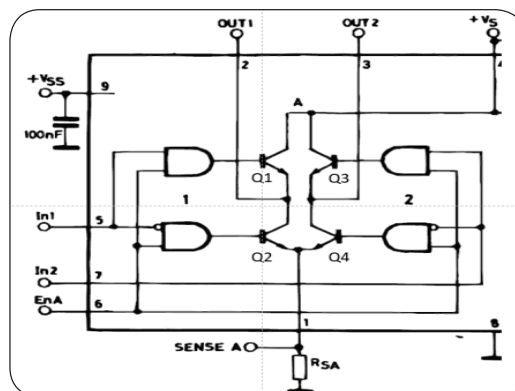


Fig. 6: Motor Driver L298N

7. **DC Motor:** DC Motor is referred to as any type of rotary electric motor that converts direct electrical energy into mechanical energy by engendering a magnetic field. The celerity of DC motor can be balanced by utilizing a dynamic supply voltage, or by modifying the current vigour in its field windings.

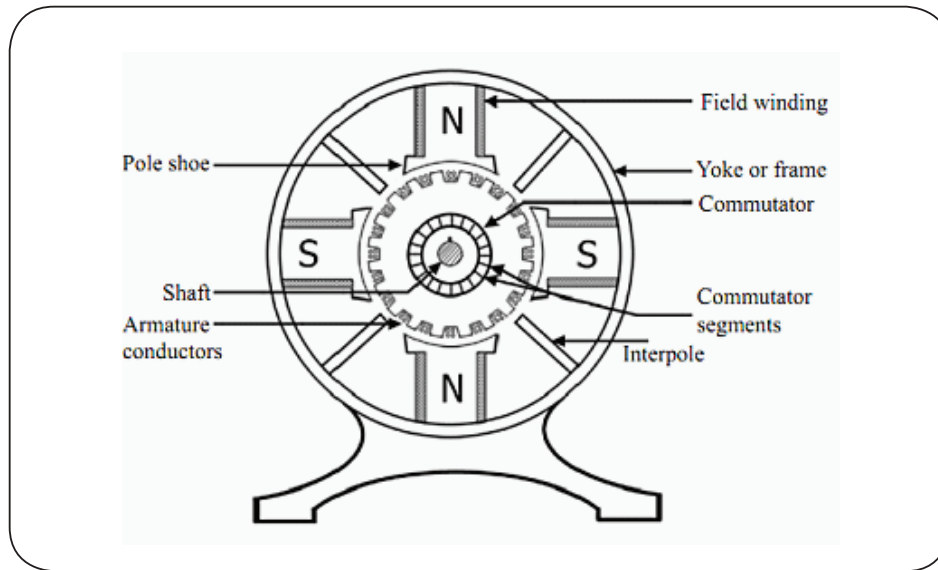


Fig. 7: DC Motor

WORKING PRINCIPLE

The proposed system/robotic vehicle is mainly based on two sensors i.e. Ultrasonic sensor and IR sensor for crack detection on the railway track. The Ultrasonic sensor transmits the ultrasonic waves of sound which get reflected back on reaching the target. If the target contains any crack it will be detected by varying time taken by the returned echoes. Followed by GPS module to track the most precise location of the crack and GSM module for sending the information to the head office/control room. Initially the robotic vehicle is placed on the railway track and commanded to move. When it faces any faulty track or crack it will stop moving. And the microcontroller command GPS to give precise location of the area so that it will be send a SMS to the nearest control room of the railway through GSM module.

The system flow chart is shown below in Fig 5:

IMPLEMENTATION

The principle aim of the proposed system is to identify any crack or impediment on the railway line effectively with the use of modern microcontroller technology. This system will be more efficient and less time consuming than the ordinary manual system. The present system needs railway workers to walking or riding the trolley on the railway track. It takes more time and labours. But here we are using ultrasonic and infrared sensors connected with the microcontroller (Arduino UNO) for the same purpose. The whole system will be driven my DC motors supplied with DC supply through battery and solar panel.

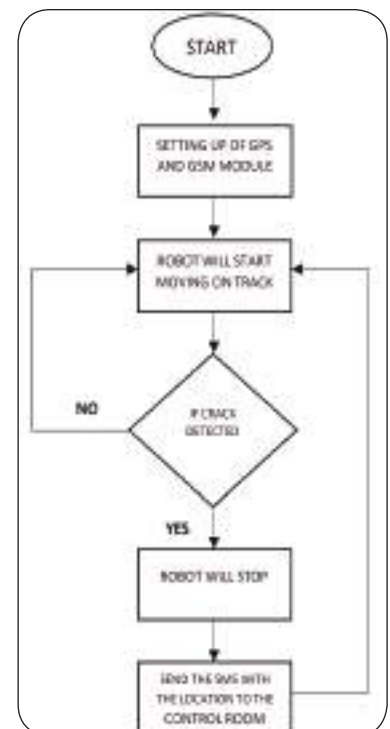


Fig. 5: Flow Chart

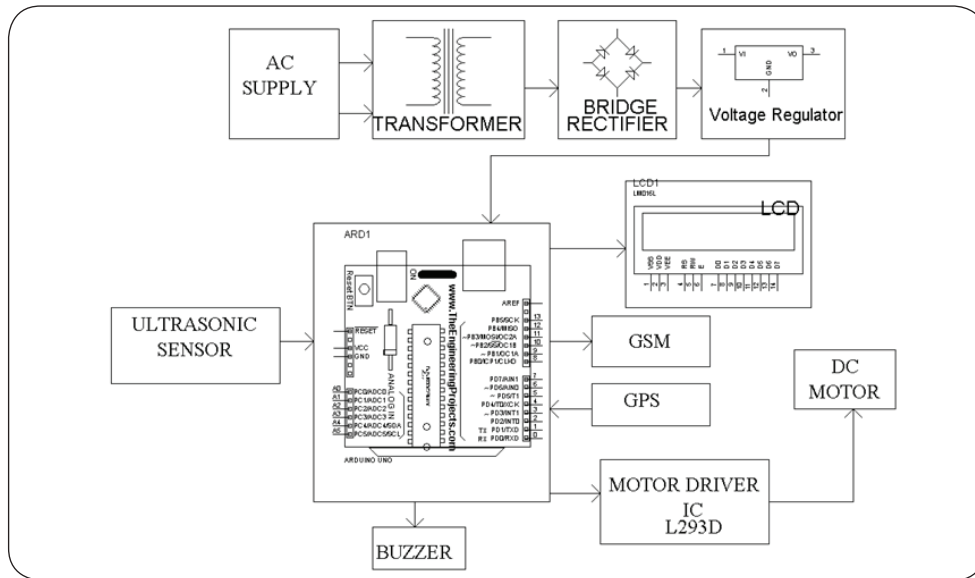


Fig. 1: Circuit Diagram

When the crack detected a message will be send to the concern authorities with the help of GSM module. And GPS module is inserted for identifying the exact location of the crack as shown in Fig 6.2.

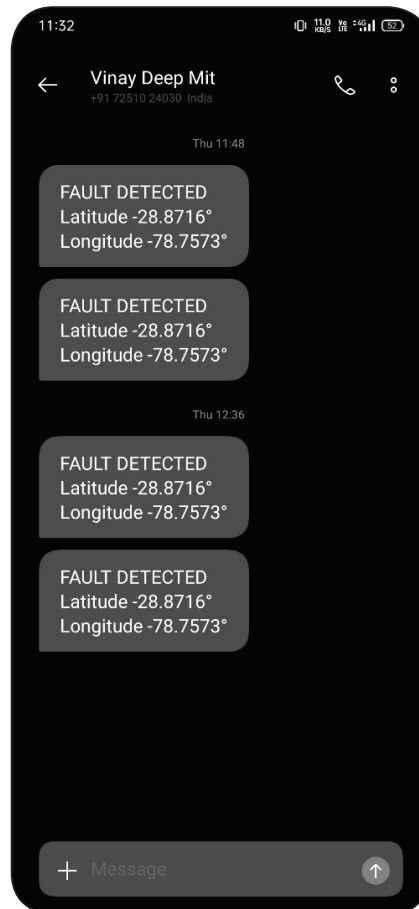


Fig. 2: Screenshot of the Outcome

Advantages

Following are some advantages of the proposed idea:

- (a) Fast detection of track discontinuity leads to the prevention of accidents.
- (b) The mechanism saves time and it is more efficient than current manual checking of track.
- (c) Construction is simple and easy to use.
- (d) Maintenance is easy.
- (e) The system will reduce the man power and labour.

Applications

The proposed idea has various applications:

- (a) Wireless identification to the station master.
- (b) The inspection of cracks will be done automatically rather than manually.

CONCLUSION

The solar powered railway track crack detection autonomous robotic vehicle used for the analysis of railway track and crack detection, it will have a major impact in the maintenance of track which will be subsidiary in averting train accidents to a prodigiously and sizably voluminous extent. This robotic vehicle can be used for the analysis in regions like hilly regions, deep coal mines and dense thick forest regions where manual analysis is impossible. Whenever the crack is detected by vehicle sensors, an automize Short Message Service (SMS) will be sent to the pre-destinate phone number. This will help in reducing the railway accidents, derailments and saves the passengers life, also reduces the economic losses. The system demonstrates the application of Internet of Things (IOT) in the Railway Department. The proposed system has many advantages over existing system that includes cost minimising, energy consumption reduces, efficient detection without involvement of human and saves time. Hence, we conclude that through this process we can simply inform Railway Controller about cracks and able to give information of damaged track so that effective measures can be taken timely.

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Digital Camera: A Review and Comparative Analysis

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▶ ABSTRACT ◀

Digital cameras (DC) have a wide range of application and can be integrated with cutting-edge technologies like virtual reality (VR), artificial intelligent (AI) and machine learning (ML) to improve the quality of life. DC has various applications such as photography, videography, security & surveillance, medical imaging, education & research, and sports & action. For each application, DCs are in conjunction with AI/ML algorithms in order to ease their uses to solve different purposes of human life and their needs. Each application requires different DCs with specific features. To understand and move forward with advancement, it is first important to realize what role of each component of the camera plays, and what applications does it resolve. The technology used in DCs is based on the understanding of the elements of the magnetic spectrum. DC uses sensors, processors, and storage devices. In this paper, brief introduction, comprehensive review, and comparative analysis of different DCs have been presented on the basis of their technology, components used, features, and different applications.

Keywords: *Digital Cameras, Lens, Images, Videos, Photography, Videography.*

INTRODUCTION

Worldwide, the multimedia data services/applications are increasing explosively. The data generated by these applications consists of educational, industrial, healthcare/medical, entertainment and surveillance data/information in the form of text files, high definition (HD) or high quality images and videos. This may be of business, or commercial, or both type. Currently, 53.72% Internet traffic bandwidth was consumed by the streaming videos in which the YouTube, Netflix, and Facebook video is on the top three categories as per the Sandvine report (Jan. 2022) [1]. Also, the advent of social media apps like whatsapp, tik-tok, snapchat, facebook, twitter, telegram, etc, and their uses are increases day by day. The content of such apps are mainly images and videos. To capture these images and videos, digital camera is required, which may be used as separate gadget or attached with smart/android based mobile phones or other devices [2].

Digital cameras (DCs) are electronic devices used to capture and store digital images and videos. They use a charge-coupled device (CCD) or complementary metal-oxide-semiconductor (CMOS) sensor to convert light into an electrical signal, which is then processed and stored as a digital file on a memory card or internal memory storage device. DCs are available in various shapes and sizes from the compact point-and-shoot cameras to the professional-grade DSLR (Digital Single-Lens Reflex) cameras [3]. They also offer various features and functions, such as zoom lenses, image stabilization, autofocus, and manual controls, to cater to different user needs and preferences.

DCs have numerous applications namely photography, videography, security & surveillance, medical imaging, education & research, and sports & action. Based on these applications the digital cameras can be integrated with the cutting-edge technologies like virtual reality (VR), artificial intelligent (AI) and machine learning (ML) to improve the quality of life. To justify each distinct purpose of the camera, it uses a specific technology or a component specially designed to meet their objectives.

In this paper, a brief review and comparative analysis of DCs have been presented, along with their applications, component, and technology used. The flow of study and paper organization is shown in Fig. 1. Rest of the paper is divided in four sections. Section 2 describes different components of DCs. The technology used in DCs is discussed in Section 3. Different applications of DCs are presented in Section 4. Comparative analysis and advancement in DCs are reported in Section 5 and Section 6, respectively. At last in Section 7 conclusion of the paper is reported including future direction of this work.

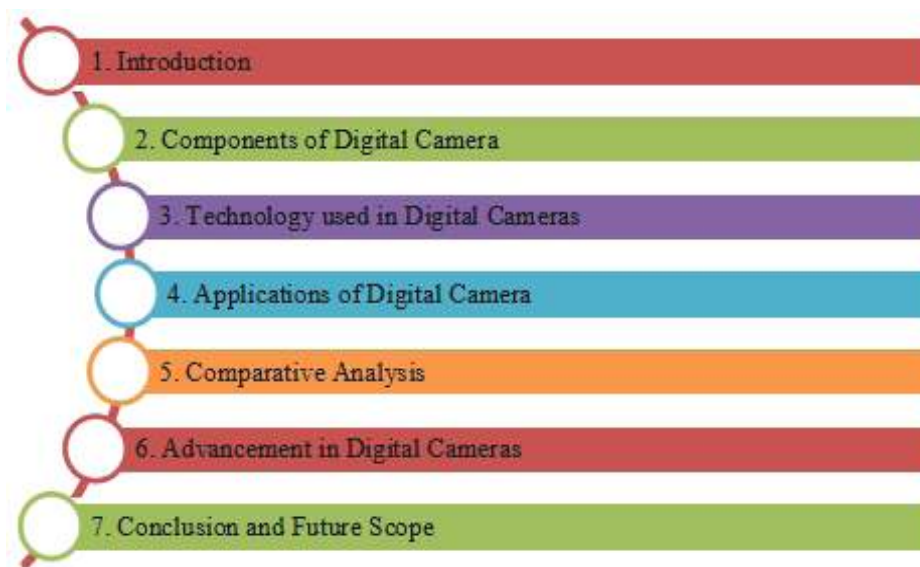


Fig. 1: Flow Chart of the Paper

Components of Digital Camera

DCs consist of several components that work together to capture and store digital images. The main components of a DC are:

- 1. Image Sensor:** The image sensor is the heart of the camera and captures the image. There are two main types of image sensors: CCD (Charge Coupled Device) and CMOS (Complementary Metal Oxide Semiconductor).
- 2. Lens:** The lens captures the light from the scene and focuses it onto the image sensor. The quality of the lens is crucial for the quality of the final image.
- 3. Processor:** The processor processes the data from the image sensor and prepares it for storage. It also performs other functions such as image stabilization, noise reduction, and color correction.

4. **Memory Card:** The memory card is used to store the digital images and videos. The most common types of memory cards used in digital cameras are SD (Secure Digital) cards and CF (Compact Flash) card.
5. **LCD Screen:** The LCD screen is used to preview the image before and after it is captured. It is also used to access the camera's menu and settings.
6. **Viewfinder:** Some digital cameras have an optical or electronic viewfinder that allows the user to compose the shot and see exactly what the camera will capture.
7. **Flash:** The flash is used to illuminate the scene in low light conditions.
8. **Battery:** The battery provides power to the camera. The type and capacity of the battery vary depending on the camera model.

Let us see which type of the above mentioned components is used to differentiate the purpose of a DC.

Technology used in Digital Cameras

Photons are the fundamental particle that comprises all forms of electromagnetic radiation, such as light and radio waves, as depicted visible light, which spans a range of 380-750 nanometers, as illustrated in the insert of Fig. 2, is of particular significance for imaging purposes [3]. Scientific microscopes usually employ visible light in the form of a lamp or laser, which necessitates the use of a scientific camera that can detect and count photons within the visible light range of the spectrum (380-750 nm). However, certain applications may also benefit from photon detection in the ultraviolet and infrared regions. To accomplish this, scientific cameras are equipped with sensors. A scientific camera's sensor detects and counts photons, converting them into electrical signals. Photo-detectors made of thin silicon layers convert photons into electrons upon impact, enabling detection. A single block of silicon in a sensor doesn't identify the origin of photons, only detecting their landing. A grid of tiny silicon squares called pixels allows for detection and localization, with millions of them fitting onto a sensor. A camera that is popularised as 1 megapixel camera sensor is a camera with an array of one million pixels (Fig. 3). Each pixel on a scientific camera's sensor detects the number of photons it receives, generating a bitmap of values for the image. Electrons are stored in each pixel well, and their count is converted into a digital signal using analog-to-digital converter. The grey levels are then displayed on a monitor. Quantum efficiency and gain affect the quality of the image. Dynamic range is determined by the well depth or bit depth. Image metadata includes camera settings, software settings, and microscope hardware information.

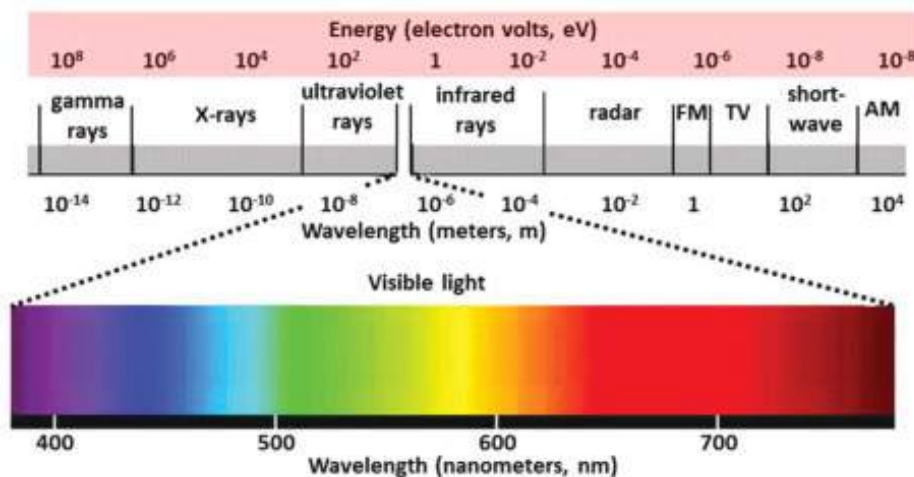


Fig. 2: The Electromagnetic Spectrum

- (a) A 10×10 grid of large squares.
- (b) A magnified example of a large square from A, which contains 10,000 pixels.
- (c) A magnified example of the small squares in B, which contain 100 pixels (colored green and blue). [3]

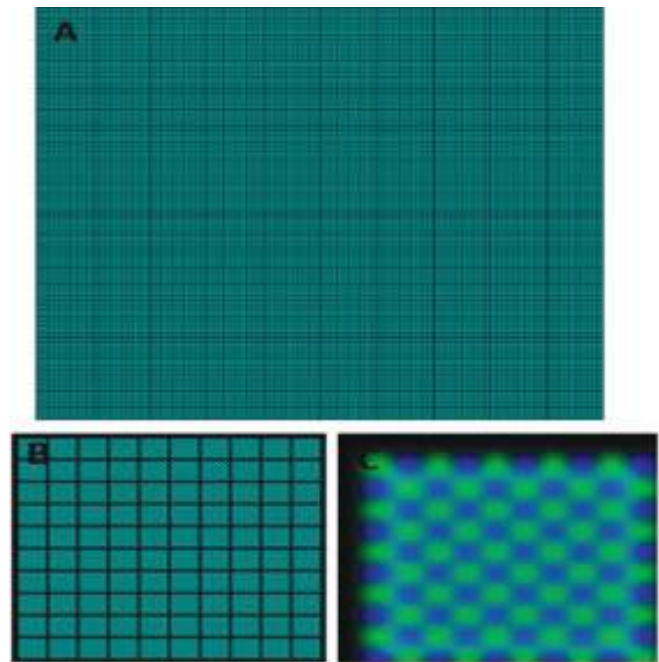


Fig. 3: One Million Pixels, Visualized

Applications of Digital Camera

DCs have a wide range of applications in the modern world. Here are some examples:

- 1. Photography and Videography:** DCs are widely used for capturing photos and videos, both professionally and for personal use. They offer high-quality images and the ability to edit, and share photos and videos easily [4-5].
- 2. Security and Surveillance:** DCs are used for security and surveillance purposes, such as monitoring public places such as traffic signals, railway station, bus stations, historical places, gardens, homes, and businesses. They can be connected to networks for remote access and monitoring [6].
- 3. Medical Imaging:** DCs are used in medical imaging applications, such as endoscopy and laparoscopy, to capture high-resolution images of the internal organs and tissues which is used to early prediction of the disease in order to start treatment in early stages.
- 4. Education and Research:** DCs are used in education and research to capture images and videos for scientific analysis, such as microscopy and astronomy.
- 5. Entertainment and Gaming:** Digital cameras are used in entertainment and gaming applications, such as virtual reality and augmented reality, to capture 360-degree images and videos and create immersive experiences.
- 6. Sports and Action:** DCs are used in sports and action applications, such as action cameras, to capture high-speed and high-motion images and videos.

Overall, DCs have become an integral part of modern society, with a wide range of applications in various fields.

Comparative Analysis

Analyzing the components used in digital cameras to better understand the differences between different camera models and features. By comparing cameras, we can identify the strengths and weaknesses of each camera, and make informed decisions about which camera is to use for a particular task or project. This can help us optimize our use of cameras and consolidate multiple features into a single device, making it cost-efficient. Additionally, comparing cameras can help us stay up-to-date on the latest advancements and technologies in the field, and identify areas for further development and innovation. Comparison will be on the basis of the technology, basic components, and their applications.

- 1. Satellite Imagery:** Satellite imagery is typically captured using specialized satellite cameras that are specifically designed for capturing images of the Earth's surface from space. These cameras are known as earth observation satellites and are equipped with sensors that can detect different wavelengths of light, including visible light, infrared, and thermal radiation.

The cameras on these satellites can capture images with high resolution and accuracy, which makes them useful for a wide range of applications, including environmental monitoring, urban planning, and military surveillance. Some of the commonly used sensors include panchromatic, multispectral, and hyper-spectral cameras, which capture images in different wavelengths of light and provide different types of information about the earth's surface.

A strategy for multi-spectral imaging involves using a combination of cameras, such as one for visible light and one or more for infrared, each equipped with band pass filters. This approach optimizes each optical system for its relevant spectral region, but requires multiple camera objectives and careful alignment of images. Alternatively, a mixed approach uses common optics but separates different wavelength channels before sending light to multiple image sensors.

2. **Biomedical Imagery:** The working principle of biomedical imagery involves the use of various imaging techniques to produce visual representations of the internal structures and processes of the human body. These techniques include X-rays, computed tomography (CT) scans, magnetic resonance imaging (MRI), ultra-sound, positron emission tomography (PET) scans, endoscopy, arthroscopy and others.

Each imaging technique utilizes different physical principles to create images. For example, X-rays and CT scans use ionizing radiation to produce images of the body's internal structures, while MRI uses magnetic fields and radio waves to generate detailed images of soft tissues. Ultrasound utilizes high-frequency sound waves to create images of internal organs and tissues, and PET scans use radioactive tracers to visualize the metabolic activity of tissues and organs.

Once the images are produced, they are processed and analysed using specialized software to extract useful information. This information is then used to diagnose medical conditions, guide surgical procedures, monitor disease progression, and assess treatment effectiveness.

3. **Surveillance Systems:** Cameras used in surveillance rely on capturing and recording visual information to monitor and observe a specific area or object. They use a combination of optics, sensors, and image processing technology to capture and record images or video footage [6].

The working principle of surveillance cameras involves the following steps:

- (i) Light enters the camera lens and is focused on the image sensor.
- (ii) The image sensor converts the light into electrical signals which are then processed by the camera's electronics.
- (iii) The DC processor then converts the signals into digital information and compresses it for storage or transmission.
- (iv) This information is then saved to a recording device, such as a digital video recorder (DVR) or a network video recorder (NVR).
- (v) The footage can then be accessed and viewed remotely through a network or stored locally for later viewing. In addition, surveillance cameras can also have features such as motion detection, night vision, and facial recognition technology, all pertaining to AIML to enhance their effectiveness. These cameras are widely used for security and surveillance purposes, such as in public areas, businesses, and homes.

We talked about the various applications of digital cameras pertaining to the modern world, following which were discussed components that are used to structure a DC. Table 1 compare the different cameras based on the basis of specific applications, image sensors, lens use, processor, and memory card detail.

Table 1: Table Comparing the Cameras on the Basis of Commonly used Components [2-18]

S. No.	Type of Cameras	Categories	Image sensor	Lens	Processor	Memory Card
1.	Panchromatic	Satellite Imagery	CCD or CMOS	Single lens with a fixed focal length (FL)	Dedicated image processing chip	Removable memory card such as SD, CF, or XQD
2.	Multispectral	Satellite Imagery	CCD or CMOS image sensor with multiple channels	Interchangeable lenses with different FL	Dedicated image processing chip, have specialized algorithms for processing multispectral images, such as band selection, fusion, or analysis	Removable memory card such as SD, CF, or XQD
3.	Hyper spectral	Satellite Imagery	CCD or CMOS image sensor with multiple channels	Interchangeable lenses with different FL	Powerful image processing unit or computer to handle the large amount of data, may include algorithms for spectral un mixing, classification, or anomaly detection	High-speed and high-capacity removable memory such as ENVI or HDF card,
4.	Fluorescence microscopes	Bio-Medical Imagery	CMOS or CCD	Interchangeable lenses with a C-mount or F-mount	-	SD or CF
5.	Confocal microscopes	Bio-Medical Imagery	CMOS or CCD High sensitivity for low-light imaging	Interchangeable lenses with a C-mount or F-mount	-	SD or CF
6.	X-ray cameras	Bio-Medical Imagery	Special type of CCD sensor, High sensitivity for low-dose X-ray imaging	Fixed-focus lenses with specialized coatings to minimize X-ray scatter	-	Typically specialized memory cards such as CF or PCMCIA
7.	Infrared cameras	Bio-Medical Imagery	Micro-bolometer or an indium gallium arsenide (InGaAs) sensor	Fixed-focus lenses with specialized coatings to maximize transmission of infrared radiation	-	SD or CF
8.	Endoscopic Camera	Bio Medical Imagery	CCD and CMOS	Lenses are designed to capture high-resolution images in low-light conditions	Processors provide in combination with distinct light sources, enhancement technologies like narrow band imaging, auto fluorescence or flexible spectral imaging colour enhancement	SD or CF

9.	ANPR/LPR Cameras	Surveillance	CMOS or CCD sensors	May Vary	-	Internal storage, but may also support external memory cards
10.	Dome Camera	Surveillance	CMOS / CCD sensor	May Vary	Typically store captured images and license plate data on internal storage	Typically store captured images and license plate data on internal storage
11.	Bullet Camera	Surveillance	CMOS or CCD sensors	A high-quality lens is important for capturing clear images of license plates, A wide aperture (small f-number) can help capture clear images in low light conditions	Faster processors allow for faster image processing and better recognition accuracy	
12.	C-mount Camera	Surveillance	CMOS or CCD sensors	C-mount lenses can have a range of FL, from wide-angle to telephoto. Common focal lengths include 8mm, 12mm, 16mm, 25mm, and 50mm	Processing speed can vary from 1.5 GHz to 2.5 GHz or higher	Support memory cards with a capacity of up to 256 GB or higher
13.	Infrared Cameras		micro bolometer sensor	Can have a range of FL from wide-angle to telephoto. Common FL include 9mm, 13mm, 19mm, 25mm, and 35mm.	Can vary from single-core to quad-core, depending on the camera model, processing speed can vary from 1.5 GHz to 2.5 GHz or higher.	Typically support memory cards with a capacity of up to 128 GB or higher

The table above gives us an insight to the different components and how a little change in the combination of specification and the calibration of components can support a different application (Table 1).

Advancement in Digital Cameras

The future of DC is exciting; with many advancements and new technologies being developed that will further enhance the capabilities and features of these devices [12]. Here, are some potential developments in the future of DCs:

- Higher Resolution:** DCs are likely to continue improving in terms of image resolution, with even more pixels packed into sensors to produce higher-quality images and videos.
- Artificial Intelligence:** DCs are already incorporating AI and ML algorithms to enhance features like autofocus and facial recognition. In future, we may see more advanced AI capabilities that can automatically adjust settings for the best possible shot, recognize specific scenes or objects, and even generate new images based on existing ones.
- Computational Photography:** Computational photography is a rapidly growing field that uses algorithms and software to enhance and manipulate digital images. In future, the cameras have the features to

incorporating computational photography techniques for improve the dynamic range, reduce noise, and create more realistic images.

4. **Augmented and Virtual Reality:** As AR and VR continue to grow in popularity; digital cameras will likely be integrated with these technologies to provide more immersive experiences. Cameras may be used to capture 360-degree images and videos, which can then be used to create virtual environments or add AR elements to the real world.
5. **Advanced Sensors:** DCs may incorporate advanced sensors like LiDAR and time-of-flight sensors, which can provide more detailed depth information and improve autofocus performance in low light.

Overall, the future of DCs is bright, with many exciting developments and advancements on the horizon. As these devices continue to evolve, we can expect to see even more capabilities and features that enhance our ability to capture and share the world around us.

CONCLUSION

The use of DCs is surging day by day, whether it is in the celestial or terrestrial spaces. The development in this field is rapid and understated. Due to the frequent up gradation in features, it is challenging to assemble necessary information and review it. A comparative analysis helps in understanding how the smallest differences in the component can make a camera useful for a certain application in a specific field out of these, three are discussed above i.e. Satellite imaging, bio-medical imaging, and surveillance imaging. The DCs are categorized on the basis of the field that they are used in, image sensor, lens used, processor, memory card, LCD screen. The detailed analysis of the working is presented and the applications are reviewed.

The scope for future research lies within the amalgamation of digitization of imaging techniques with the latest software tools like AIML, VR, AR, etc, [15]. These tools can be developed and used in satellite imaging to enable real-time object recognition, enhance image analysis, and provide immersive experiences. AI algorithms can analyze satellite imagery for object identification, while VR and AR technologies can overlay additional information or simulate virtual environments for data visualization and analysis. These tools can be employed in biomedical imaging to assist in real-time image analysis, provide interactive visualization of medical data, and facilitate surgical planning. AI algorithms can aid in image interpretation, while VR and AR technologies can enhance medical training, surgical navigation, and patient education through immersive simulations and overlays of medical information. In surveillance imagery AI, VR, and AR can by automate object detection and tracking, analyzing video streams in real-time, and providing augmented visual overlays for situational awareness. AI algorithms can detect suspicious activities, while VR and AR technologies can display relevant information and enhance the field of view for surveillance operators [16]. Some ongoing research in these fields is discussed. The need for efficient ways of recording and presenting multicolor immunohistochemistry images in a pioneering laboratory developing new techniques motivated a move away from photography to electronic and ultimately digital photo-microscopy [17]. Within the context of constructing modern smart cities, conventional fire-detection systems can be substituted with vision-based systems to establish enhanced fire safety measures in society, leveraging emerging technologies like DCs, computer vision, AI, and deep learning [18].

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PIMV: Portable Invasive Mechanical Ventilator

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▶ ABSTRACT ◀

The paper describes a new design model/prototype of a low-cost Portable Invasive Mechanical Ventilator (PIMV). The motivation to design the prototype model comes from the worldwide problem of shortage of the mechanical ventilators in hospitals/health centers during the post Covid-19 pandemic. Constructing PIMV aims to decrease the cost of a traditional mechanical ventilator and to be ready for any type of future virus pandemic. A mechanical ventilator is a medical device that is used in medical services for improving the health condition, there are two types of ventilators—positive ventilator and negative ventilator, a positive ventilator directly provide oxygen to the patient using a mask or endotracheal tube whereas, a negative ventilator helps the patient in which negative pressure is applied outside of the chest, both type of system helps a patient for breathing when the patient is not able to breath and facing problem in breathing. The proposed prototype model is a positive type ventilator namely PIMV. PIMV delivers oxygen to the patient and also, helps in breath out the carbon-di-oxide (CO₂) gas. The traditional mechanical ventilators available in the market are very costly and bulky in size. So, we prepared a small size, low cost PIMV using lightweight plastic body cylinders.

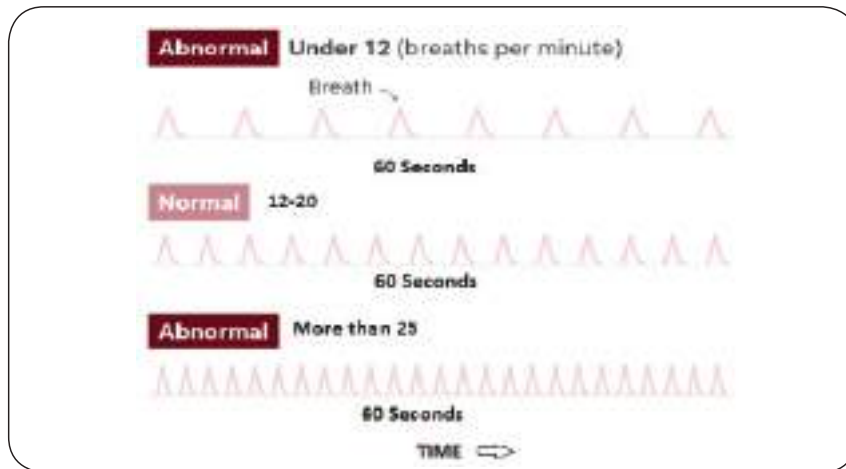
Keywords: *Mechanical Ventilator, Covid-19, Portable, Invasive, Positive Ventilator, Negative Ventilator.*

INTRODUCTION

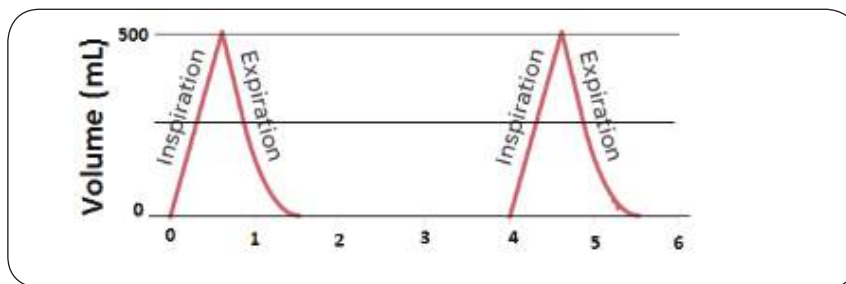
Portable Invasive Mechanical Ventilator (PIMV) is a low-cost ventilator, which helps in respiratory operation during lungs malfunctioning. During the recent covid-19 crises, there was a shortage of conventional ventilators,

and the cases of lungs collapse were coming in rapid numbers, so the use of mechanical ventilator increases rapidly [1-7]. A machine which mechanically assists patients inhale and exhale allowing the exchange of oxygen and carbon-di-oxide (CO₂) to occur in the lungs, a process referred to as artificial respiration.

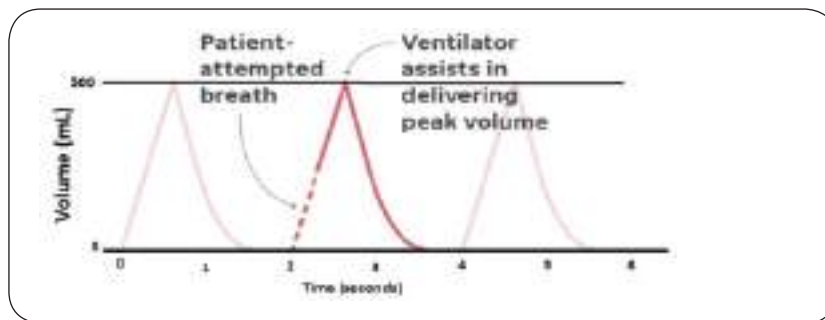
The number of breaths required per minute for a normal patient is 12-20, if the number of breaths per minute is under 12 or more than 25, it comes under abnormal patient. The volume of air inhaled and exhaled by a normal person is 500-600 ml per breath. This is called tidal volume (depth of inhalation) [8]. Fig. 1(a) shows the number of breaths per minute for a normal and abnormal patient, Fig. 1(b) shows an inspiration and expiration graph between volume (mL) and time (seconds) and Fig. 1(c) shows use of ventilator when the patient breath is low and not up to the ideal inhale volume. Ventilator assists patients in delivering peak volume of breath [8].



(a)



(b)



(c)

Fig. 1 (a) Graph of Number of Breaths Required Per Minute for a Normal and Abnormal Patient, (b) Inspiration and Expiration Graph and (c) Use of Ventilator when the Patient Breath is low [8].

In literature, the ventilation process classified as two types: (i) Invasive mechanical ventilation and (ii) Non-invasive ventilation. The invasive mechanical ventilation contains humidifier to match air to body temperature and add moisture. A tube is required for airway in invasive mechanical ventilation as shown in Fig. 2(a). While, in a non-invasive ventilation face mask is fitted over nose and mouth, no tube for airway. Fig. 2(b) shows the non-invasive ventilation. Non-Invasive mechanical ventilation and invasive ventilation are not ventilation modes, they represent two ways to connect to artificial airway to a natural airway, and both can work with multiple type ventilation mode. The mode of ventilation describes the pattern of breath delivered to the patient. With the help of mode, we can deliver different types of breath pattern to the patient. Modes refer to the characteristics of mechanical ventilation which mainly include trigger (how inspirations begins), cycle (how inspiration ends), and limit (when inspiration should be ended). The most commonly used modes of ventilation are Volume-Controlled, Pressure-Controlled, Dual-Controlled, Continuous Mandatory Ventilation (CMV), Intermittent Mandatory Ventilation (IMV), Continuous Spontaneous Ventilation (CSV), Peep, Flow pattern, etc. [8].

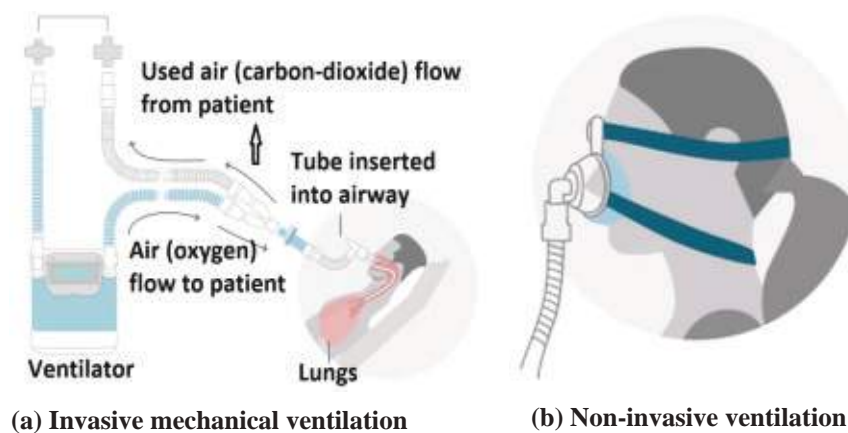


Fig. 2: Ventilation Process; (a) Invasive Mechanical Ventilation, and (b) Non-invasive Ventilation [8]

In this paper, we have designed a new PIMV. The proposed model of PIMV is small in size and can be easily installed at home and serves the purpose. The solid structure of the ventilator has been built with the help of 3D printing technology allowing easy modifications as per need. Custom 3D printed parts are used in making the PIMV, this system provides pressurized oxygen to the patient and its maximum capacity of delivering the oxygen to the patient is 600 ml.

The paper is organized into six sections. Section 2 presents the design and dimensions of the proposed PIMV. Component description and working of PIMV is presented in Section 3 and Section 4, respectively. The advantages of the proposed PIMV are highlighted in Section 5. Finally, the conclusion of the proposed work is mentioned in Section 6.

Design and Dimension of the Proposed PIMV

In this section we have discussed the design of the proposed PIMV. Fig. 3 shows an image of the proposed PIMV which indicates the nomenclature of each unit/part. The design of PIMV is made with the help of fusion 360 (cad software) and its dimension is 800mm×150mm×150mm, Arduino Uno and Arduino Nano both are used for controlling the system, 110mm PVC pipe have been used for making the piston cover, first piston provide the air to the patient up to 600ml and 2nd piston helps for taking out the CO₂ from the lungs. Fig. 4 shows the 3D CAD and real image of PIMV.

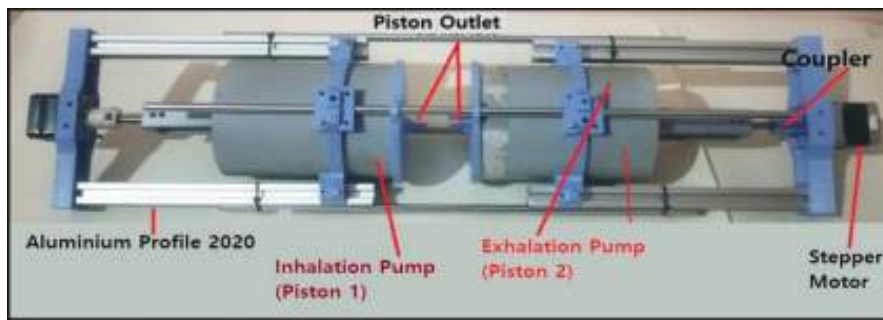


Fig. 3: PIMV Image with Nomenclature of Different Parts

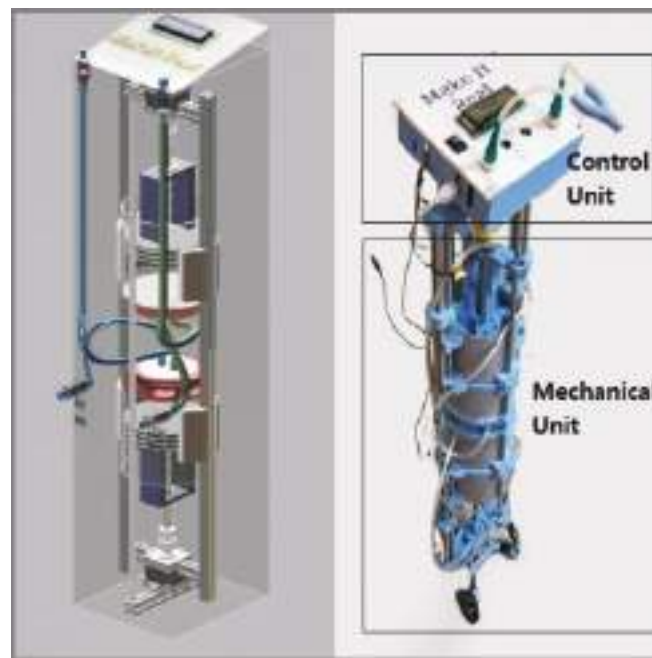


Fig. 4: 3D CAD and Real/Actual Image of PIMV Model

For running the piston, we connect the lead screw in that way when we rotate the lead screw piston goes up and when we rotate in reverse direction it goes down. For rotating the lead rod stepper motor is coupled using a 5×8 mm coupler, and its torque 4.2 kg provide the sufficient energy for moving piston to goes up and down, Stepper motor run by the A4988 stepper motor driver and it's mounted on the V3 CNC shield.

Component Description

1. **Arduino Uno:** Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It is an open-source microcontroller and it's coded with the help of Arduino IDE software [9-10].
2. **A4988 Driver:** A4988 is a motor driver and is used for running the bipolar stepper motor. The complete micro stepping motor driver operates in full, half 1/2, 1/4, 1/8, 1/16th step modes.
3. **Valve:** Valve is used for the control of the air flow, it allows one direction flow, and it is made with the help of 3D printer and run with the help of Gear motors.
4. **Power Delivery:** This system operates on 12v dc power supply, and it consumes 5 amps current and, we connected 11.1 V DC lithium ion 10000 mAh capacity battery pack for power backup when domestic supply failure.

5. **Stepper Motor:** We use two Nema 17 4.2 kg-cm single shaft bipolar stepper motor for running the piston and its dimension is 42 mm×42 mm×40 mm.
6. **Inhalation Valve and Exhalation Valve:** Inhalation valve is connected with the first cylinder (Piston1) of second outlet valve and exhalation valve is connected with the second cylinder (Piston2) of first inlet valve and its end connected with Endotracheal tube.
7. **Lead Screw:** We use 4 stator 150 mm length lead screw and its diameter 8 mm and its pitch 2 mm it means when we rotate screw it covers 8 mm distance in one full rotation.
8. **Aluminum Profile 2020:** Aluminum profile used in this system for holding the cylinder and stepper motor.

Fig. 5 shows the electronic circuit diagram in which we use various electronics equipment/components to design a PIMV. Direction in Fig. 6 represents the flow of signal to the device, if arrow in both direction it represents the system is received or transmit the data. We use I2C protocol between Arduino Nano and Arduino Uno for communicate the system.

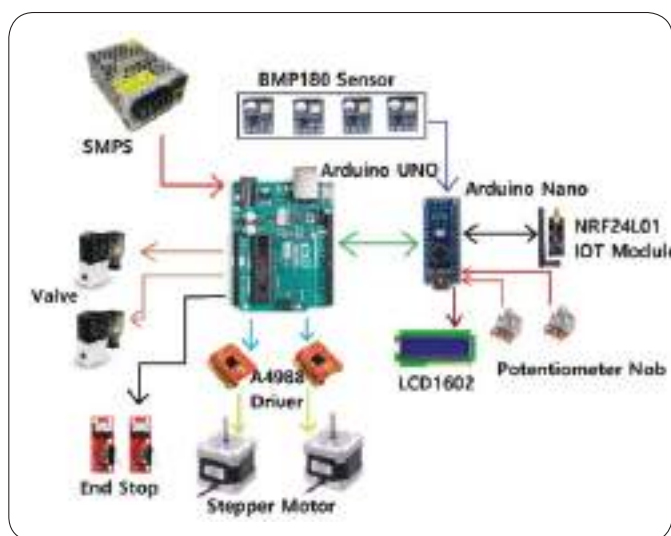


Fig. 5: Electronic Circuitry used to Design a PIMV

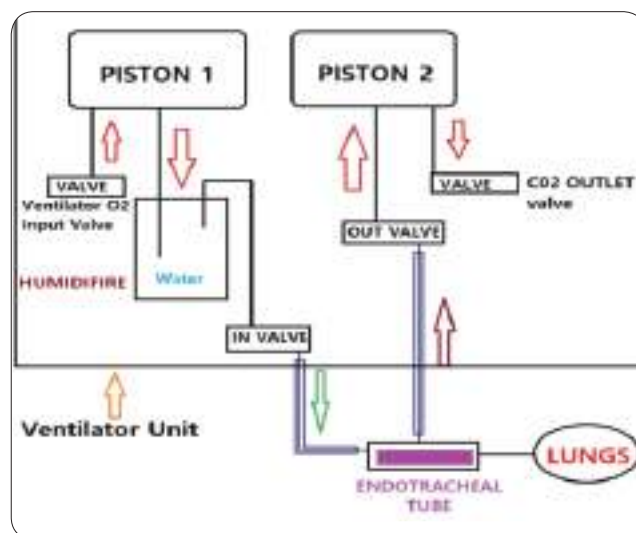


Fig. 6: Image Shows Flow Direction of Air in PIMV

Working of PIMV

In this section, we describe the working of PIMV in four steps.

- Step 1:** Inlet Valve of first cylinder at inlet point opens and cylinder take oxygen with help of motorized piston of syringe. During this process the outlet of inlet syringe is kept closed to maintain the pressure difference between outside and inside the cylinder.
- Step 2:** After the first step is over, the inlet valve of first cylinder closes and the outlet valve of first cylinder opens. Piston now starts to move up and air inside the cylinder is released in the outlet pipe of first cylinder and is eventually released in the lungs.
- Step 3:** After the second step, the second cylinder piston to come in action and simultaneously first step is repeated, the valve of second cylinder which was connected to the lungs with the help of Endotracheal tube open and piston moves downward to exhaust the CO₂ from lungs to the second cylinder. While this is done, the second valve of the second cylinder is closed to maintain the pressure difference between lungs and second cylinder.
- Step 4:** After the third step, the final step of one cycle comes to action and the second valve of the second cylinder opens and the inlet valve of second cylinder closes and the piston moves up to remove CO₂

gas out of the atmosphere. While this step is performed, the second step comes into action and this way, subsequent cycles are performed one after the other. Fig. 6 shows the direction of air flow in PIMV and Fig. 7 represents the way of using endotracheal tube and flow air in the tube [8], [11].



Fig. 7: Image Represents the Way of using Endotracheal Tube and Flow Air in the Tube [8], [11]

Advantages of the proposed PIMV model

Following are the advantages of the proposed PIMV Model.

- This ventilator is portable and can be easily carried like a suitcase.
- We have reduced the manufacturing cost of the Ventilator, which is easily affordable to purchase for every household. The cost of a Ventilator is approximately in INR 20K. We could only reduce the price because of the use of 3D-printed parts of the ventilator.
- All ventilator valve was connected with a pressure and temperature (bmp 180 sensor), which allow to control all type of breathing mode like volume control, pressure control, dual control, continuous mandatory ventilation (CMV), intermittent mandatory ventilation (IMV), continuous spontaneous ventilation (CSV), peep, flow pattern, etc.
- Both inhalation & exhalation pumps are used in our ventilator.
- Using the pressure sensor, we print the graph of pressure and volume on the screen, and we can control them by control button on ventilator.

CONCLUSION

In conclusion, the PIMV is a low-cost and compact solution to the shortage of traditional mechanical ventilators, especially during the COVID-19 pandemic. This paper has provided an overview of the importance of mechanical ventilators in medical services and the need for a low-cost solution. The proposed prototype model of PIMV supports positive type ventilation, which delivers oxygen to the patient and also helps in breathing out CO₂. The paper has also explained the different types of medical ventilation, including invasive mechanical ventilation and non-invasive ventilation, and the various modes of ventilation. The PIMV can be used in hospitals and health centers for respiratory operation during lungs malfunctioning. The compact and portable design of PIMV makes it easy to use and handle, which is an advantage in emergency situations. The PIMV can potentially reduce the cost of traditional mechanical ventilators and make them more accessible to patients in need. Furthermore, the PIMV can be used in any type of future virus pandemic, which makes it a valuable contribution to the medical field. Overall, the PIMV prototype model presented in this paper has the potential to address the global shortage of mechanical ventilators, especially in low-income countries, and improve healthcare accessibility and affordability.

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Development of Self Balancing Robot

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▶ ABSTRACT ◀

A self-balancing robot is a unique robot that is based on the principle of an inverted pendulum. Robot consist of components several including sensors, arduino , motor driver and etc. Its design and development involves consideration of several aspects like maintenence, testing ,implementation and many more . This robots unique stability differentiates it from other types of robots.

INTRODUCTION

Robots have always played a vital role in society and for humanity, with this changing world design and development of robots have rapidly changed.

Robots are being used in many fields including automobile, medical, the IT sector, and many more. New designs and rapid changes in technology in robotics allow machines to interact and contribute to the world in various ways. Robots today are capable of performing different computations required as per needs. Self-balancing robot development is a major contribution to the field of robotics.

To develop a two-wheeled self-balancing robot we have to first understand its principle. This robot is based on the principle of an inverted pendulum. It is important to understand the inverted pendulum problem. This principle involves complex equations and calculations. The goal of this project is to balance the robot while the wheels move forward and backward. The inclination angle must be considered when a robot is being moved forward and backward. The whole concept revolves around the inclination of the robot and the movement of the wheels when the robot inclines in a particular direction, the wheels move in that inclined direction. To make the process smooth and simple the movement of the robot is confined to one axis like moving forward or backward only. By doing this evaluation of various parameters becomes much simpler such as sensor reading. This research paper explains the design and development and mechanism of two-wheeled self-balancing robots.

This is a self-driven robot that involves components like DC motors, Arduino, gyroscope, motor module, and accelerometer.

Advancements in technology enabled us to create machines that replicate human behavior and characteristics. While the Calculation behind this self-balancing robot is a little complex but robot's movement being confined to one axis makes it simpler and much more manageable. Potential in robotics continues to help and serve society and the world.

INVERED PENDULM THORY

The inverted pendulum concept is a mechanism that contains a rod attached to a cart by a hinge. Which allows free one-dimensional movement for the rod. Balancing the free-moving rod vertically is the main objective of the cart. A two-wheeled self-balancing robot is based on the principle of this inverted pendulum concept.

Inverted pendulum theory is also called the Port and Cart theory, this theory serves as the base model for self-balancing robots. While we cannot directly compare two-wheeled robots to this theory but the same principle is being applied. Comparing carts with wheels and poles with a robot's chassis. The combination of both left and right wheels will further simplify the complex calculations as both wheels will work together and provide stability. To determine the value of torque for each wheel, the value of the wheels of the robot can be halved for an approximate single-wheel value. The inverted pendulum concept aims to keep wheels beneath the robot's chassis mass. When the robot begins to fall forwards, the wheels of the robot move forward to maintain stability and prevent falling further. Mathematical problem related to robot parameters is very important to consider to keep the movement of the robot smooth. The inverted pendulum concept is being used in many fields.

EXISING TWO WHEELD BALNCING ROBOTS

There are several self-balancing robots including Segway, not n Bender, and Emview 2. Segway was invented by Dean Kamen and the Emview 2 was built by Hitachi. The development and design of these robots are changing by the time very rapidly. These robot designs are being improved continuously over time.

These robots have the same design concepts which include the use of a gyroscope to measure the tilt, shaft encoders for distance measuring, and a microcontroller for various computations. The Segway is a widely used and well-known available two-wheeled robot, currently available in 2nd generation of the models. This Segway has a variety of uses including adventure, law enforcement, and general transportation. These all robots are based on the concept of an inverted pendulum. Overall these robots describe the potential for better stability and control systems in robotics, paving the way for future innovations in the field of robotics.

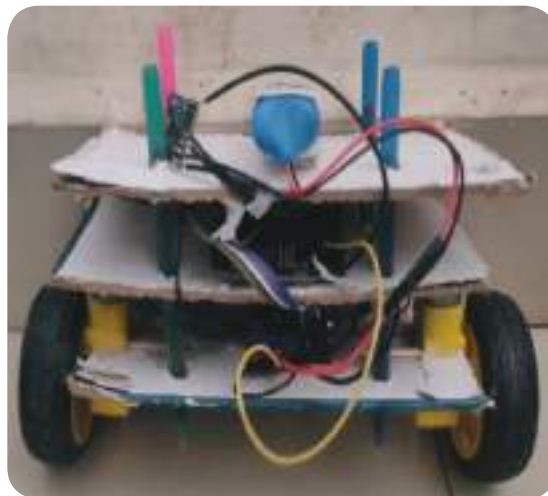


Fig. 1: Designed Robot

DESIGN AND DEVELOPMENT

The development and design phase is very crucial for developing ideas and objectives of components that will make a robot. Logical analyzing of the conditions and requirements enables to ensure the concept remains feasible throughout the project.

A. Contol System

The control system maintains a system or plant depending on various parameters. The control system includes a range of settings, production, assembly, and industrial plants, as well as computer, electrical,

and electronic systems. This project focuses on the control system mainly responsible for the stability of the robot. Sensors are used to detect the direction and angle, while another application provides signals to motors. Sensors play an important role in preventing the falling of robot. Overall, the control system ensures that the robot remains stable and functions as required, and performs designated tasks effectively.

B. Microcontrollers

Microcontroller is an integrated circuit, which is capable of various computations and processing data by executing instructions or programming. Microcontrollers are designed to perform specific operations in an embedded system. They are commonly used in household appliances due to their compact size, these are widely used in embedded systems. It is also known as an embedded controller. Microcontrollers should contain essential devices for working such as timers, ADC, DAC, and PWM outputs, reducing the need for additional hardware and peripherals which only increases complexity and power consumption. Microcontroller controls a singular function in the device this controlling is done by interpreting data that it receives from its input peripherals. It then uses this data for further communication and desired action.



Fig. 2: Arduino Uno Board

C. Whels

The wheels of the robot play a vital role in providing traction and locomotion as well as ensuring the stability of the robot chassis. The torque requirements of the robot decide the diameter of both wheels. The type of tire is also crucial as it decides the smoothness of motion of the robot. A higher level of torque is required if the robot needs to perform on poor traction. The tires of the robot should have maximum contact with the ground and minimal resistance through the drive system. Width of 30-45 mm of rubber tread is ideal as it provides a reasonable one on most terrains. This width also makes it ideal for turning on the spot, which is a major feature of the self-balancing robot. It is important to consider the durability and load-bearing capacity of these wheels to ensure the smooth functioning of the robot. Wheels provide overall mobility and stability to the robot, usually, the wheels of the self balancing robot are driven by a PID (Proportional -Integral -Derivative) control system, speed and direction of the wheels are adjusted constantly by PID.

D. Motors

The self-balancing robot typically uses electric motors, usually the motors are brushless DC motors used to maintain balance. These motors are connected to wheels and other components of the robot. RPM rating is taken into consideration for proper movement and stability of the robot, most motors are rated between 2000-7000 RPM. Motors are typically controlled by using feedback from sensors, such as accelerometers and gyroscopes, which gives information about the robot's orientation and motion. Two motors are being used in an ideal self-balancing robot, these two motors allow torque to be effectively applied to the wheel shafts. Additionally, some robots use specific motors such as linear or servo motors for specific functions.

E. Motor Control

Motor controllers are an essential part of a self-balancing robot it is used to control the speed and direction of the motor by varying the output voltage signal and setting its polarity. These controllers are responsible for controlling the motors that drive the wheels. There are several types of motor controllers available depending on the application. H bridge motor controller is a popular motor controller, it uses PWM(pulse width modulation) signal output to adjust speed. The output voltage of PWM varies with the duty cycle. The duty cycle is the percentage of voltage-time high compared to the voltage output. This H bridge motor controller is a reliable and efficient solution for motor control in a wide variety of applications. Ideally self balancing robot involves use of two motors with motor controller smooth functioning of motors is ensured.

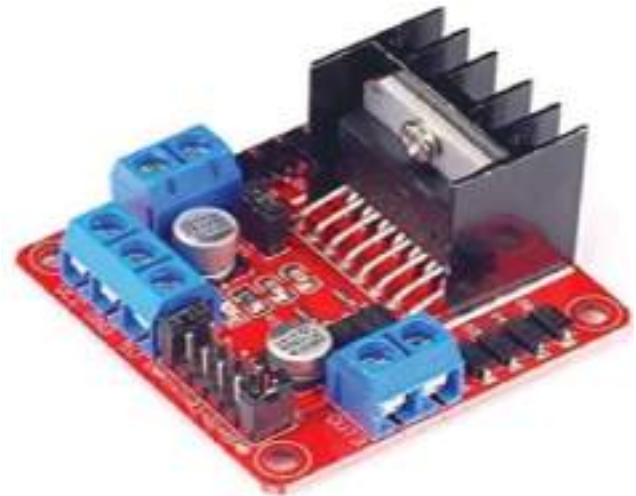


Fig. 3: Motor Control Unit

F. Sensors

The sensor is a device that produces output signals based on the sensing. Sensors have a wide variety of uses. There are two types of sensors analog and digital. Analog sensors are mainly for measuring rates and volumes on the other hand digital sensors are used for absolute indication. The sensitivity of sensors indicates how much output quantity changes when input quantity is changed. In self-balancing robot sensors are the most important component, they give information about of external environment and conditions which is further used in the form of data.

A Gyroscope sensor is used in self-balancing robots. This sensor senses the angle of orientation of the robot which is further used for producing output in the form of moving wheels forward and backward. The gyroscopic sensor senses the velocity, speed, and direction of the robot. Accelerometers and gyroscopes are commonly used sensors in robots that require stability control. These sensors provide the ability to measure acceleration, velocity, and direction. For measuring multiple axes, a sensor is required for each particular axis. Sensor fusion is the process of combining different sensors to overcome issues such as gyroscope drift and noise, while keeping the required accuracy. example of sensor fusion involves combining a gyroscope and inclinometer. In conclusion, sensors are crucial components in robot technology, providing the robot with the ability to interpret and respond to its environment. The combination of different sensors through sensor fusion helps to overcome sensor issues and ensures accuracy in measuring various parameters.

G. PID Control System

The autonomous self-balancing two-wheel robot uses a PID controller to maintain its balance. The PID controller is a three-term controller that adjusts the control signal based on the error between the system's output and the desired set-point. The proportional, integral, and derivative constants, K_p , K_i , and K_d , respectively, determine the effect of each term on the control signal. The closed-loop control system is a negative feedback system, where the process output is measured by a sensor and subtracted from the reference set-point to produce an error signal. The error signal is then fed into the PID controller, which adjusts the control signal based on the three terms.

The proportional term is directly proportional to the error signal and contributes to the control signal's immediate response to changes in the error signal. The integral term considers the cumulative error over

time and adjusts the control signal to eliminate steady-state errors. The derivative term considers the rate of change of the error signal and adjusts the control signal to handle overshoots and oscillations. After processing the error signal, the PID algorithm produces a control signal that is used to control the system. The control signal adjusts the system's inputs to bring the process output closer to the desired set-point. The PID controller's ability to adjust the control signal based on the error signal allows it to maintain the system's stability.

H. Power Source

In order for a machine to operate, it requires a reliable and sufficient power source. Without energy, the machine would not function properly or at all. Power sources can come in the form of AC through electrical main supplies or generators, or DC from batteries. Batteries are rated by their voltage output and ampere hours (AH), which refers to the amount of current they can supply per hour. When it comes to robots, batteries are crucial in allowing them to maintain autonomous operation. Without them, a direct connection between the robot and a power source would need to be maintained at all times. This would be impractical and limit the robot's functionality. To ensure that the robot operates efficiently, it is important to minimize power consumption during the design phase. This will allow for a smaller power system to be implemented, which is essential because power systems tend to be the heaviest element of a robot or device.

In summary, a reliable power source is essential for any machine to operate effectively. Batteries are a critical component in allowing robots to maintain autonomous operation, and it is important to minimize power consumption during the design phase to ensure that the robot is as light weight and efficient as possible.

WORKING PRINCIPLE

The IMU (Inertial Measurement Unit) sensor on top of the vehicle is a device that measures acceleration and angular acceleration in three axes, namely x, y, and z. The information gathered by the IMU is then processed by the Digital Motion Processor (DMP), which translates the data into yaw, pitch, and roll values. The pitch value, which is the tilt in the axis being considered, is then sent to the controller for feedback to the microcontroller. The microcontroller processes the data from the DMP using specific algorithms that have been programmed into it. It then compares the pitch value obtained from feedback with the pre-set value to determine if there is any deviation. If there is a deviation, the error value is sent to the PID (Proportional-Integral-Derivative) controller, which produces a proportional force to be applied to the motor. This force is responsible for bringing the vehicle back to its original vertical position, ensuring its stability and accuracy.

The control signal produced by the PID controller is sent to the motor controller, which is an L298N. The motor controller is responsible for controlling the motor's speed, torque, and direction based on the specified settings. This system ensures that the vehicle's movements are accurate and precise, even on uneven or sloping surfaces.

To summarize, the IMU sensor measures acceleration and angular acceleration, which are processed by the DMP to produce pitch values. The microcontroller processes these values using specific algorithms, and the controller compares the pitch value with a pre-set value. If there is any deviation, the PID controller produces a proportional force that is applied to the motors via the motor controller. This system ensures that the vehicle remains stable and accurate, even when operating on uneven surfaces. Overall, the system described above is an example of closed-loop control. The IMU sensor measures the vehicle's orientation and sends it to the microcontroller, which then sends it to the controller for comparison with the pre-set value. The controller then sends the error signal to the PID controller, which calculates the proportional force required to correct the deviation. The motor controller then applies the required force to the motors, ensuring that the vehicle remains stable and accurate.

CONCLUSIONS

This project involves creating a self-balancing robot using the concept of the inverted pendulum, which is similar to how a Segway works. The robot is able to balance itself when pushed forward or backward, and the

requirements, functioning, and connections of its components have been thoroughly discussed. Although the project was completed under time constraints, there are opportunities to improve the robot's performance. One potential upgrade is to use quadrature optical encoders to enhance the precision no motor speed readings, which would improve the robot's stability. Additionally, potentiometers could be used to fine-tune the error constants of the PID control system. A self-balancing robot like this has many potential applications, such as serving as an intelligent gardener in agricultural fields, an autonomous trolley in hospitals, shopping malls, offices, and airports, or even as an intelligent guide. Overall, this project provides a strong foundation for the development of more efficient and versatile self-balancing robots in the future.

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Arduino RFID Solenoid Lock for Home Safety

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▶ ABSTRACT ◀

An inventive security solution that combines solenoid locks and radio-frequency identification (RFID) technology is the Arduino RFID Solenoid Lock system. This solution offers a quick and trustworthy way to secure access to locations and deter unauthorized access. The system's performance and dependability were assessed utilizing testing procedures after it had been designed and implemented using a variety of components. The testing methods' results demonstrated that the system responded in less than a second, accurately scanned RFID tags, and only allowed authorized users access. The system's performance remained consistent under a variety of circumstances, making it the perfect security solution for a range of applications. The use of the Arduino RFID Solenoid Lock system has important implications for the security industry, and future work may concentrate on the incorporation of biometric sensors to boost security and prevent identity theft.

Overall, the Arduino RFID Solenoid Lock system offers a creative and practical response to security-related issues.

Keywords: *Arduino, Solenoid Lock, RFID, Security, Access Control, Authentication, Microcontroller, Sensor, Automation, IoT..*

INTRODUCTION

There has been an increase in demand for sophisticated security systems due to the increased requirement for security in a variety of applications, including homes, offices, and other facilities. The solenoid lock system, which uses an electromagnetic lock to secure entry to a particular location, is one of the most widely used security systems in use today. Various authentication methods, including keypads, biometric sensors, and RFID (Radio Frequency Identification) technologies, can be utilised in conjunction with the solenoid lock system.

The use of RFID technology to identify and monitor people or objects has grown in popularity in recent years. It is a safe and practical method. It operates by communicating with RFID tags using radio waves. These tags include data such as an individual's ID or access level. To add an extra degree of protection and authentication, the RFID system can be linked with the solenoid lock..

An unique solution that combines the strength of RFID technology with the dependability of solenoid locks is the Arduino RFID Solenoid Lock system. To restrict access to a certain location, the system makes use of an RFID reader, an Arduino microcontroller, and a solenoid lock. The system is a useful tool for controlling security in various applications since it can be customised to only permit access to authorised users.

The goal of this research paper is to present an in-depth analysis of the Arduino RFID Solenoid Lock system. In order to assess the system's efficacy as a security system, the study will concentrate on its design, implementation, and performance. The study will also point out the system's advantages and disadvantages and offer suggestions for future development. Overall, by shedding light on the potential of RFID and solenoid lock systems as cutting-edge security solutions, this study report will add to the expanding body of knowledge on these technologies.

LITERATURE REVIEW

RFID technology and the solenoid lock mechanism have both been widely researched and used in the security industry. According to earlier studies, solenoid locks are dependable and efficient at controlling entry to a particular space. RFID technology also offers a quick and safe way to authenticate people and things.

In order to provide cutting-edge security solutions, several studies have concentrated on the integration of solenoid locks and RFID technology. To regulate access to particular locations, for instance, researchers have looked into the use of RFID tags, with the solenoid lock serving as the actual physical barrier. Other research have looked into the usage of solenoid locks, RFID, and biometric sensors together to increase security.

Keeping the system secure and reliable is one of the difficulties in this area. To prevent unauthorised access and data breaches, researchers have emphasised the significance of adopting encryption and secure communication methods. Additionally, a number of variables, including the calibre of the system's hardware, software, and programming, affect how well the system performs.

Overall, the examination of the literature indicates that solenoid locks and RFID integration have the potential to offer sophisticated security solutions. To increase the dependability and efficiency of these systems, more research is necessary.

METHODOLOGY

Fig. 1 proposes circuit diagram of Arduino RFID Solenoid Lock for Home Security. The electrical connections between the RFID reader, solenoid lock, Arduino microcontroller, relay module, and LED lights are shown in the circuit diagram for the Arduino RFID Solenoid Lock system. In order to ensure proper functionality and control of the solenoid lock based on RFID authentication, it acts as a visual reference for proper wiring and construction.

This Methodology is divided into further 3 categories-



Fig. 1: Circuit Diagram of Arduino RFID Solenoid Lock for Home Security

Design and Implementation

The Arduino RFID Solenoid Lock system is designed and implemented using following components:

- (a) Arduino Uno microcontroller
- (b) RFID reader module
- (c) Solenoid lock
- (d) Power supply unit
- (e) Breadboard and jumper wires
- (f) LEDs and resistors for visual feedback

Jumper wires were used to connect the RFID reader module to the Arduino Uno microcontroller, and a relay module was used to connect the solenoid lock to the Arduino. The RFID library and relay library were utilised for the RFID reader and solenoid lock control, respectively, in the system's software development, which was carried out using the Arduino Integrated Development Environment (IDE). A list of authorised IDs was saved in the microcontroller's memory, and the system was configured to read the RFID tag ID and match it with that list. The mechanism would activate the solenoid lock to unlock the door if the RFID tag ID had been approved. LEDs were used in the system's design to provide visual feedback indicating the lock's condition.

Testing Procedures

The testing methods for the Arduino RFID Solenoid Lock system were created to assess the system's dependability and performance. The following tests were executed:

- (a) **RFID Tag Reading Test:** This test made sure the RFID reader could correctly read the ID on the RFID tag.
- (b) **Authorization Test:** This test involved testing the system's ability to compare the RFID tag ID with the list of authorized IDs and grant access only to authorized individuals.
- (c) **Lock Control Test:** In this test, the system's capability to check an RFID tag's ID against a list of authorised IDs and only allow access to those who are authorised was put to the test.
- (d) **Performance Test:** In this test, the system's speed and dependability were assessed under various circumstances, including low battery voltage and variable RFID tag distances.

Data Collection

Data was gathered during the testing processes to assess the system's performance. The time it took to read the RFID tag, the number of successful and unsuccessful access attempts, the time it took to lock and unlock the door, and the system's response time under various conditions were all included in the data that was gathered.

In general, the design and implementation of the Arduino RFID Solenoid Lock system included using a variety of parts and programming software. The system's performance and dependability were assessed using the testing procedures and data collection techniques. The methodology offered a thorough mechanism for evaluating the system's performance as a security solution.

RESULTS

The results of the testing procedures conducted on the Arduino RFID Solenoid Lock system revealed the following findings:

1. RFID Tag Reading Test

The Arduino RFID Solenoid Lock system displayed a high degree of accuracy in reading the RFID tag ID during the RFID tag reading test. The system successfully detected and identified the RFID tags positioned within the required proximity with a reliable range of 3-5 cm.

2. Authorization Test

Only authorised people could gain access thanks to the system's ability to match the RFID tag ID with the list of authorised IDs. Unauthorised people were not allowed in, and the system gave visible feedback about the lock's state using LEDs.

3. Lock Control Test

The Arduino RFID Solenoid Lock system demonstrated dependable and quick lock control performance in the lock control test. The system made it possible for the door to lock and open smoothly and quickly by activating the solenoid lock mechanism. The system typically responded in under a second, guaranteeing effective access management while minimising delays and potential annoyances for users.

4. Performance Test

Under many circumstances, including low battery voltage and various RFID tag distances, the system's performance was discovered to be stable. The RFID tag reading distance was determined to be reliable up to a range of 5 cm, and the system was able to function effectively even with low battery voltage.

Overall, the findings show that the Arduino RFID Solenoid Lock system is a trustworthy and efficient security measure. The system was able to operate locks, read RFID tags with accuracy, and only allow authorized users access quickly and accurately. The system's performance was discovered to be consistent under a variety of circumstances, making it the perfect security solution for a range of applications.

Table 1: Status of Tag

Sr. No.	Serials No. of RFID Tags	Status
1.	A0:10:3E:50	Authorized Access
2.	53:A8:56:18	Authorized Access
3.	A1:70:C0:1B	Unauthorized Access
4.	F3:E4:7E:B7	Unauthorized Access

Based on the table, it is clear that some RFID tags have been authorized while others have not. Access has been granted to the tags with serial numbers A0:10:3E:50 and 53:A8:56:18, while access has been denied to the tags with serial numbers A1:70:C0:1B and F3:E4:7E:B7.

This emphasizes the significance of having an effective access control system in place, such as the already stated Arduino RFID solenoid lock system. This system effectively controls access to a protected area or object, giving admittance to only those with authorized RFID tags. It does this by combining RFID technology with a solenoid lock. Businesses and individuals can be certain of improved security and asset protection when using such a system.

CONCLUSION

In conclusion, the Arduino RFID Solenoid Lock system's integration of solenoid locks and RFID technology has shown to be a successful security solution. The performance and dependability of the system were assessed using testing processes and data collection techniques. The system was created and executed using a variety of components.

The system was able to reliably read RFID tags and only allow authorised people access, according to the testing methods' results. With a response time of less than a second, the lock control was prompt and dependable. The system's performance was discovered to be consistent under a variety of circumstances, making it the perfect security solution for a range of applications.

The use of the Arduino RFID Solenoid Lock system will have a big impact on the security industry. The technology can be used to guard access to particular locations and stop unauthorised entry. The system is a perfect security solution for a variety of applications, including homes, workplaces, and industrial sites, thanks to its efficiency

and dependability. The integration of biometric sensors to improve security and prevent identity theft may be the subject of future study in this area. Research could also be done to enhance the system's performance in various environmental settings.

In the future, there are several possibilities for further development and improvement of the Arduino RFID Solenoid Lock system. These include:

Integrating multi-factor authentication utilising biometric sensors or keypads to boost security is one area of advancement. Implementing Bluetooth or Wi-Fi remote access and monitoring capabilities, which allow control and monitoring via mobile devices or a central system, is another direction. To guarantee the confidentiality and integrity of the data, strong encryption and security measures should be put in place. An integrated security solution with other smart devices could be created by integrating with home automation systems. Access logs and analytics integration would also offer priceless insights for security management and audits. For the Arduino RFID Solenoid Lock system, these future directions offer better security features, easier integration, and greater security management capabilities.

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TRACK : 6



Effect of Daylighting, Classroom Orientation and Design on Teaching, Learning Activities of an Educational Building

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▶ ABSTRACT ◀

The study was done on Madhav Institute of Technology and Science, Gwalior, located in the city of Gwalior, Madhya Pradesh, India (26.2314° N and 78.2053° E). The primary purpose of daylighting on orientation is to maximise the utilisation of natural light in accordance with the building's orientation. The orientation of a building, along with other elements like location, temperature, and time of day, can alter the quantity and quality of natural light that enters the structure. India is totally situated in the Earth's Northern Hemisphere. India is situated in the Eastern Hemisphere of the Earth, as can be observed by looking at the Prime Meridian, the 0-degree longitude. Two different orientations classrooms were considered in this study of daylighting orientations for the month of April. It was found that average illuminance level varies between 56 lux to 294.7 lux in the classroom no. 117. It was found that average illuminance level varies between 25 lux to 259.3 lux in the classroom no. 112. The orientation of room 117 is facing northeast to southwest. The orientation of classroom 112 is facing southeast to northwest. The wwr ranges between 0.1831 to 0.1975, If the orientation change is possible or increase wwr is possible then we can save electricity consumption by 2838.36 kwh every year in the room-112 and similarly 951.48kwh every year in the room-117. Similarly, CO₂ mitigation can be saved around 4450.5484 kg/year in classrooms-112 and 1491.92 kg/year in classroom-117. It was found that North-South oriented classroom is best performance classroom majorly for illuminance in northern-hemisphere according to the past study. But the orientation of both the classrooms were other than this orientation so none of the classrooms has reached the minimum average illuminance in the month of April that is 300lux.

Keywords: Daylighting Orientation, Optimum Illumination, Role of Orientation.

INTRODUCTION

The orientation of the building plays a very important role in daylighting illuminance. According to most of the study the orientation of buildings in northern hemisphere is North to South[1]. Energy conservation is one of the most crucial issues facing the globe today, especially in Lebanon. One of the most crucial energy-saving factors is daylighting, whereas the primary energy-consuming factors in buildings are their heating and cooling systems. Daylight is crucial for the teaching process in schools, mentally as well as physically[2].

The South direction delivers practically zero Annual Sunlight Exposure and the best value for four of the five daylight measures, making it the top direction for yearly daylight performance[3]. The North direction has the highest annual energy production, offering 179–186 kWh (95% prediction interval) each year, but with greater uncertainty than the South due to the incidence of direct sunshine. The findings of tests, modelling, and modelling of a building prototype with solar glazing BIPV on one of the vertical façades have been described in this paper [4]

The goal of this study is to assist architects and decision-makers in Ouagadougou, Burkina Faso, in choosing the best design for office buildings at a starting stage of the building outline process. This will improve thermal comfort and energy performance by using inexpensive unassertive like daylighting and naturally ventilated. The best simulation produced a reduction in annualised energy demand, energy cooling demand, and in spite of raising solar gains to 14.9%, 25.3%, and 68.3%, it additionally boosted hourly average airflow to 64.8% and 2% in the hot and cold seasons, respectively [5].

The combination of WWR 30%, wall reflectance of 0.8, and south orientation is the most ideal configuration with the shortest mean distance to the utopia spots [6]

This study employs a multi-objective optimization method to refine the architectural design elements that shape the geometry of a classroom, considering several previously unexplored factors. In addition, the authors introduce a practical methodology for minimizing lighting energy consumption by segmenting the group into discrete lighting zones with controls. The findings of this study will facilitate the creation of a primary school classroom that is both energy-efficient and comfortable for occupants[7].

The implementation of controlled lighting systems is necessary to realize energy savings from daylighting in a building. The daylight factor remains the most commonly used measure for assessing the daylight condition within a structure. A comfortable level of brightness can be achieved by maintaining a suitable luminance ratio between areas of significant size, as viewed from a typical observation point[8].

Material and Methods

The table 1 shows the details of the instrument that were used during the measurement of illuminance, average ambient temperature, dimensions of classroom in the month of April. This study focuses on two different cases of illuminance, first is all the doors and windows were open and second is all the light in the classroom were on and doors and windows were closed, and different readings such were taken on hourly basis every day for the average of first 15 days in the month of April.

Table 1: Description of Instrument Used

Instrument	Purpose	Range
Lux Meter	The amount of light in a space or on a particular work surface should be determined.	0 to 200000 lux
Thermocouple	Used to determine the temperature at a certain location	-20 to 120 °C
Measuring Tape	Used to determine the size of classrooms.	6 to 40 inches

BACKGROUND INFORMATION

Classroom No.117

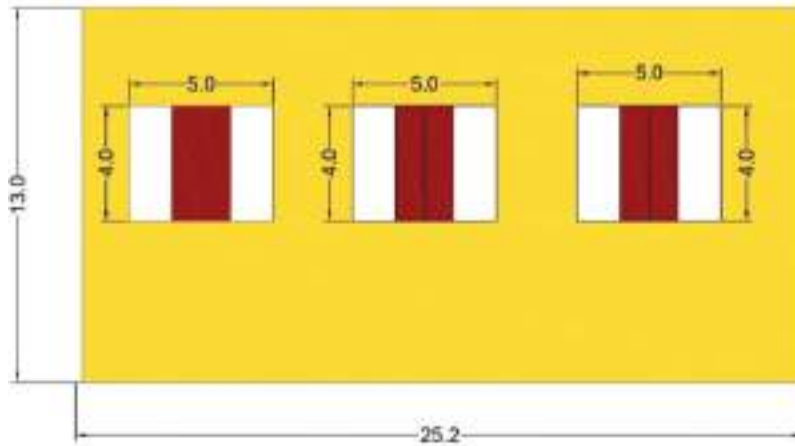


Fig. 1: Front View of Classroom 117

Fig 1 provides the details of the front view of the room 117 that is in vertical plane on which windows are mounted. The location of classroom is on the first floor. It features two windows, two of which face southwest, and one gate, which faces southeast. The orientation of room is facing northwest and southeast. It has two windows with area 20ft^2 each. Vertical wall is 327.6ft^2 . Area of floor is 590.89ft^2 . Windows to wall ratio, (wwr) is 18.31%. Door to wall ratio is 11.05%. It has 5 tube light of each 25 watt. Total electricity consumption per hour is 125 Watt.

Classroom no.112

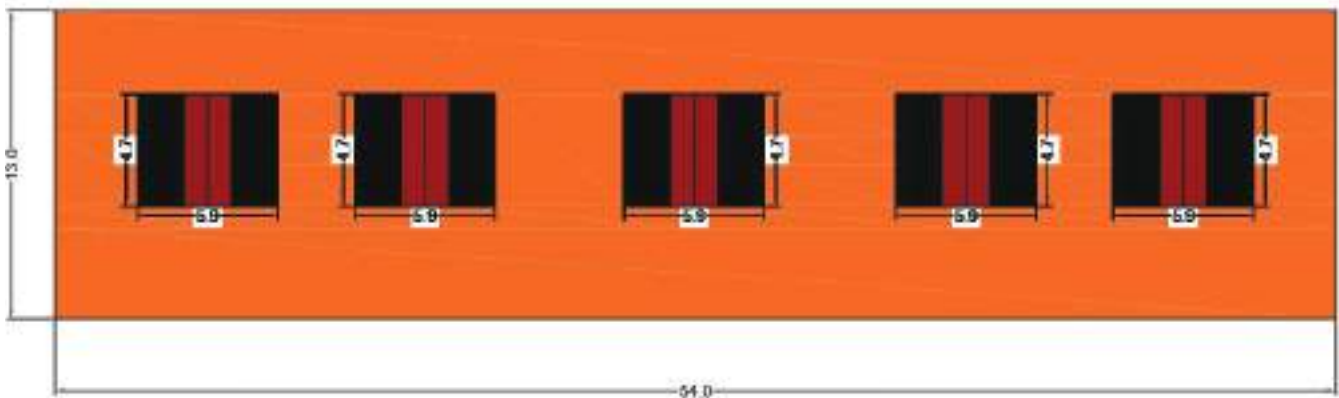


Fig. 2: Front View of Classroom 112

Fig 2 provides the details of the front view of the room 112 that is in vertical plane on which windows are mounted. It includes two gates facing southwest and five windows, each facing northeast. The floor area under examination is 1890 square feet, and the area of each window is 27.73 square feet. The windows' mounting face is approximately 702 feet square feet. There are 16, 25-watt lights in all. 400 watts of power are used overall. The windows to wall ratio (wwr) is 19.75% and the door to wall ratio is 13.43%.

ENERGY SAVING

The potential energy savings from daylight have been calculated using the following formulas.

Luminous Flux

The hourly luminous flux, or lumen, of daylighting in the classroom may be calculated using the formula below[9].

$$\Phi = (E_{ia} \times A_f) \quad (1)$$

where A_f (m^2) is the horizontal working surface area and E_{ia} (lx) is the hourly average daylight illuminance inside the working surface.

Lighting Power, P_i (W)

The following formula may be used to get P_i (W) hourly lighting power[9].

$$P_i = \left[\frac{\Phi}{B \times e} \right] \quad (2)$$

Where ϕ is lumen flux, B is ballast factor and e (lm/w) are luminous efficacy of unnatural light source.

Daily Artificial Reductions in Energy Consumption, E(KWH)

It is defined as the accumulation of the separate powers[9].

$$E = \sum_{i=1}^n P_i \quad (3)$$

Mitigation of CO₂

It is calculated by this formula[10]

$$\text{Energy saving(kwh/year)} \times 1.568(\text{kg of CO}_2/\text{kWh}) \quad (4)$$

METHODOLOGY

The daily experimental observation has been placed in the working area. The formula was used to the work surface within the classroom to calculate the lumen for two distinct situations that are specified in the material and technique for determining the luminous flux per hour. The hourly illumination output P_i (w) and the daily artificial reductions in energy consumption potential E (Kwh) were determined using equations 2 and 3, respectively. It is assumed that ballast factor (B_p) and e_c (lm/w) have values of 0.9 and 70, respectively. The potential for daily artificial reductions in energy consumption was determined by adding the potential for hourly energy saving. Monthly energy savings are determined by aggregating the daily energy savings for each respective month. The reduction in CO₂ emissions can be evaluated based on the energy-saving formula by making appropriate assumption.

RESULTS AND DISCUSSION

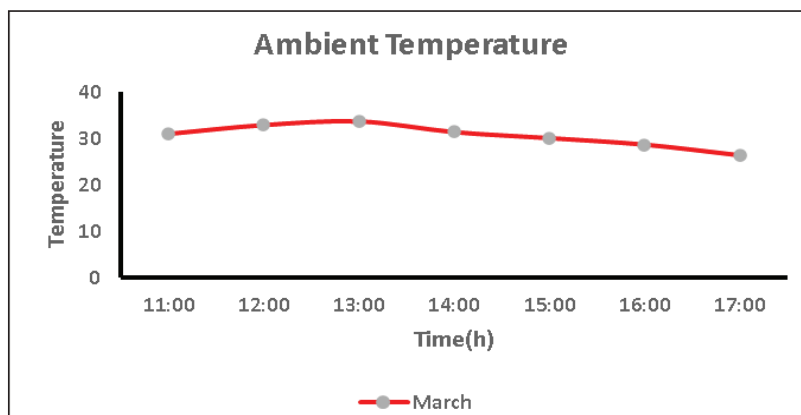


Fig. 3: The Hourly Variation of the Average Ambient Temperature in the Month of April.

Fig 3 shows the Average ambient temperature varies between 33.7 °C to 26.4 °C in the month of April between 11am to 5pm.

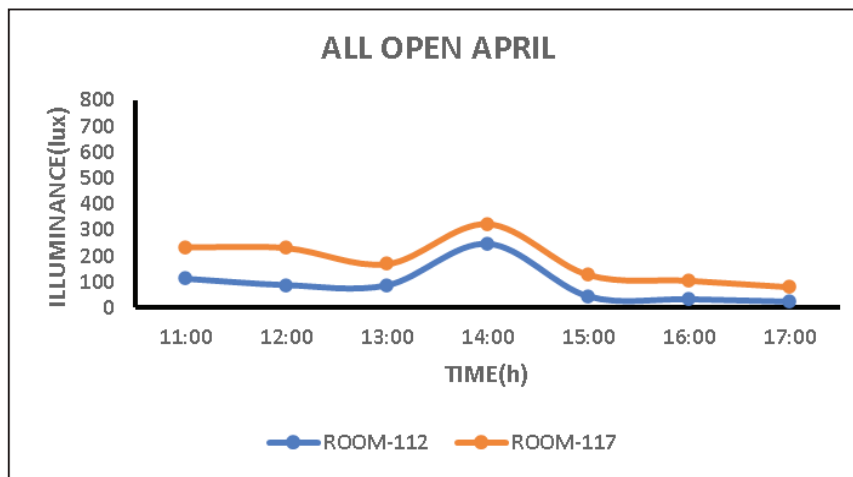


Fig. 4: The Interior Lighting for the Two Rooms on an Hourly Basis in April

The Fig4 shows the graph for the illuminance variation with respect to the time in hourly variations for open conditions that is when all doors and windows were open, and lights were shut. The maximum average illuminance was found in room 117 at 12:00pm is 143.28lux and the minimum average illuminance were 25lux in room 117.

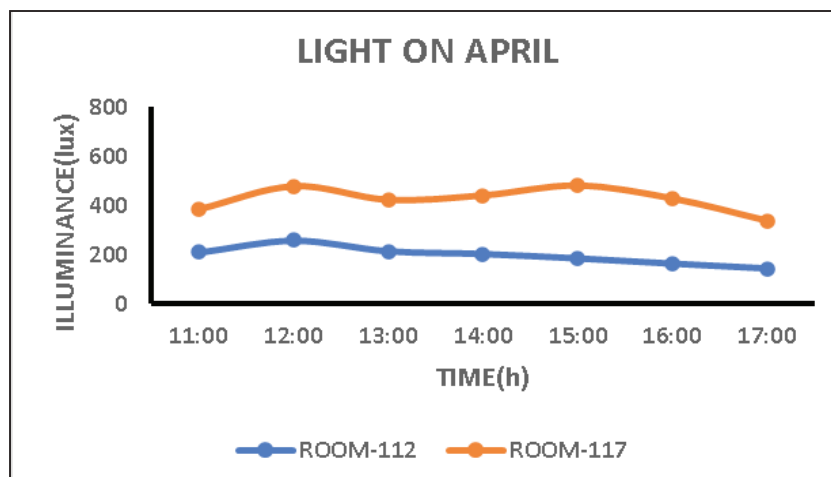


Fig. 5: The Interior Lighting for the Two Rooms on an Hourly Basis in April

The Fig5 shows the graphical representation of the illuminance variation with respect to time on hourly basis. Based on the observations the maximum average illuminance was found in room-117 at 3:00pm is 294.7 lux and the minimum average illuminance were 145.2lux at 5:00pm in room-112.

The Fig 4 and Fig 5 represent the illuminance level present in two different classrooms for two different conditions that is light on (when all doors and windows were closed) and All Open (when lights were off, and all windows and doors were kept open). The illuminance for light on scenario is found more than all open scenarios. Initially there is gradual increase in average illuminance and is maximum around noon then again, the graph shows average illuminance decreases in both the cases and is minimum at 5pm. The average natural power available in the room-112 is 201.98kwh similarly average artificial power available is 438.51kwh for 20 working days in the month of April. The average natural power available in the room-117 is 77.59kwh similarly average artificial power available is 156.88 kwh for 20 working days in the month of April.

CONCLUSIONS

None of the classrooms reaching the minimum standard average illuminance which is 300lux for reading, writing, and learning. The reason behind this may be either wwr or orientations of the classrooms. The wwr ranges between 0.1831 to 0.1975, which is very less as compared to standard values of wwr 0.30 to 0.45. Also, none of the classrooms exactly facing north-south orientations as per research in northern hemisphere zone the orientation of buildings in north to south for optimum illuminance. If the orientation change is possible or increase wwr is possible then we can save electricity consumption by 2838.36 kwh every year in the room-112 and similarly 951.48kwh every year in the room-117. Similarly, CO₂ mitigation can be saved around 4450.5484 kg/year in classrooms-112 and 1491.92 kg/year in classroom-117. Hence the role of orientations in daylighting is very important for designing in future the designer should prefer north-south orientations in northern hemisphere region.

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Study of Single Axis Active Solar Dish Type Cooker

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▶ ABSTRACT ◀

The international demand for high-grade and low-grade energy increases in consistency. Researchers discovered a sustainable and effective alternative that reduces the demand for fossil fuels. Solar energy is viewed as a healthy, sustainable, still ineffective substitute. Numerous investigations and tests have been carried out in the recent years to improve the effectiveness of solar energy. But they are continually making solar energy more efficient, day by day. In this study, we fabricate the single-axis active solar dish-type cooker on thermal parameters. The experiment is conducted on April 19, 2023, on the rooftop of MITS in Gwalior, MP, India. The maximum temperature of water was reached at around 81.9°C and Overall, the solar cooker's effectiveness was around 0.010418241.

Keywords: *Solar Concentrator, Active Solar Tracker Mechanism, Arduino Uno.*

Nomenclature

A	Area of solar collector, m ²
q_{rad}	Radiation heat, kj
q_{cf}	Heat receive by cooking fluid, kj
M	Mass of cooking material, kg
C_s	Specific heat of storage material, kj/kgk

T_{amb}	Atmospheric temperature, °C
T_{pot}	Cooking pot temperature, °C
Δt	Time interval, sec
ΔT	Temperature difference between pot and ambient temperature
η	Thermal efficiency
I	Solar radiation, W/m ²

INTRODUCTION

The global demand for energy usage increases daily, but a common resource, such as fossil fuel, is limited. So, the use of solar energy is considered one of the good options for achieving demand, and solar energy is environmentally friendly and sustainable. Harnessing solar energy efficiently is one of the prime areas of research.[1]. The concern for the preservation of the environment, the economy and energy efficiency measures, the relatively attractive costs etc. have boosted the industry of solar energy in particular, concentration technologies[2]. Solar radiation available on the Earth’s surface depends on local climatic conditions. For the proper design of building energy system there should have understanding of the local solar-radiation [3]system COP and water outlets temperatures are investigated. Study shows that both the water mass flow rate and inlet temperature have significant effect on system performances. Test results show that the effect of evaporator water mass flow rate on the system performances and water outlet temperatures is more pronounced (COP increases 0.6 for 1 kg/min. After energy crisis most of the nation forced to explore other energy alternative for their domestic and industrial applications.[4] To make such changes, scientists and engineers work relentlessly to develop new devices that can convert nature’s available energy (low grade energy) resources to abstract maximum useful energy, such as solar panels for sunlight energy and wind turbines for wind energy[5] There are many kinds of research ,devices being developed for increasing the thermal efficiency of solar cookers. The main component of any solar system is its solar collectors. Solar collectors are generally classified into two categories: 1. non-concentrating collectors, and 2. concentrating collectors. Non-concentrating collectors are further classified as 1.1 flat plate collectors and 1.2 evacuated tube collectors. Where concentrating collectors are classified, there are the 2.1 compound parabolic collector, 2.2 parabolic dishes, 2.3 parabolic troughs, and 2.4 heliostat field collectors. Solar collectors are responsible for the absorption of solar radiation and its reflection back to the specified location. The primary purpose of solar tracking systems is to maintain the dish system perpendicular to the orientation of the solar radiation beam. In general, the efficiency of any system increases after enabling the solar tracking system in the devices, but there are a few devices in which the fitting of the solar tracking mechanism is different for a number of reasons.

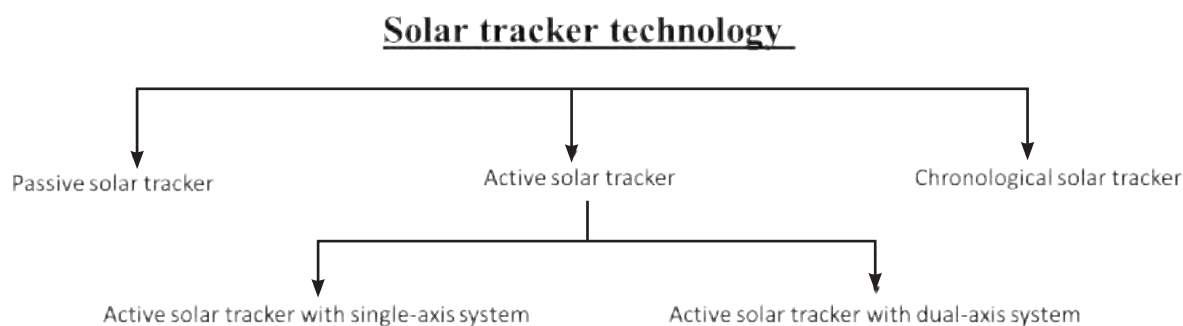


Fig. 1: Classification of Solar Tracker Technology [6]

Passive solar trackers are able to employ the idea of thermal expansion or imbalance forces developed between the two ends of the solar device to orient their sensing units towards the direction of the solar radiation beam. In this system, there is no mechanical mechanism for tracking solar radiation. The main advantages of using passive trackers are low cost and maintainability, easy installation, and a less complex system, but the major disadvantages of this system are its lower efficiency and dependence on the environment.

Sensors and motors are utilized in active solar tracking systems to move the solar collectors in the direction of the sun's energy beam. The most crucial parameter of the system is the number of axes over which the concentrator moves. The advantages of an active solar tracker are that it is more accurate and efficient at tracking the solar radiation beam, but some disadvantages include its high-power consumption and its ineffectiveness on cloudy days.

An active solar tracker with a single axis system rotates the collector only on a single axis of rotation for tracking the solar beam with the help of sensors and motors [6] Simplest tracking system and less complex than the multi-axis mechanism

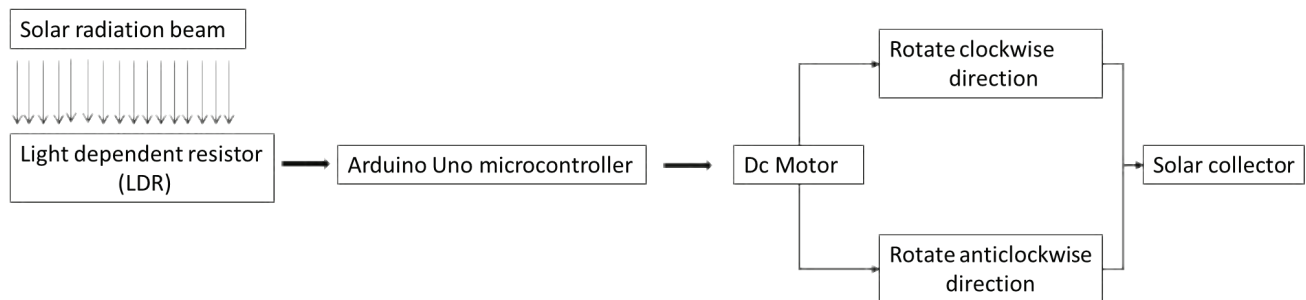


Fig. 2: Active Solar Tracker System Block Diagram [7]

Active solar tracking with a dual axis system: The earth follows a complex motion that consists of two motions: the daily motion and the annual motion. The daily motion causes the sun to appear from the east to the west over the Earth. Meanwhile, for the annual motion, the sun will tilt at a particular angle while moving in an east-west direction. There are two axes of rotation over which the collector rotates for absorbing maximum solar radiation, and each system requires at least four light-dependent resistors for tracking the light. Numerous studies have been carried out in order to improve the thermal efficiency of solar devices. While doing a study or analysis, the two most important parameters are taken into account, namely polar altitude and azimuth altitude. Chronological solar tracking, also known as time-based solar tracking, rotates 15 degrees per hour. Low energy is required, and a chronological solar tracking system has fewer tracking errors. The major drawbacks of this system are as follows: Continuous rotation requires more energy and causes more work loss on cloudy day.

MATERIAL AND METHOD

A solar dish cooker experimental setup consists of several components that are broadly divided into five major sections: 1. the frame; 2. the solar collector; 3. the solar tracking mechanism; 4. the cooking pot; and 5. the battery.

1. **Frame:** The main structure on which all other components are mounted, made of rectangular and circular hollow pipes. Plastic wheels and the stand for the cooking pot are fixed with frame.
2. **Solar Collector (or Concentrator):** It has a dome-like shape for concentrating solar radiation light onto its focus, which is made up of stainless steel with an aluminium sheet cover over it. Mounted over the pipe, connect with the frame. The weight of the solar collector is 1.5 kg. The reflectivity of aluminium is approximately 0.95, which is high enough for the collector and the insulation also used at the back of the dish.
3. **Cooking Pot:** An ordinary cooking pot made of aluminium with black paint on the outer side.

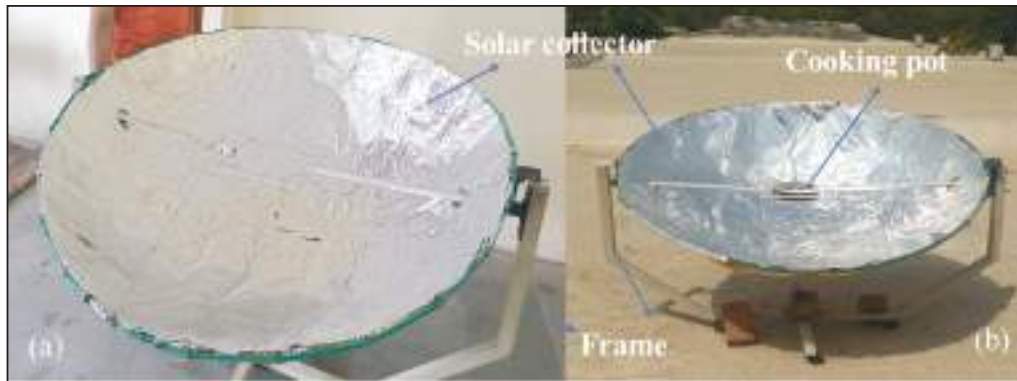


Fig. 3: Solar Concentrator

4. **The solar tracking mechanism:** is a single-axis active solar mechanism and consists of a number of sub-components, including: Worm and worm wheel:

- | | |
|-----------------|-------------------------------|
| (a) Shaft | (b) Bearing |
| (c) Platform | (d) Gear DC motor |
| (e) Arduino Uno | (f) Light-dependent resistors |



Fig. 4: Active Solar Mechanism

5. **Battery:** A 12 V, 7 Ah sealed lead-acid battery is used for providing power to the Arduino Uno as well as the dc motor.

Through the use of solar radiation and temperature readings at various segments, the experiment's method for calculating overall thermal efficiency It is calculated to determine the temperature. with the aid of a thermocouple. To determine the inlet, outlet, and ambient temperatures, a thermocouple sensor is positioned at various locations. There should be a reading obtained every 15 minutes.

THERMAL ANALYSIS OF SOLAR COOKER

Assumption

1. Solar radiation incident perpendicular to the dish and uniform all over the dish.
2. effect of wind and dust negligible.
3. area of concentrator and mass of cooking food is constant.
4. variation in difference of temperature of cooking pot is constant of an 't' time interval.

5. temperature over cooking pot is uniform.

(a) radiation heat transfer to the solar collector and reflected back to the centre of curvature:

$$q_{rad} = A\Delta t \int_{i=1}^5 I \quad (1)$$

(b) the heat q_{rad} is received by the cooking pot and transfer into the cooking fluid which eventually increase the temperature of cooking fluid.

$$q_{cf} = mc\Sigma\Delta T \quad (2)$$

(c) the ratio of equation 1 and 2 give the overall thermal efficiency of the solar cooker [8]:

$$\eta = \frac{q_{cf}}{q_{rad}} \quad (3)$$

RESULTS & DISCUSSION

Figure 5 shows the variation of ambient temperature along with inner cooking pot and outer cooking pot temperature with respect to time. The experiment is start at 11:35 am and then 11:45 am and after that reading was taken in 15 min interval up to 4:00 pm.

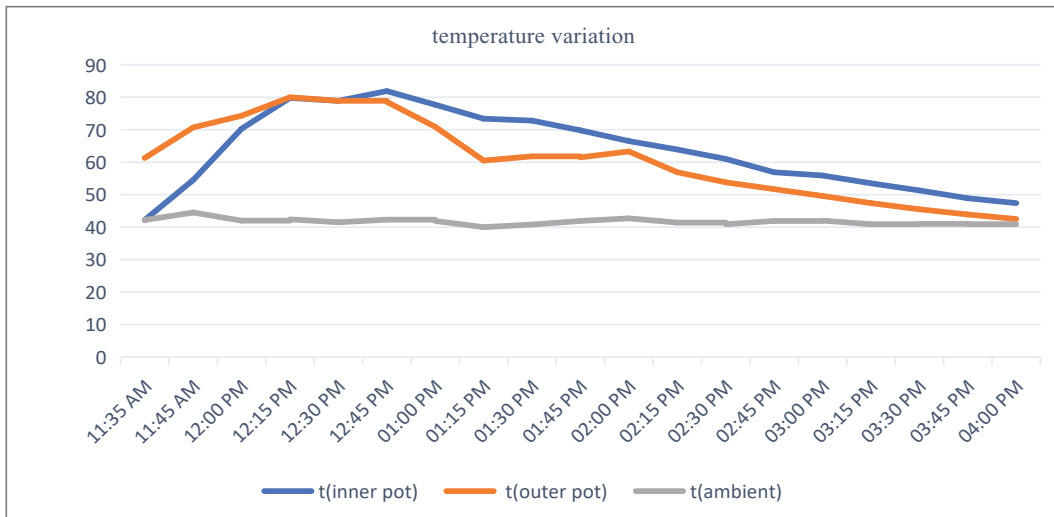


Fig. 5: Variation of Temperature with Time

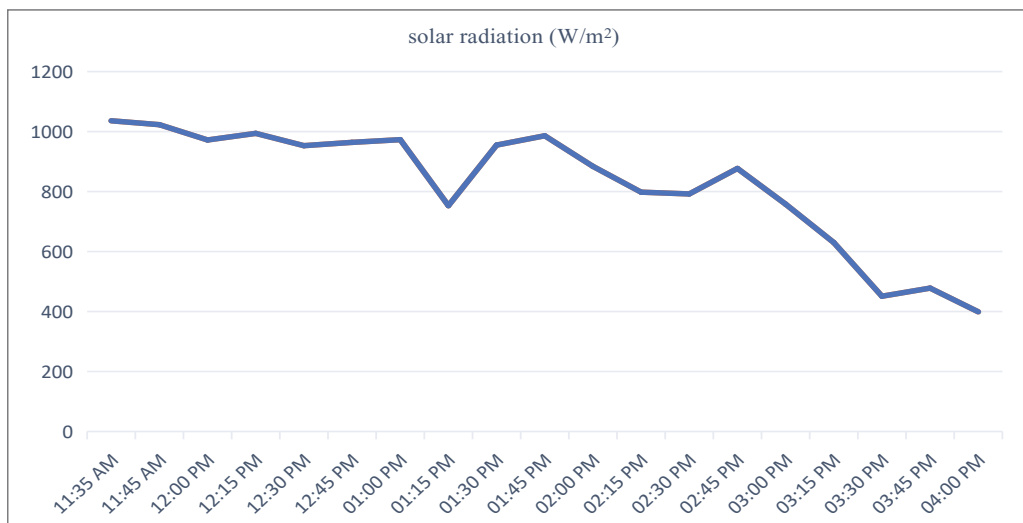


Fig. 6: Variations of Radiation During Experiment

The solar radiation is almost constant from 11:35 AM to 13:00 PM, whereas in Figure 5, the cooking pot temperature increases because the specific heat capacity of the storage material is high, so it takes a long time to reach a particular temperature at a constant heat input. table 1: show the different values of heat input, heat output and heat loss in the experiment. Heat input is calculated while using eq1. Where area of collector was 5.908m^2 and time interval was 900 seconds. Heat output is calculated while using eq2. Where mass of cooking fluid was 500g and specific heat of water was taken as $4.186\text{J/g}^\circ\text{C}$. and heat loss is difference between input and output heat.

Table 1: Variation of Heat with Respect to Time

Time	Q_{input} (KJ)	Q_{output} (KJ)	Q_{loss} (KJ)
11:35 AM	5508.619	0	5508.619
11:45 AM	5439.496	20.93	5418.566
12:00 PM	5168.318	59.2319	5109.087
12:15 PM	5285.297	78.2782	5207.019
12:30 PM	5067.292	78.2782	4989.013
12:45 PM	5125.781	82.8828	5042.898
01:00 PM	5173.636	74.9294	5098.706
01:15 PM	4003.852	69.9062	3933.945
01:30 PM	5077.926	66.976	5010.95
01:45 PM	5242.759	58.3947	5184.365
02:00 PM	4700.405	49.8134	4650.591
02:15 PM	4243.126	47.0925	4196.033
02:30 PM	4211.222	42.0693	4169.153
02:45 PM	4663.184	31.395	4631.789
03:00 PM	4030.438	29.0927	4001.345
03:15 PM	3349.836	26.3718	3323.464
03:30 PM	2398.057	21.5579	2376.499
03:45 PM	2541.622	16.744	2524.878
04:00 PM	2121.563	14.4417	2107.121

Thermal efficiency of solar collector will be defined as the ratio of input to the output heat of the solar dish cooker and the efficiency is calculated will using eq3. And shown in Figure 7. Here the efficiency increases at a much higher rate initially, up to a certain point because of the high concentration ratio of the concentrator; after that, the variation mainly depends on the radiation. And there is a sudden dip in the graph, mainly because clouds cover the sun, and radiation will also decrease at that particular interval.

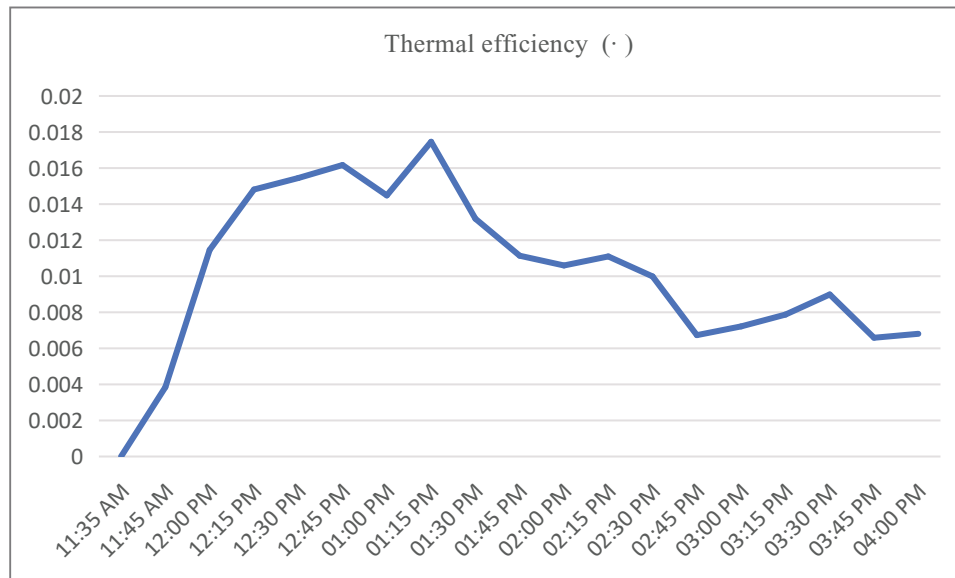


Fig. 7: Show Thermal Efficiency of Solar Collector with Respect to Time Variable

CONCLUSIONS

After the successfully conducted experiment the following conclusions are:

- Total heat input is 83352.4272KJ and total heat output is 868.3857 KJ.
- The overall thermal efficiency is 0.010418241.
- The maximum temperature of cooking pot is 81.9°C.
- After using single axis mechanism, the efficiency of solar cooker increases significantly.
- It has been demonstrated that a solar tracking mechanism has an advantage over a static solar collector since it can follow the location of the Sun throughout the day. This shortens the time required for cooking by allowing the solar collector to capture more solar energy.
- In the future, there should be a focus on two major components: a specially designed solar cooking pot and improving the surface finish of the reflecting surface of the collector. These two components play a vital role in improving thermal efficiency further.

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Condition-Based Monitoring for Bearing Fault Detection: A Comparative Study

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▶ ABSTRACT ◀

Rolling element bearings have a high load capacity, high precision, low energy requirements, and high mechanical efficiency. Since they minimise friction between parts of many types of machinery, they are widely employed in numerous industries. This article summarises several great studies from the last few years and over the past few decades and discusses their applicability to the identification of rolling element-bearing faults using. And presents a comparative study of conventional and machine learning-based condition monitoring techniques. The authors listed rolling bearing fault and their types, signal analysis, fault locations, and sensors. The study findings compiled in this article demonstrate that new and improved research techniques have emerged over time, accelerating the identification and diagnosis of rolling bearing defects. Artificial intelligence-based technologies, such as convolutional neural networks, machine learning, and artificial neural networks, for instance, continue to advance quickly and are also reviewed in this article. These techniques can help to acquire experience, improve the database, and swiftly identify bearing faults and their root causes.

Keywords: *Condition Monitoring, Rolling Element Bearings, Fault Diagnosis, Signal Processing, Vibration Analysis, Artificial Intelligence, Machine Learning, Deep Learning.*

Key findings of the study

- *This study offers a precise comparison of conventional and artificial intelligence-based condition monitoring techniques.*
- *This article offers a thorough description of recent advancements in bearing fault-detecting techniques.*

INTRODUCTION

Rolling element bearings constitute a fundamental component of rotating machinery, bridging the connection between stationary and rotating parts while supporting the rotational movement of shafts. Comprising four key elements - cage, rolling element, inner ring, and outer ring - their intricate interplay ensures efficient and smooth operation. The inner ring's synchronization with the shaft's rotation is pivotal, while the outer ring provides structural support. Consequently, these rings interact harmoniously, alternating in receiving the rolling components within the cage. The optimization of rolling element size, shape, and quantity significantly influences bearing performance and service life. Moreover, the dynamic lubrication facilitated by the cage contributes to precise control over rolling element rotation.

Critical to the prolonged functioning of rolling bearings is the meticulous scrutiny of potential faults. The integrity of the inner and outer ring surfaces, raceway, rolling bodies, contact surfaces, and even the cage edge is paramount. A notable phenomenon is the formation of cracks, which has substantial implications for bearing reliability. In this paper, we delve into the intricate process of crack formation within rolling bearings. Notably, we unveil the progression of cracks from initiation to propagation, shedding light on their underlying mechanisms.

Moreover, our study emphasizes the resemblance in defect frequencies across diverse bearing components. These encompass the defect frequencies for inner and outer rings, ball bearings, and the cage.[1] An intriguing aspect of our analysis is the examination of micro-crack formation and its interplay with the concept of fatigue endurance. Our findings underscore the significance of fatigue endurance limits as manifested through the lack of micro-crack formation on inclusions. The observation of non-propagation of butterfly-like structures further accentuates the premise of an endurance limit in fatigue-induced degradation.

In the conclusive stages of crack propagation, our investigation delineates the crack's trajectory toward the ring raceway. The eventual outcome encapsulates the emergence of surface cracks on the raceway or the amalgamation of adjacent cracks. Our insights bear significance for predictive maintenance strategies, facilitating the early detection of bearing faults and enabling informed decisions.

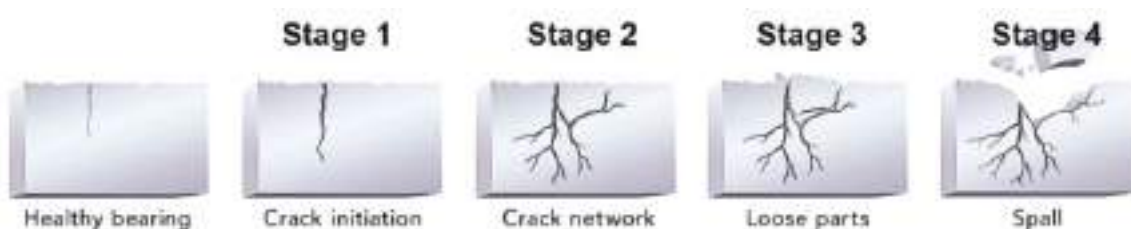


Fig. 1: Crack Formation in Bearing

Source: based on: <https://www.spminstrument.com>

Since rolling bearings are essential components of rotating machines, their failure may result in an unexpected shutdown of the plant and it may lead to high economic losses, By early detection of such defects as well as the severity of the damage in the operating conditions of the bearing, machine breakdowns can be avoided, condition monitoring plays a vital role in bearing fault detection, the main goal of condition monitoring is to maintain overall equipment effectiveness and personnel safety.[2] It is more effective than reactive maintenance since faults can generally be avoided.

In Today's era, there are two types of condition monitoring used in industries, one using conventional techniques and another using machine learning techniques.[3]

Purpose of Fault Diagnosis

To prevent rotating machines from catastrophic breakdowns, early detection of bearing faults is necessary. Fault Detection and Diagnostics (FDD) technology offers substantial cost reduction and operational efficiency

enhancement for rotating machinery. Identifying the problem that occurred or the cause of an out-of-control condition is called fault diagnosis. Early Fault detection helps to assess the current state of the plant. In industrial processes, fault detection is a difficult operation that requires fast and accurate techniques under difficult conditions that include noisy measurements, huge amounts of inputs, highly connected data, and complicated interactions between symptoms and problems. [4]. The accuracy of the data used to identify and diagnose classes is crucial for FD systems that use data-driven approaches to solve classification problems. [5] Selection of accurate signal processing techniques reduces the computational complexity and consequently, training and testing time. For a large feature set, feature selection is used to limit the number of features. It is shown in Fig 2.

Types of Defects

There are many faults occurred in bearings, some of the examples of main types of roller-contact bearing damage are as follows. [6]

1. **Flaking:** The phenomenon known as flaking is characterised by material flaking off the raceway and rolling elements as a result of rolling fatigue. This occurrence happens when the bearing life is at an end. However, if flaking appears sooner than anticipated, it may be considered abnormal and call for a cause-and-effect analysis and the implementation of preventative measures.
2. **Wear and Tear:** Wear occurs most frequently on sliding contact surfaces such as roller faces and rib faces, cage pocket surfaces, and guiding surfaces of cages and bearing rings. Keep in mind, nevertheless, that corrosion or foreign matter can lead to wear on both sliding and rolling surfaces.
3. **Cracking and Chipping:** Cracking is the general term for splits and fractures. On the other hand, chipping refers to flaws that emerge in a roller's corner or the rib of a bearing ring.
4. **Brinelling and Notches:** Brinelling is defined as a small surface deformed on the raceway surface through plastic deformation at the point of contact between the raceway and the rolling elements.
5. **Scratches and abrasions:** The term scratch is used to describe the relatively shallow scratches left behind by sliding contact that moves along with the sliding yet do not seem to disappear. The term abrasion describes traces whose surfaces have partially melted as a result of a larger thermal action and greater contact pressure. Most people believe that chafing is a more serious form of scratching.

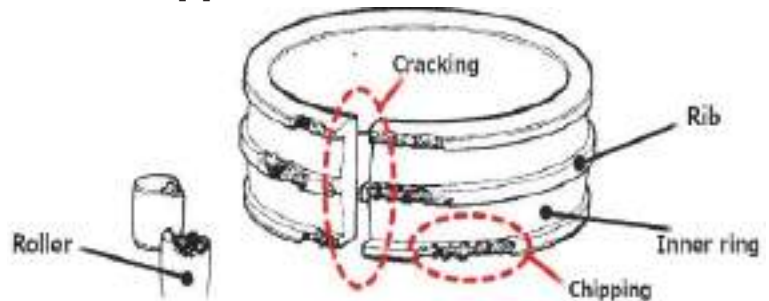


Fig. 3: Cracking and Chipping [4]

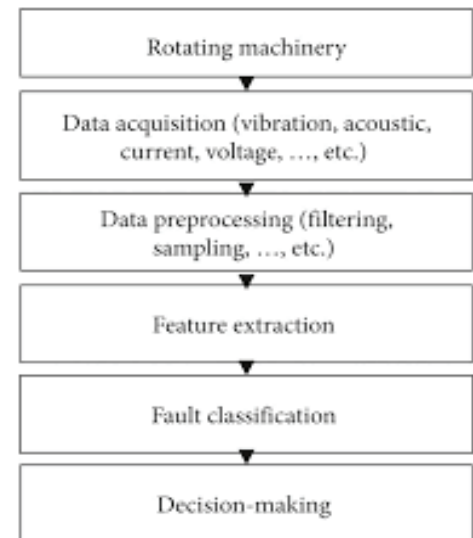


Fig. 2: General Block Diagram of FDD [4]

PROCESSING OF SIGNALS

The foundation of the vibration fault detection and AE (acoustic emission) analysis process rests upon three essential pillars: data collection, signal processing, and fault classification. Data is acquired through the utilization of analyzers and sensors. To gather vibration data, accelerometers, velocity transducers, and various other sensors are commonly employed. Meanwhile, AE signals are captured using piezoelectric sensors. Once collected, the signal processing unit takes charge of subsequent signal processing steps. Among these, statistical analyses encompassing the necessary information for assessing the bearing's condition are conducted. However, the collected data represents a blend of bearing-related information, noise, and data pertaining to other operational components such as gears and shafts.

Signal processing encompasses a range of operations including feature extraction, signal amplification, noise reduction, signal filtering, and defect diagnosis. The methods of processing the signal are diverse, including but not limited to the Wavelet transform, Fast Fourier transform, envelope analysis, Root Mean Square Value, Empirical Mode Decomposition, Matching Search, Cepstrum, and Wigner Ville, among others. Notably, for the extraction and selection of features, techniques such as cyclo-stationary analysis and three domain techniques can be effectively employed.

Time Domain Method

The time domain analysis stands as a fundamental signal processing technique that provides a straightforward and essential approach to accurately analyze signals, whether they are healthy or faulty. When assessing bearing faults, this method centers on key attributes like the slew factor, kurtosis value, peak value, and RMS value[10]. The RMS value offers insight into vibration force, while the peak signifies the highest value within a signal's timeline. The crest factor, a ratio of the peak value to the effective value, adds a dimension of assessment. Notably, kurtosis, a statistical measure, serves to pinpoint the peak of a signal. Intelligent fault diagnosis for rolling bearing faults has been advanced by combining artificial neural networks (ANN) with time domain characteristics[10]. This synergy has been substantiated by research literature. Specifically, the ANN technique employs inputs from time domain-processed signals, encompassing RMS value, kurtosis value, and negative parameters. However, it's crucial to acknowledge that the applicability of time domain analysis might be constrained in larger and higher-level machinery, where fault detection proves more intricate[11]. For a comprehensive understanding of the strengths and limitations of the time domain method, refer to Table 1.

Table 1. Advantages and Drawbacks of the Time-Domain Method

Time-domain Features	Benefits	Drawbacks
RMS	A real method that is simultaneously connected to the energy content of the vibration profile	RMS vibration changes only impact high-amplitude components.
Kurtosis	Strong ability in detecting periodic impulses and great shock sensitivity	Costs for the kurtosis metre are high.
Peak	Easily understood method	Noise sensitivity

Frequency Domain Method

The frequency domain contains many characteristics that the time domain does not. Signal information is shown using the frequency domain technique as a function of amplitude on the frequency axis. It provides fast signal analysis and characterisation from frequency domain signal Power spectrum, cepstrum, envelope spectrum, and Fourier transform.[12] Drawbacks and benefits of frequency domain method is shown in table 2.

Table 2. Various Frequency Domain Techniques with Advantages and Drawbacks

Frequency Domain Techniques	Benefits	Drawbacks
FFT	This method is easy to use and put into practice.	Being unable to quickly examine transitory features.
Envelope analysis	Even in the presence of a few amount of random variation, it performs effectively.	It may lead to a significant diagnosing mistake.
Power spectrum	In comparison to the FFT, this method performs better in estimating the spectrum, which is useful for identifying signals that change significantly quickly.	Due to its complexity, it needs expert expertise. Peaks in the power spectrum are very susceptible to shaft oscillations.
Cepstrum	Sideband analysis is easy to apply and beneficial.	Only well-separated harmonics can be employed since the filtering averages out the variances in the spectrum curve, computationally costly.

Fast Fourier Transform (FFT)

In the 19th century, the French physicist and mathematician Joseph Fourier introduced the concept of the Fourier transform. He unveiled the remarkable insight that "any periodic function can be broken down into a series of simpler oscillatory functions, specifically sine and cosine waves." This groundbreaking revelation signifies that vibration signals can be extracted through the Fourier transform, which manifests as a complex exponential function operating at various frequencies [13]. Fast-forward to 2007, when two researchers embarked on an innovative exploration. They combined the Fourier Transform with the Hilbert Huang Transform (HHT), directing their focus toward intrinsic mode functions (IMFs) for diagnosing rolling bearing failures. However, while the FFT offers advantages, an initial limitation emerged—it necessitates continuous calculation, rendering the differentiation between stationary and transient data components challenging.

Time-Frequency Domain Techniques

Sections 2.1 and 2.2 have delved extensively into the analyses within the time and frequency domains. In the present section, we plunge into the intricate fusion of these two analytical dimensions. This combination presents an expansive outlook on a signal's attributes in the time-frequency domain, encompassing insights along both the temporal and spectral axes.

A vibration signal embodies a blend of diverse signal constituents, enlisting elements such as stationary and non-stationary signals, linear and non-linear behaviors, and more. Untangling this intricate amalgamation, capturing the fundamental properties of the signal while mitigating the impact of noise interference, necessitates the convergence of time and frequency analyses. This juncture marks the significance of the symbiotic relationship between these dimensions, assuming a pivotal role in the process.

At the core of this undertaking resides an array of time-frequency techniques, each meticulously designed to unveil distinctive facets of a signal's intrinsic characteristics. Within this array, noteworthy contenders encompass the short-time Fourier transform, empirical mode decomposition (EMD), wavelet transform, empirical wavelet transform, matching pursuit, Wigner-Ville distribution, and more [14]. Nevertheless, a critical evaluation of the merits and limitations of each technique is indispensable. A comprehensive elucidation of these aspects is provided in Table 3.

Table 3: Various Time-Frequency Domain Techniques with Benefits and Drawbacks

Time-Frequency Domain Techniques	Benefits	Drawbacks
STFT	A basic method with low computational complexity that is appropriate for those are new to time-frequency analysis	It is hard to develop a quick and effective method to compute STFT for the full signal analysis with constant frequency resolution.
EMD	Method of self-adaptive breakdown not requiring a set of mathematical operations that already exist.	To increase the likelihood that the mode mixing issue may arise while processing the signal, EMD overestimates the number of modes.
EWT	EWT prioritises the oscillating portion more. Additionally, it has a faster computing speed than EMD.	The EWT won't be able to discriminate between two chirps in an input signal .
Matching Pursuit	The optimal waveform is iteratively chosen from the input signal via MP, a materialism technique.	The dictionary density introduces the efficiency of the MP algorithm. Although more efficient, denser systems may also require more computer resources and storage space.

WVD	Its frequency and temporal resolution are good. The use of a window function is not necessary for its implementation.	It is falsely indicated by the cross-term interference that there are signal components present between the auto-terms.
WT	Compared to STFT, they offer greater temporal localisation at high frequencies, are more adaptable, and support a wider variety of wavelet functions.	It is difficult to select the mother wavelet type.

CONDITION MONITORING FOR BEARING FAULT DETECTION

Detection of REB fault is one of the most challenging tasks in condition monitoring, particularly when the breakdown is in its early stages. If occurred a fault not found on time, it can cause failure in rotating machinery. Rolling bearing failures can occur due to a variety of factors, including poor roller path alignment, uneven roller diameters, improper lubrication, overloading, fatigue, and wear. Many fault detection methods are used to find bearing faults. An extensive investigation identified four distinct techniques for locating and identifying bearing problems can be categorised as vibration measurement, acoustic measurement, temperature measurement, and specified analysis of abrasive contaminants. It is possible to assume that the vibration signal coming from worn-out bearings contains a particular component that represents a big number of fault characteristics and noise components. These features were extracted using a Bayesian estimator from the vibration signals after the wavelet coefficients were processed.[8] Condition monitoring plays vital role in bearing fault detection, the main goal of condition monitoring is to maintain overall equipment effectiveness and personnel safety.[2] It is more effective than reactive maintenance since faults can generally be avoided.

In Today's era, there are two types of condition monitoring used in industries, one using conventional techniques and another using machine learning techniques.[3]

Using condition monitoring makes it possible to plan maintenance or other measures to be taken to prevent indirect damage and avoid consequences.

Traditional Methods for Fault Classification

A comparison of various conventional methods for bearing fault diagnosis is shown in Table 4.

Table 4: Conventional Techniques Used for Finding Bearing Faults

Traditional Methods	Advantages	Disadvantages
Sound and Acoustic Emission Analysis	<ul style="list-style-type: none"> This method is used for reliable and remote condition monitoring. Can be easily implemented. 	<ul style="list-style-type: none"> It is Sensitive to noise. An expensive sensor is required.
Temperature and Infrared Analysis	<ul style="list-style-type: none"> Basic and Non-invasive method. 	<ul style="list-style-type: none"> An expensive sensor is needed. The main disadvantage of this method is, it cannot be used as an early FDD
Vibration and Noise Analysis	<ul style="list-style-type: none"> It is a Reliable and standard method and Can be used as an early FDD It is Sensitive to noise 	<ul style="list-style-type: none"> An costly sensor is required.
Chemical and Oil Analyses	<ul style="list-style-type: none"> It has excellent Fault estimation and localization capabilities and it has high performance for FDD. 	<ul style="list-style-type: none"> It is an expensive method.
Analysis of Current, Voltage and Electromagnetic Field	<ul style="list-style-type: none"> Cheapest Non-disruptive method. 	<ul style="list-style-type: none"> Sensitive to noise Cannot be used as an early FDD
Ultrasound Analysis	<ul style="list-style-type: none"> Effective in low-speed bearings It deals with low and medium frequency ranges . 	<ul style="list-style-type: none"> An expensive sensor is required.

Artificial Intelligence for Fault Classification

The preceding sections of this study have explored a spectrum of signal-processing methodologies harnessed in vibration analysis. However, the crux of modern condition monitoring lies in its potential to autonomously detect and diagnose faults, rendering human intervention unnecessary. This is where the prowess of artificial intelligence (AI) comes into play, offering a transformative edge. The expansive applications of AI systems within rotating machinery fault diagnostics stem from their reliability and adaptability. Moreover, their potency is underscored by the fact that they don't necessitate exhaustive prior knowledge, which can be elusive in real-world scenarios. At the heart of this paradigm stands "machine learning," a subset of AI. This facet revolves around machines imbibing datasets and autonomously learning from them. As these systems progressively delve into the data they process, they dynamically adapt their algorithms, recalibrating their understanding [15]. Notably, "machine learning" and "artificial intelligence" are often employed interchangeably, a testament to their interconnectedness. This domain bifurcates into three key subcategories: supervised learning, unsupervised learning, and reinforcement learning. In the realm of supervised learning, labeled objectives and training data empower systems to generate outcomes. Predictive in nature, these systems learn mappings that yield outputs corresponding to inputs. Noteworthy techniques span logistic regression, support vector machines, and decision trees. Among the AI techniques commonly employed for diagnosing rolling element bearing (REB) issues, two prominent players emerge: deep learning and machine learning [16].

AI Methods used in Condition Monitoring and FDD for Rotating Machinery

AI methods used in Condition monitoring and FDD for rotating machinery are shown in Fig 4.

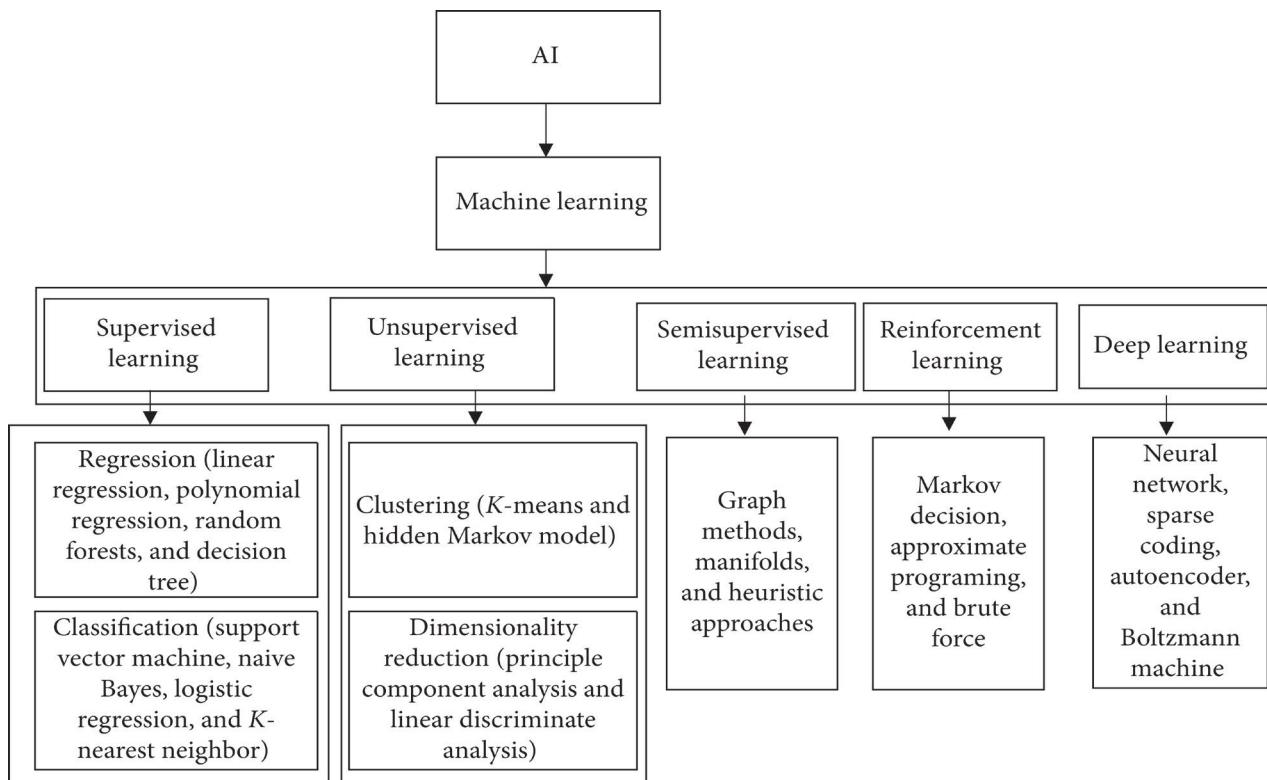


Fig. 4: AI Methods used in Condition Monitoring and FDD for Rotating Machinery [4]

Machine Learning Algorithms

Various machine learning approaches play a crucial role in fault detection utilizing artificial intelligence. Notable methods include k-nearest neighbors, naive Bayes classifier, support vector machines (SVM), deep learning, and

artificial neural networks (ANN). The comparison of the efficiency of artificial neural networks, support vector machines, and Gaussian regression for calculating the remaining bearing life is detailed in Table 5. The field of rolling bearing fault diagnosis employs a range of artificial intelligence techniques, as elaborated in section [17].

Table 5: A Comparison of AI-based Techniques with Pros and Cons

AI-Based Methods	Benefits	Drawbacks
k-NN	It has a simple procedure. It is adaptable and can be used for classification and regression. It has High accuracy.	It costs a lot to compute and takes up more storage space.
SVM	This method has High accuracy and support for large and complex datasets	It is ineffective for multi-class classification because it is primarily used for binary-class classification.
NB	In this method, Missing values are not an issue, and a lot of storage space is not required.	It has Strong assumptions and prior probability are needed for the NB classifier.
ANN	It has High classification accuracy and a good approximation of complex nonlinear functions	It has a Long processing time due to the complex design process and large network. There are many parameters, and overfitting is easy.
Fuzzy	It has Strong sturdiness, a straightforward design, and a simple layout	In this method Understanding the knowledge norms and determining the proper membership function are challenging tasks.
PSO	It has an easy-to-understand application, is resistant to parameter changes, and is computationally effective.	low convergence rate in the iterative process and is susceptible to falling into local optima.
Deep Learning	The deep architecture of this method enables learning more complex structures from data without the need for the feature extractor, making it possible to learn features and detect faults without it.	Due to the complicated data models, it needs a large amount of sample data, costs a lot to train, etc.

The Main Differences Between Traditional Analysis and AI-Based Analysis

Classification models infer the correlations between the various variables using mathematical equations and statistical analysis. However, AI-based models avoid using such algorithms and rely on the ability to learn from a large enough number of datasets.[18]Comparison of Conventional and AI based analysis is shown in table 6.

Table 6: Comparison of AI-based and Conventional Analysis

Factors	Conventional Analysis	Artificial Intelligence Based Analysis
Time as a factor	The system cannot withstand if the events vary over time rather than being effective in time invariance, n index.	It is an ideal method for non-stationary and transitory occurrences .
User expertise required	The ability of the user to access pertinent data is crucial for model development, and the model's efficacy is judged by the user.	Using AI Essential information and pertinent facts are automatically identified. The information is directly related to the activity. Value can be immediately collected.
Identification of diagnostic data	In traditional analysis, the fault diagnostic library needs to be defined explicitly.	The event itself includes fault diagnostic information. The system incorporates user feedback so that it can learn from its experiences.
Model training and data pre-processing	To train a model, bad points in data collection are manually identified and excluded.	The model recognises standard deviations and normal behaviour automatically.

Feasibility and Efficiency of Different Approaches for Detecting Early Faults and Low Energy Defects

A feasibility study on diagnostic methods for the detection of bearing faults at an early stage is shown in Table 7.[19]

Table 7: Lists of Viability and Effectiveness of Numerous Methods for Finding Low-Energy Defects and Early Failures

Methods	Detection of Early fault	Efficiency for low energy defects	The number of information sources
Time domain	×	Low	4
Frequency domain	√	Low	10
Cyclo-stationary	√	Low	3
Time-frequency domain	√	Moderate	19
Time domain + artificial intelligence	√	Moderate	4
Frequency domain + artificial intelligence	√	Moderate	17
Time-frequency domain + artificial intelligence	√	High	23

The Methods Employed by Various Researchers, Along with their Goals and Key Discoveries

N. Tandon and A. Choudhury examined the techniques used for rolling element bearings (REB) fault identification in 1999. They described the methods for measuring vibration and acoustics and compared them to some more recent ones. Y. Hassan Ali et al. released a summary study on problem detection and condition monitoring of REB based on AE analysis using artificial intelligence in 2014. Soon after, a review article on the use of signal processing methods was released by two researchers. The main condition monitoring tools and their capabilities were covered in great detail in this study. There was a published examination of the techniques used in FD, fault measuring, and fault modelling of REB. Techniques employed by various researchers, along with their goals and key discoveries are shown in Table 8.

Table 8: The Methods Employed by Various Researchers, Along with Their Goals and Key Discoveries

Main Objectives of the Method	Techniques Used	Main Findings of the Method
Fault diagnostics of REB	Matching pursuit	It reduces dictionary redundancy and makes outcomes easier to interpret
Analysis of REB vibration signals	Cyclo-stationary analysis	It has improved capability under varying situations
REB fault diagnosis	Local characteristic-scale decomposition-teager energy operator	It has improved performance in erratic circumstances
Fault detection of ball bearing	STFT	It has Perfect spike detection, efficient as a diagnostic tool
Rolling bearing FD	STFT + Deep learning	It is Easy to apply, robust and has better diagnostic performance
REB diagnosing method	EMD	This method has Better fault detection capability at the early stages
Bearing fault diagnostics in variable speed conditions	Acoustic spectral imaging	It has Invariant to fluctuations in shaft speed

Evaluation of the REB's remaining usable life	WPT + ANN	It has improved the ability to anticipate remaining useful life
categorization of ball bearing faults	Vibro-acoustic sensor data fusion + KNN	This method has increased robustness, accuracy, and dependability
Early flaw detection and diagnostic supervision in REB	High-frequency resonance technique	It can identify the early stages of inner race and outer race defects

CONCLUSION

This article provides an encompassing exploration of the foundational principles and practical applications of vibration signature analysis, a crucial methodology employed to discern and diagnose bearing faults. Within this discourse, frequency domain analysis emerges as the preferred approach, overshadowing time domain analysis and the Acoustic Emission (AE) method. The author meticulously reviews an array of traditional and cutting-edge condition monitoring techniques, both rooted in conventional practices and hinging on artificial intelligence. Notably, the spotlight falls on an exhaustive comparison of pivotal machine learning methods tailored for fault detection. This inclusive assessment encompasses a spectrum of techniques: K-Nearest Neighbours, Naive Bayes Classifiers, Support Vector Machines (SVM), Deep Learning, Artificial Neural Networks (ANN), as well as Gaussian regression techniques. Central to this analysis is the meticulous juxtaposition of condition monitoring methods stemming from artificial intelligence and those rooted in conventional paradigms. This comprehensive study not only synthesizes disparate approaches but discerningly highlights their unique attributes, engendering a holistic understanding of their strengths and limitations.

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A Comparative Study of the Thermal Sensors in Predicting Skin Burn Injury

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▶ ABSTRACT ◀

In this study, different thermal sensors are used and compared for their responses at 40°C, 50°C, 60°C and 100°C. These sensors are used in accessing the performance of protective clothing against different thermal exposures such as radiant, convective heat transmission along with molten metal and steam exposure. The copper calorimeter, Pyrocal, epoxy and skin simulant sensors were compared by exposing them to hot plate which was maintained at particular temperature. Initially, bare sensors were placed, and the temperature rise was observed with time, later on neoprene coated 100% para-aramid fabric was utilized for comparative study. It was observed that at lower temperature the responses were comparable with slight variations between epoxy, skin simulant and Pyrocal sensor, however at higher temperature, the results varied significantly. Further study needs to be conducted for better prediction of responses with and without using variety of inherent flame-retardant fabrics.

Keywords: *Stoll Curve, Burn Injury, Thermal Sensor, Protective Clothing, Skin Simulant Sensor.*

INTRODUCTION

Various protective clothing are designed to protect workers from mechanical and thermal hazards while handling sharp metal products [1, 2] and hot objects in industries. Protective clothing for thermal hazards is designed to protect workers from high temperatures, flames, and other thermal hazards that may exist in their work

environment. Thermal protective clothing can be made from various inherent flame-retardant materials, such as para-aramid, meta-aramid, FR viscose, modacrylic or blend of flame-resistant cotton with inherent flame-retardant fibres. Here are some examples of thermal protective clothing:

- **Firefighters' Turnout Gear:** Firefighters wear turnout gear made from materials such as meta-aramid or para-aramid to protect themselves from flames, heat, and smoke. The gear consists of a helmet, coat, pants, gloves, and boots, all designed to protect the firefighter from thermal hazards.
- **Aluminized Clothing:** Workers in high-temperature environments, such as foundries or steel mills, may wear aluminized clothing. This clothing is made of materials that reflect heat, such as aluminum or silver, and can protect the worker from radiant heat and molten metal splashes.
- **Heat-resistant Gloves:** Workers in industries such as welding, foundries, and glass manufacturing may wear heat-resistant gloves to protect their hands from thermal hazards. These gloves are made from materials such as leather or aluminized fabric and can protect the worker from high temperatures and hot surfaces.
- **Arc Flash Clothing:** Workers in the electrical industry may wear arc flash clothing to protect themselves from the thermal hazards of an electrical arc. Arc flash clothing is made from flame-resistant materials and is designed to minimize burn injuries in the event of an arc flash.

Abbreviations			
Kg	Kilogram	μ	Microns
m	Mass (kg)	Q_c	Transmitted heat flux (kW/m ²)
C_p	specific heat (J/kg°C)	Q_o	Incident heat flux (kW/m ²)
A	Area (m ²)	IFR	Inherent flame retardant
J	Joules	SS	Stainless steel
s	Second	ISO	International Organization for Standardization
kW	kilowatt	ASTM	American Society for Testing and Materials

Specialized protective clothing can also protect the wearer from cut, stab, bullet and other hazards. The performance of these functional cloths are evaluated by conducting different test as per international standards. Various parameters are determined to rate and access the protective performance of protective clothing.

Particularly, in thermal protective clothing, thermal stability and insulative behavior of these clothing is determined by exposing them to different thermal environments such as vertical flame, radiant, convective heat, hot surface [3, 4], molten metal [5–7], hot water, steam [8, 9], flash fire [10, 11] etc . In most of the thermal testing, thermal sensors are utilized to access the temperature rise in the protective clothing with respect to time while exposing to the hot environment [12].

The most commonly used thermal sensor is copper calorimeter, however, shape of copper disc can be different depending upon the test equipment. In order to mimic the skin of human and reduce the heat loss, modifications were made and pyrocal, epoxy, skin simulant sensors were developed. The working principle of these sensors are based on cumulative heat flux against particular hazard exposure. The accumulative heat flux is calculated by utilizing temperature rise data and equation 1 [13] is used for this purpose;

$$\text{Cumulative heat energy} \left(\frac{J}{cm^2} \right) = \frac{mC_p(t_f - t_i)}{A} \quad (1)$$

Where, m is mass of sensor or copper disk (kg), C_p is specific heat (J/kg°C), A is area of sensor or copper plate; t_f is final and t_i is initial temperature of sensor while logging temperature with respect to time. These sensors are highly sensitive as T-type thermocouple is used to measure the temperature and subsequently heat flux. There might be slight variation in temperature sensed by these sensors because of heat leakage or heat loss

through the body of the sensor. To tackle the problem of heat leakage compact design and better insulation is recommended, also thermal storage in sensor body need to be considered before designing it. Thermal sensors used in this study are shown in figure 1 (a), (b), (c) and (d).

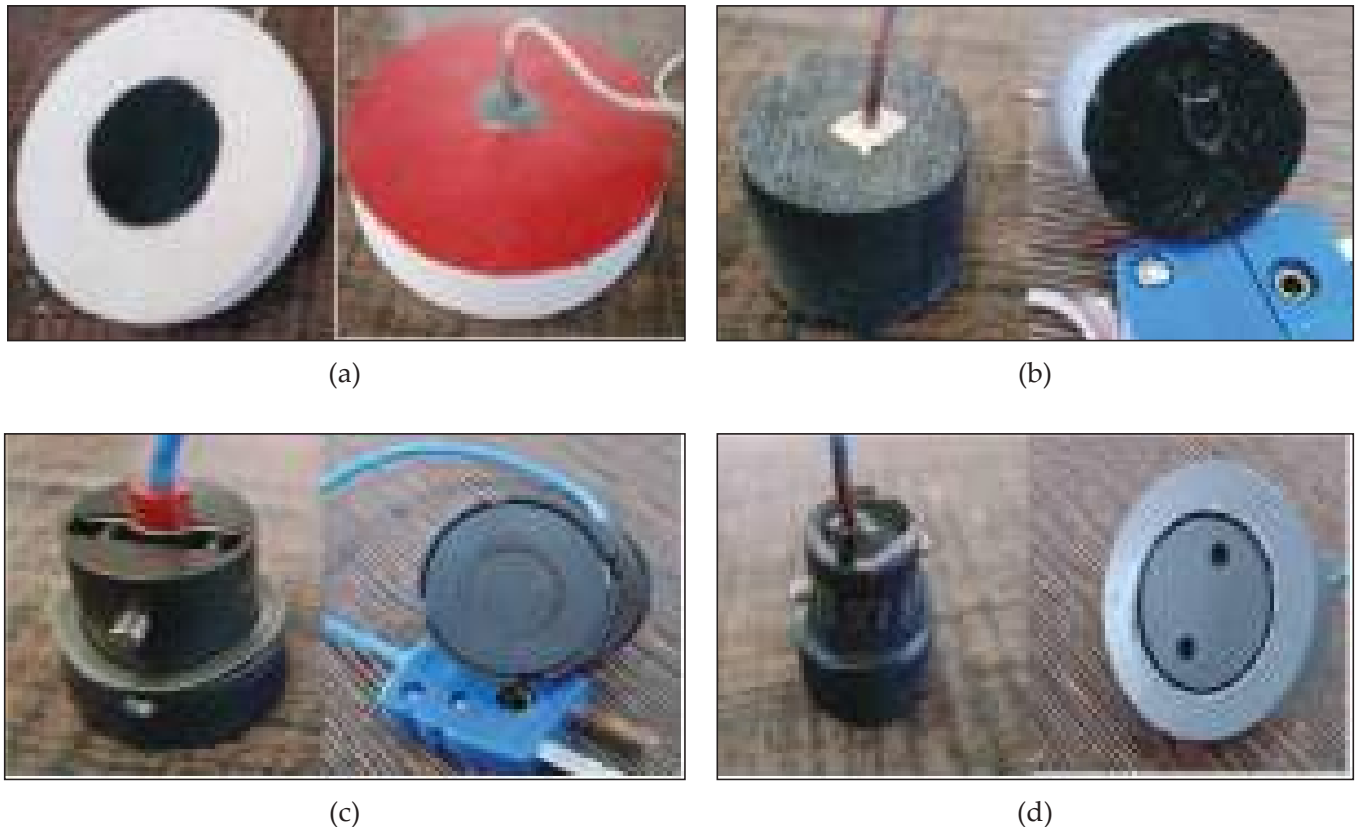


Fig. 1: Thermal Sensors (a) Copper Calorimeter, (b) Skin Simulant, (c) Pyrocal and (d) Epoxy used in this Study

Skin Burn Injury

The effect of burn on human skin are painful and may generate severe injury depending upon the degree of burn. The degree of burn is categorized as 1st degree (burn effects on the upper layer of skin ‘epidermis’ which effects redness on the skin), 2nd degree (which effects on second layer of skin ‘dermis’ penetrating through ‘epidermis’ in which blood veins are located resulting in pain, swelling and blisters) and 3rd degree burn (that affects the all layers of skin ‘epidermis, dermis and fat-subcutaneous layer’ get damaged). The 1st, 2nd and 3rd degree burn injury are shown in figure 2.

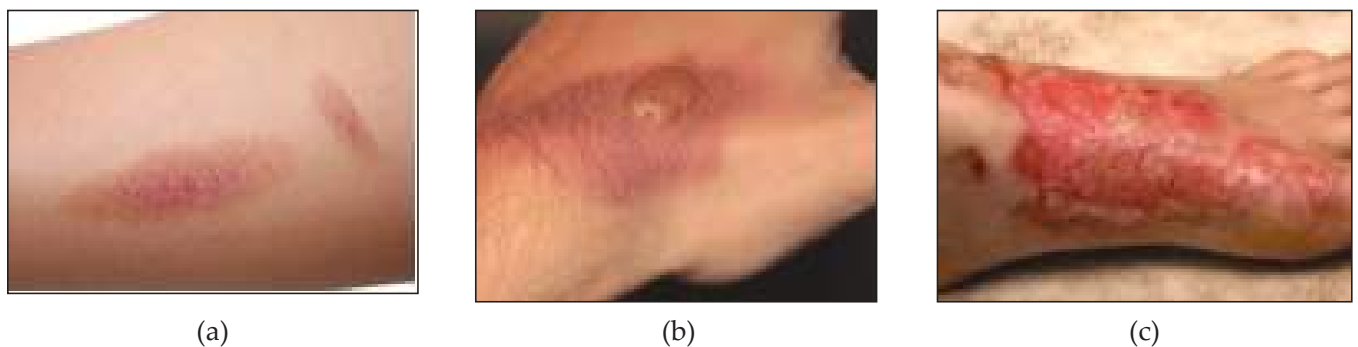


Fig. 2: Degree of Burn: (a) 1st, (b) 2nd and (c) 3rd Degree of Burn Injury

In order to increase the survival time and alleviate the burn injury thermal protective clothing were developed. The performance of protective clothing is evaluated with the help of these thermal sensors and one should have proper understanding of them while recording the data against particular thermal exposure. The recorded data from thermal sensor is compared with Stoll curve to predict the second degree burn [13]. Stoll curve is based on accumulated energy which is evaluated by the exposure time of particular heat flux over the protective clothing. The accumulated energy [13] is calculated by equation 2.

$$\text{Cumulative heat energy} \left(\frac{J}{\text{cm}^2} \right) = 5.0204 \times t_i^{0.2901} \quad (2)$$

Where t_i is the elapsed or exposure time in seconds since the start of exposure to particular heat hazard.

Stoll Curve

The Stoll Curve was discovered by Alice Stoll and her team where the blackened human skin was subjected to radiant heat. The pain sensation and start of blister in human were considered and accessed for predicting second degree burn [14]. Later invention of Stoll was sought as important discovery in the field of protective clothing and a criteria was developed for measuring the performance of protective clothing [15]. This rating system is commonly used for evaluating the performance of protective clothing and cumulative (Stoll curve) & accumulative heat energy (sensor response) are calculated. The minimum heat exposure required for generating second degree burn can be predicted where the accumulative heat energy plot intersects cumulative heat energy plot as shown in figure 3. It can be anticipated from the figure 3 that 12.5 s is the time for second degree burn injury.

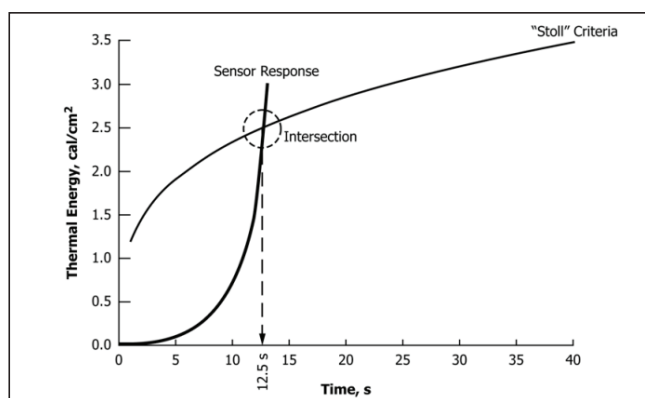


Fig. 3: Sensor Response at Particular Heat Exposure and Time for Second Degree Burn Injury [15]

In this study, the behaviour of inherent flame retardant (IFR) fabrics was studied by developing two kinds of para-aramid based fabrics. Later, the response of different sensors was accessed by utilizing neoprene coated 100% para-aramid fabric.

Materials and Method

In order to study the behaviour of IFR clothing against different thermal exposure, two samples were developed. One was blend of para-aramid, modacrylic and 50 μ stainless steel (SS) wire and other was neoprene coated 100% para-aramid fabric. The neoprene coated 100% para-aramid sample was further utilized to compare different type of temperature sensors. The properties of developed samples are given in table 1 and samples are shown in figure 4.

Table 1: Physical Properties of the Developed IFR Samples

Sample	Composition	Thickness (mm)	Weight (g/m ²)
A	75% para-aramid, 15% modacrylic, 10% SS wire	0.71	360
B	Neoprene coated 100% Para-aramid	0.77	325

Different thermal testing such as flame spread, contact, convective and radiant heat transmission, were performed over the samples. The flame spread test was conducted as per ISO 15025:2016. In this test, bottom edge and surface edge ignition were performed & after flame as well as afterglow were observed. Further, contact heat transmission testing was performed in accordance with ISO 12127-1:2015. The sample was placed on

aluminium calorimeter (sample holder) and heated cylinder was made to contact with the sample at 250°C. The performance of test sample was evaluated by calculating threshold time which is time required to raise the temperature of the sample by 10°C. The thermal characterization of the samples was carried further by exposing them to 80 ± 2 kW/m² heat flux under direct flame as per the test standard ISO 9151:2016. The heat transfer index (HTI 24) was evaluated which is the time required to raise the temperature of the test sample by 24°C. Similarly, the sample was tested against the radiant heat as per ISO 6942:2022 after exposing to heat flux of 20 kW/m². The performance was evaluated by calculating heat transmission factor (TF) as per equations 3 and 4;



Fig. 4: IFR Fabrics used in this Study: (a) Sample A and (b) Sample B

$$Q_c = \frac{mC_{p12}}{A(t_{24} - t_{12})} \quad (1)$$

$$TF = \frac{Q_c}{Q_0} \quad (2)$$

Where, m, Cp and A are the mass, specific heat and area of the copper disc. t_{24} and t_{12} are radiant Heat transfer index (RHTI) for 24°C and 12°C temperature rise. Q_c and Q_0 are the transmitted and incident heat flux. the test apparatus used in characterizing the behaviour of IFR fabrics are shown in figure 5.

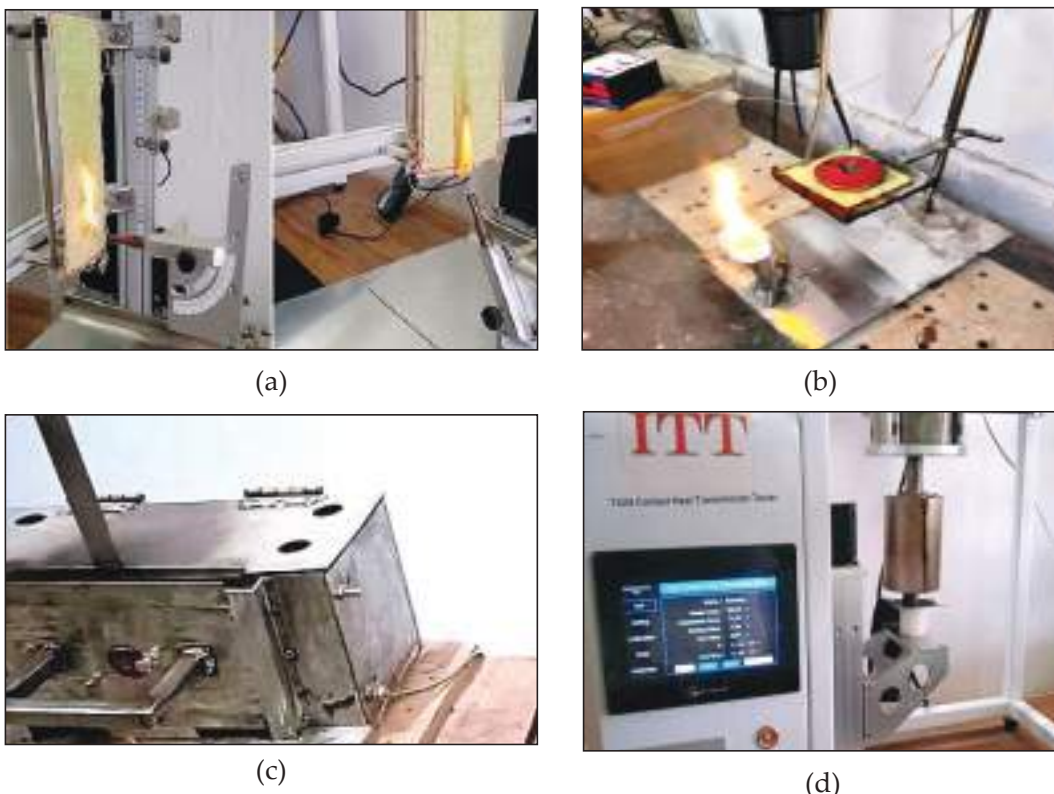


Fig. 5: Test Apparatus used in Characterising the Behaviour of IFR Fabrics: (a) Vertical Flammability, (b) Convective Heat (c) Radiant Heat and (d) Contact Heat Transmission Testing Machine

After characterizing the thermal behaviour of IFR fabrics, a comparative study of temperature sensors was conducted on digital hot plate as shown in figure 5. The test was performed as per ASTM 1060 with certain modifications. The bare temperature sensor was initially tested against 40°C, 50°C, 60°C, 100°C; later, the neoprene coated sample was used with these sensors for accessing their response.



Fig. 6: Digital Hot Plate and Sensor Arrangement

Results and Discussion

The results of sample's performance against different thermal exposure were given in table 2. As the samples were developed by inherent flame-retardant fibers, the flame self-extinguishes after the removal of burner during flame spread test. There was no dripping, melting or afterglow was observed in any sample.

The samples A & B were tested for its resistance against convective heat and it was observed that the neoprene coated sample B performed better than sample A which could be due to higher percentage of para-aramid and neoprene coating reducing the pore size of the fabric. Additionally, the presence of stainless steel in sample A could conduct heat faster due to its conductive nature which needs further study by taking into account the covering factor of stainless steel wire by high performance yarn.

Similar results were observed for radiant and contact heat transmission, where the properties of para-aramid and stainless steel wire dominated over the weight of the fabric. Due to this fact sample B performed better than the sample A.

Table 2. Test Results of Samples Against Different Thermal Exposure

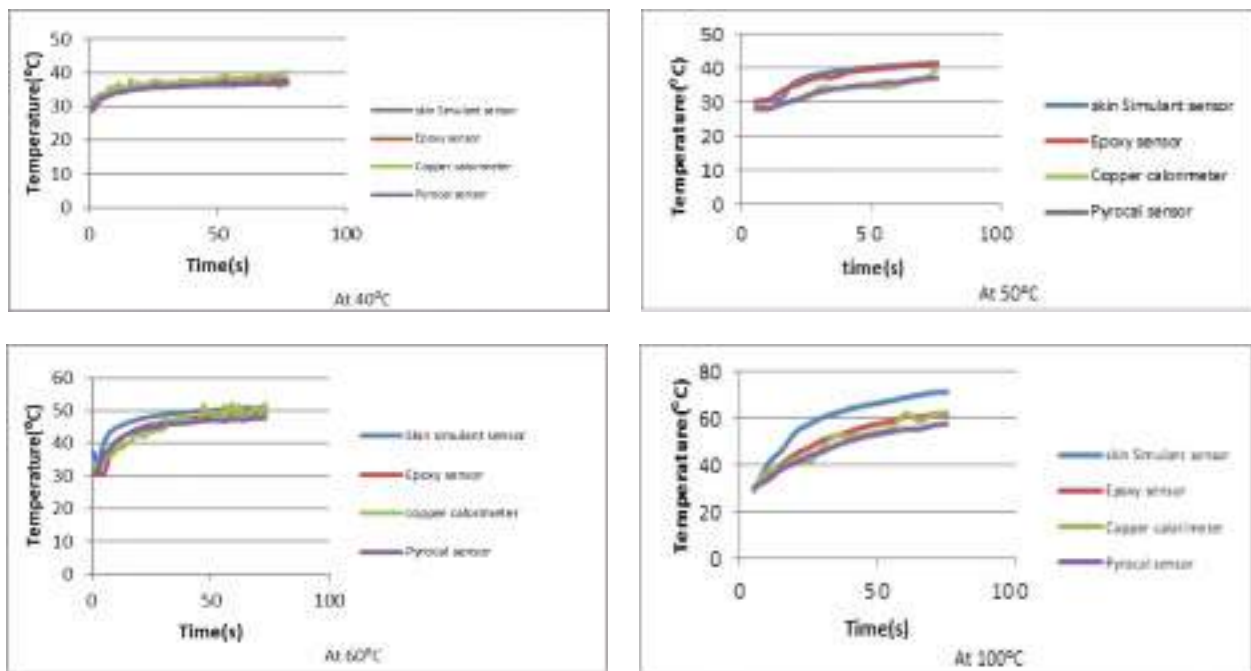
Samples	Flame spread test bottom edge and surface exposure		Convective heat transmission (HTI ₂₄ , s)	Radiant heat transmission (HTI ₂₄ , s)	Contact heat transmission (T _p , s)
	After flame (s)	Afterglow (s)			
A	0	0	11	5.6	53
B	0	0	13	6.2	59

The performance of samples is rated in accordance with ISO 11612:2015 and corresponding performance levels are given in table 3.

Table 3. Performance Level of Samples as per ISO 11612:2015

Samples	Flame spread test	Convective heat transmission (HTI ₂₄ , s)	Radiant heat transmission (RHTI ₂₄ , s)	Contact heat transmission (T _c , s)
A	A1, A2	B2	C3	F1
B	A1, A2	B2	C3	F1

The bare temperature sensor was initially placed at digital hot plate and tested at 40°C, 50°C, 60°C and 100°C under 1N weight and their responses were observed for 1 minute as shown in figure 7.

**Fig. 7: Response of Thermal Sensors at Different Temperature**

It is clear from the graph as shown in figure 7 that the response of thermal sensors was comparable at lower temperature such as 40°C, 50°C and 60°C. This indicates that behavior of thermal sensors is accurate or with minimum possible error. However, the response of sensors at high temperature such as 100°C was not in line with the response of each other and variation in the sensitivity of these sensors were observed.

All the observations were made in same physical environment, weight and time interval. The variations might be observed due to the material used in core of the sensors and insulating material used for reducing heat loss. Also, it can be anticipated from the graphs that skin simulant sensor is safer while predicting the performance of protective clothing. However, Further study needs to be conducted for reliable and reproducible results. Additionally, epoxy and copper calorimeter also produced comparable data to that of skin simulant sensor. The life and maintenance of these sensors are important aspects that needs to be reviewed in detail for an accurate measurement.

Further, the second degree burn injury was predicted by copper calorimeter for neoprene coated 100% para-aramid fabric to compare its performance. The response was measured at three different temperatures i.e; 50°C, 100°C and 150°C.

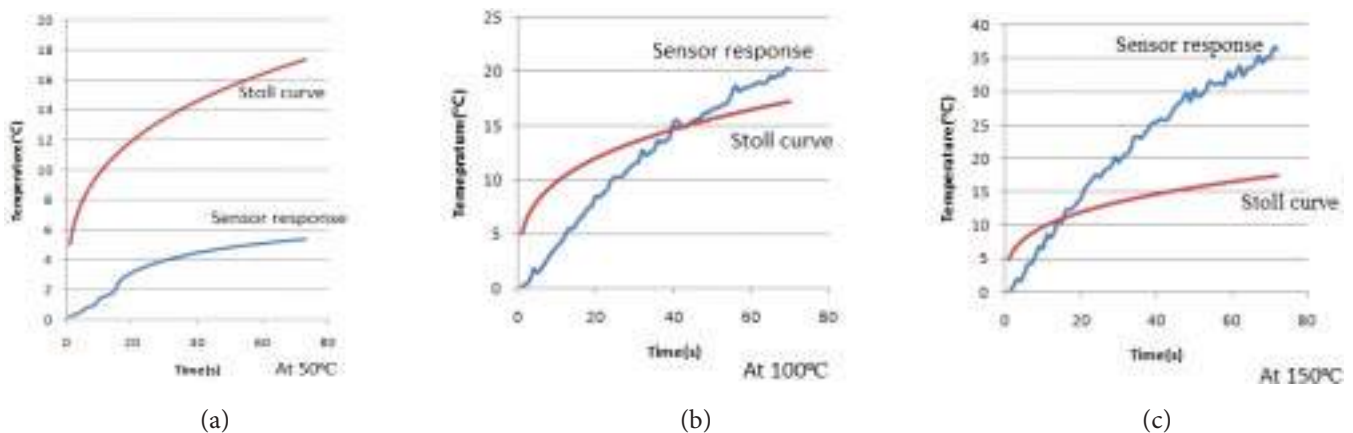


Fig. 8: Copper Calorimeter Response at 50°C, 100°C and 150°C with Neoprene Coated 100% Para-Aramid Fabric

It is obvious from the graph (Figure 8) that no second degree burn injury was observed at 50°C while exposing the fabric for 1 minute, whereas, second degree burn was observed at 100°C and 150°C. The performance of fabric decreased with increase in temperature as the test fabric attained the temperature for initiation burn injury at a faster rate. The time for second degree burn at 100°C for 100% para-aramid fabric was 38.5 second whereas 17 second was observed at 150°C. The second degree burn time is also an indication of survival time for a person equipped with protective clothing against thermal hazards. It is worthwhile to mention that the stored energy in protective clothing also needs to be considered before anticipating the final performance of protective clothing.

CONCLUSION

It was found from the study that the performance of 100% para-aramid fabric was better than that of blended fabric (para-aramid, modacrylic and SS wire), mainly due to presence of higher para-aramid percentage and lower air permeability on account of neoprene coating on single side. Additionally, the response of different thermal sensors at low temperature were comparable, whereas variations in their sensitivity was observed at high temperature. Based on the obtained data, it can also be concluded that the skin simulant sensor is more reliable to predict the performance of protective clothing. Also, the time to second degree burn at 100°C for 100% para-aramid fabric was 38.5 second whereas 17 second was observed at 150°C. Further study needs to be performed for each sensor by considering stored thermal energy of thermal protective clothing at different exposures which should also be included for accurate prediction of sensor response.

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Analyzing the Impact of Air Flow Regulation on the Performance of Earth Tube Heat Exchangers

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▶ ABSTRACT ◀

Energy conservation is a pressing concern in modern times, as our reliance on non-renewable sources of energy continues to cause environmental harm. Moving towards renewable energy sources is crucial for maintaining balance in our ecosystem and reducing toxic gas emissions, which can have a significant impact on our environment. One area where we can make a significant impact on energy conservation is in our homes. Earth Tube Heat Exchangers (ETHE), also known as earth air heat exchangers, can help fulfil our energy needs naturally, using geothermal energy as a source of power. The Earth Tube Heat Exchanger operates on the principle of heat transfer, utilizing the stable temperatures found beneath the earth's surface. By burying a copper tube at a certain depth, we can tap into this source of geothermal energy and create a sustainable source of heating and cooling for our homes. The practicality of this approach has been tested in an experimental setup. A model of an earth tube heat exchanger (ETHE) was developed to analyze air flow regulation. The model included components such as a bucket, soil, and copper tube. Where a 1.2-meter length copper tube buried at a depth of 0.5 meter was utilized. The analysis showed that higher air velocity resulted in a lower heat transfer rate, while lower air velocity resulted in a higher heat transfer rate due to the varying levels of contact between the air and tube surface. The temperature was recorded to fall from 2 degrees Celsius to 7 degrees Celsius, and a 14-watt blower was used to transport the air. Based on calculated data and theoretical analysis, this approach shows promising results in reducing household energy consumption.

Keywords: *Cooling, Heating, Performance, Geothermal Heating, Underground Heat Exchanger, Energy Efficiency.*

Introduction

Scientists and researchers have long been exploring ways to harness the natural resources available to us to improve our energy efficiency and reduce our carbon footprint[1]. One such resource that has recently caught their attention is the temperature gradient of soil[2]. It has been observed that the soil at certain depths below

the earth's surface remains cooler than the atmospheric temperature during summer months, while it tends to be warmer than the atmospheric temperature during winter[3]. This is due to the insulating properties of the soil, which can maintain a more consistent temperature than the air above it[4]. This discovery has led to the development of innovative technologies that use the temperature gradient of soil for cooling in the summer and heating in the winter[5]. One such technology is known as a ground-source heat pump, which uses pipes buried deep in the ground to transfer heat from the earth to a building during the winter months and remove excess heat during the summer months[6].

In addition to reducing energy consumption and greenhouse gas emissions, using the temperature gradient of soil for cooling and heating has other benefits as well [7]. It is a reliable and sustainable source of energy that can be used in both residential and commercial buildings, and it can also help to reduce our dependence on fossil fuels. However, the implementation of such technologies requires careful planning and consideration[8]. The soil conditions, geology, and groundwater levels must be taken into account, and the installation of the necessary equipment can be costly. Nonetheless, the potential benefits are significant, and researchers continue to explore new ways to harness the temperature gradient of soil for sustainable energy solutions[9].

TYPES OF EARTH TUBE HEAT EXCHANGER

Earth tube heat exchangers, also known as ground-coupled heat exchangers, are systems that use underground pipes to pre-condition the air entering a building. There are several types of earth tube heat exchangers, including[10]:

1. **Horizontal Earth Tubes:** These are pipes installed horizontally just below the surface of the ground. The length of the tubes depends on the building's heating and cooling requirements and the local climate.
2. **Vertical Earth Tubes:** These are pipes installed vertically in boreholes drilled into the ground. The length of the tubes depends on the building's heating and cooling requirements and the local geology.
3. **Spiral Earth Tubes:** These are pipes installed in a spiral pattern around a central core. The spiral design increases the surface area of the pipes, allowing for greater heat transfer.
4. **Helix Earth Tubes:** These are similar to spiral earth tubes, but the pipes are coiled in a helix shape. This design also increases the surface area of the pipes, allowing for more efficient heat transfer.
5. **U-tube Earth Tubes:** These are pipes installed in a U-shape, with one end of the pipe going down into the ground and the other end going up into the air intake of the building. This design can be used in situations where horizontal or vertical earth tubes are not practical.

TYPES OF SYSTEM

Earth tube heat exchangers (ETHE) can be categorized into two types: open system and closed system[11].

1. **Open System:** In an open system ETHE, also known as earth-to-atmosphere heat exchanger, air is drawn through a buried tube and then directly into the building [12]. The heat exchange occurs as the air passes over the tube walls, which are in contact with the earth[13]. This type of ETHE does not have a heat exchanger to separate the outside air from the indoor air. [14]
2. **Closed System:** On the other hand, a closed system ETHE, also called earth-to-air heat exchanger, involves a heat exchanger that separates the incoming outside air from the indoor air [15,16,17]. The heat exchanger may consist of a series of coils or a plate heat exchanger buried in the ground [18,19]. The incoming air is pre-cooled or pre-heated by the earth's temperature before it enters the building, and there is no direct contact between the indoor and outdoor air [20].

MATERIAL AND METHOD

To calculate the heat transfer rate in an ETHE system, one can use the ϵ -number of transfer units (NTU) method, which requires knowledge of the system's dimensions. This method relies on determining the outlet

temperature of the air by using the effectiveness of the ETHE system (ϵ), which is a function of the number of transfer units (NTU). Essentially, the ϵ -NTU method provides a way to analyse heat transfer in a system by using ϵ and NTU as key parameters.

To carry out experimental observations, a prototype was developed featuring a bulk bucket and soil. The experimental setup involved burying a 1.2 m long copper pipe with an inner diameter of 0.009m at a depth of 0.5m within a bucket filled with soil. To facilitate the circulation of air throughout the pipe, a 15-w blower was utilized.

EXPERIMENTAL SETUP

A thermocouple to monitor the air temperature. In the experiment, a copper pipe measuring 0.9 cm in diameter was buried at a depth of 1.2 meters. To circulate air through the pipe, a blower was employed, with the air being propelled through the length of the pipe. Measurements were taken using an anemometer to gauge the air velocity and a thermocouple to monitor the air temperature.

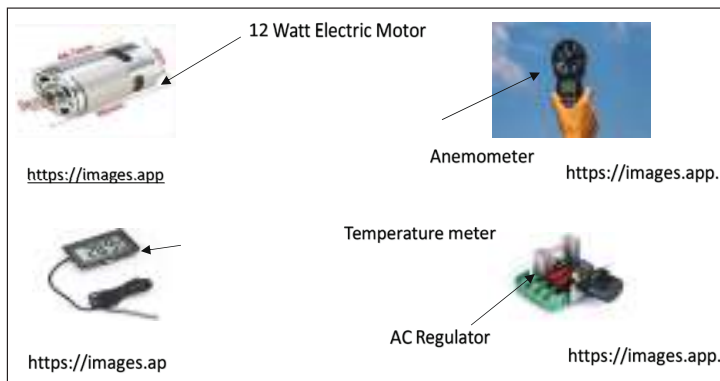


Fig.1: Equipment's of ETHE

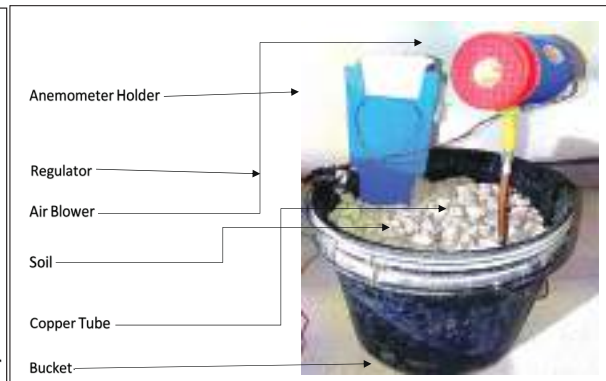


Fig.2: Schematic Diagram of Experimental Set Up

METHODOLOGY

The experiment began by turning on the blower and allowing air to pass through the pipe until a steady state was reached. To measure the velocity at the inlet and outlet, a vane-type anemometer was used. Temperature meters were also attached at the inlet and outlet, and thermocouple wires were connected to a temperature auto scanner to continuously monitor the temperatures. The experiment was repeated multiple times under different ambient conditions. Specifically, it was conducted over a 3-day period during the summer season (March 15-17, 2023). All of the data collected was compiled into a single table, and graphs were plotted to visualize various sets of observations obtained from the experiment. To calculate the total cooling and heating for flow velocities of 2m/s, the following equation was used:

Total Cooling/Heating = (mass flow rate) × (specific heat of air) × (change in temperature) By knowing the mass flow rate and specific heat of air, the change in temperature between the inlet and outlet was used to calculate the total cooling or heating. This calculation was performed for each set of observations and the results were compared using the graphs plotted earlier.

DESIGN CALCULATION

$$\bullet \quad \dot{m} = \rho AV, \text{ Where } A = \frac{\pi D_i^2}{4} \quad \dots(1)$$

$$\bullet \quad Re = \frac{\rho V D_i}{\mu} = \frac{V D_i}{\nu} \quad \dots(2)$$

$$\bullet \quad h = \frac{Nu \cdot K}{D_o} \quad \dots(3)$$

$$\bullet \quad \text{Nu} = 3 + \frac{0.068 \left(\frac{D}{L} \right) \times \text{Re} \times \text{Pr}}{1 + 0.04 \left[\left(\frac{D}{L} \right) \times \text{Re} \times \text{Pr} \right]^{0.66}} \quad \dots(4)$$

$$\bullet \quad \text{Nu} = \frac{hL}{k} \quad \dots(5)$$

K – thermal conductivity of Fluid (W/m-k)

L – characteristic length

h – Convective heat transfer coefficient (W/-k)

$$\bullet \quad R_{\text{convec}} = \frac{1}{(2\pi h L r_1)} = \frac{1}{hA} \quad \dots(6)$$

$$\bullet \quad R_{\text{cond/tube}} = \frac{\ln \left(\frac{r_2}{r_1} \right)}{2\pi L K_p} \quad \dots(7)$$

$$\bullet \quad R_{\text{cond soil}} = \frac{\ln \left(\frac{r_2}{r_1} \right)}{2 L K_p} \quad \dots(8)$$

$$\bullet \quad R = \frac{1}{U_t}, \text{ Where } U_t \text{ Overall Heat Transfer Coefficient d} \quad \dots(9)$$

$$\bullet \quad \epsilon = \frac{T_{\text{out}} - T_{\text{in}}}{T_{\text{wal}} - T_{\text{in}}} = 1 - e^{-NTU} \quad \dots(10)$$

$$\bullet \quad \text{NTU} = \frac{U_t A}{m_a C_p} = \frac{U_t \pi D_i L}{m_a C_p}, U_t \text{ Overall heat transfer coefficient} \quad \dots(11)$$

$$\bullet \quad Q_h = \dot{m} C_p (T_{\text{OUT}} - T_{\text{in}}) \quad \dots(12)$$

$$\bullet \quad \text{COP} = \frac{m C_p (T_{\text{in}} - T_{\text{out}})}{\text{Power Input}} = \frac{\text{Desire effect}}{\text{Energy input or Power input}} \quad \dots(13)$$

RESULT AND DISCUSSION

The study involved an open-loop system that used a copper tube with a length of 1.2m and a diameter of 0.009m. The tube was buried about 0.5m deep and was used to transport air using a 14 W blower. The experiment was designed to investigate the effects of different air velocities on the system's performance. Theoretical calculations were carried out for three different air velocities, namely 1.0 m/s, 1.5 m/s, and 2 m/s. These calculations aimed to predict the system's behaviour under different air velocities and to determine the optimal velocity for the system's performance.

Higher air velocity led to lower heat transfer rate, while lower air velocity resulted in higher heat transfer rate due to varying levels of contact between the air and tube surface.

The system's coefficient of performance (COP) exhibited a range of values, specifically between 0.01 and 0.51, as the air velocity increased from 1.0 m/s to 2 m/s.

The selection of the tube material is a crucial aspect to consider in designing an ETHE (Enhanced Tube-and-Shell Heat Exchanger) system. Although extending the tube's length could enhance the heat transfer rate, there

exists a threshold beyond which the heat transfer increment is insignificant. Hence, choosing the appropriate tube material plays a pivotal role in elevating the heat transfer rate.

Copper's high thermal conductivity and corrosion resistance make it an ideal tube material for heat exchangers. Yet, if cost is a concern, aluminium is a cheaper alternative with similarly good thermal conductivity.

This study provides a valuable design tool for engineers who are tasked with designing energy transport and harvesting systems, as it allows for the consideration of a wide range of variables such as pipe type, pipe dimensions, and ambient conditions. With the ability to analyse various combinations, this work can aid in the selection of the optimal design alternative based on factors such as the pipe dimension, pipe material, and type of fluid used. Furthermore, the study's findings on the impact of operating parameters on ETHE system performance align with the results of previous research, demonstrating its reliability and applicability to real-world scenarios. Overall, this work serves as a useful resource for engineers seeking to optimize the design of energy transport and harvesting systems.

Table No.1: Input Parameters

Parameter	Values	Unit
	26.3	°C
	various	°C
	.009	M
	.0085	M
	.008	M
	.0045	M
	.0042	M
	.004	M
Thickness(t)	.002	M
	1.2	M
	.5	M
	Various (1,1.5,2)	m/s
	385	W/m-K
	.54	W/m-K
K (air)	.0271	W/m-K
Cp (air)	1006	J/kg-K
ρ (air)	1.126	Kg/m ³
ν	16.61×10^{-6}	m ² /sec
Pr	.72	-
Power	14Watt	W

Table No. 2: Effect of Variation of Air Flow Velocity on Various Parameter

Parameter	Air Flow Velocity=1m/s	Air Flow Velocity=1.5m/s	Air Flow Velocity=2m/s
Re	541.84	812.76	1083.68
Nu	3.843	3.924	4.006
$h(w/m^2-k)$	11.57	11.81	12.06
$U_t(w/m^2-k)$	0.395	0.402	0.411
NTU	0.166	0.120	0.088
\dot{m}	.000071	.0001	.00014
ϵ	0.152	0.113	0.084

Table No. 3: Inlet and Outlet Temp. for Different Air Flow Velocity of ETHE March-2023

Time	Air Flow Velocity=1m/s				Air Flow Velocity=1.5m/s			Air Flow Velocity=2m/s		
	T _{in}	T _{out}	Q(W)	COP	T _{out}	Q(W)	COP	T _{out}	Q(W)	COP
10:00	27	25	0.113	.010	25.5	0.110	.010	25.8	0.102	.012
11:00	29	25.5	0.197	.017	25.9	0.229	.022	26	0.256	.030
12:00	30	25.6	0.248	.022	25.8	0.310	.030	26	0.341	.040
13:00	31	25.6	0.305	.027	25.7	0.391	.038	25.9	0.435	.051
14:00	32	25.7	0.356	.032	26	0.443	.043	27	0.427	.050
15:00	31	25.9	0.288	.026	27	0.295	.028	27.2	0.324	.038
16:00	30	26	0.226	.020	26.7	0.244	.023	27	0.256	.030
17:00	29	27	0.113	.010	27	0.147	.020	27	0.170	.020

We conducted experiments to determine the relationship between outlet temperature and environment temperature, and to find the optimal COP (Coefficient of Performance) at different air flow velocities.

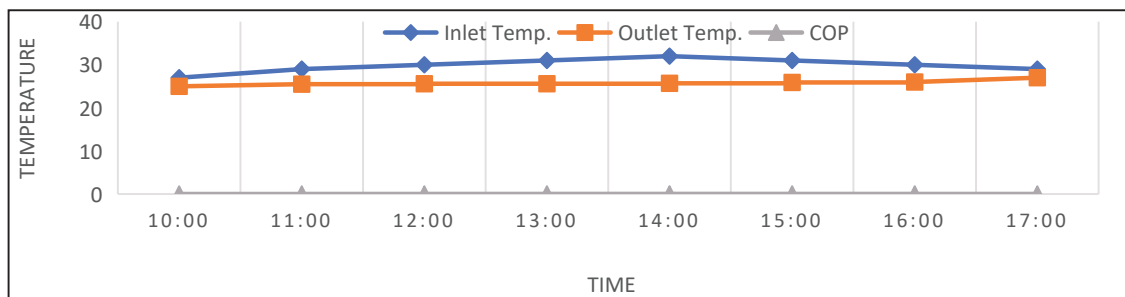


Fig. 3: Measured and Calculated Exit Air Temperature Values for March-2023

The graph shows the variation between inlet and outlet temperature with respect to each other at an air flow velocity of 1m/s. At low velocity, where thermal conductivity is high, the change in temperature between the inlet and outlet is gradual. And COP Will also vary.

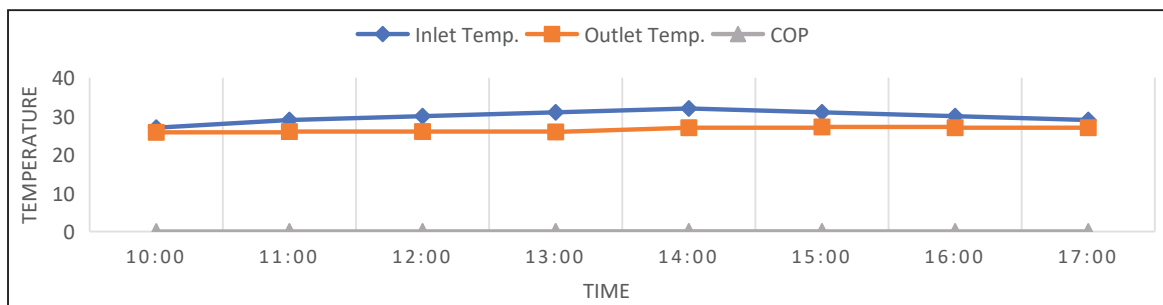


Fig. 4: Measured and Calculated Exit Air Temperature Values for March-2023

The graph shows that at an air flow velocity of 2m/s, the variation between the inlet and outlet temperature gradually changes with respect to each other. However, at high velocities, the thermal conductivity decreases due to the reduced contact time between the air and the pipe.

CONCLUSION

This paper presents a design for an earth tube heat exchanger (ETHE) and an analytical model developed for it. An experimental setup using a 1.2m long copper tube with a diameter of 0.009m was used. Theoretical calculations were performed using the NTU method.

The research showed that the faster air moves, the less heat it transfers. Conversely, slower air velocities led to better cooling and heating. Thus, it's crucial to identify the best air velocity depending on the specific experiment or needs. This can vary depending on the factors being tested

Furthermore, it has been discovered that there exists an ideal ETHE length that maximizes the effectiveness of heat transfer.

When the blower is operating at a high speed and the length of the pipe is relatively short, the temperature difference between the inlet and outlet of the pipe is minimal.

The study suggests that conduction is crucial for air cooling, as demonstrated by the insulation's ability to maintain a constant temperature. In simpler terms, insulation prevents conduction and therefore affects the cooling process.

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Design and Impact Analysis of Go-kart Chassis

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▶ ABSTRACT ◀

In this article, the chassis of a go-kart a four-wheeled vehicle with no suspension is developed and simulated for numerous dynamic impact tests, including front, rear, and side impact testing for a single material (AISI 1018). The chassis is first developed in CAD software (Solidworkes) and then simulated in ANSYS Workbench. This document represents the von-Mises stress design and failure criterion for a single material. The current inquiry aims to obtain one of the lightest weight chassis designed and to in-crease the safety factor for low ground clearance a four-wheeled vehicle with no suspension. Work presented is performed for the dynamic force values for all three impact tests to maintain the safety of the driver. The current investigation considered reliability, material strength, ease of fabrication, and structural rigidity.

Keywords: *Dynamic Impact Test, Go-kart Chassis, Chassis Analysis, Lightweight Chassis*

INTRODUCTION

A GO-KART is a four-wheeled vehicle which is light in weight easy to fabricate with no suspension and differential that is commonly used in racing and entertainment [1]. Art Ingels also known as father of karting was from southern California who devised the GO-KART in 1950 as a means to pass the time after the war [2]. Kart racing is a relatively risk-free kind of vehicle racing. A GO-KART is a vehicle with or without a body that has four non-aligned wheels in contact with the ground, two of which control steering which gives direction

to the vehicle and the other two gives power to the vehicle. The chassis of a GO-KART is usually made up of steel pipe that can have circular or rectangular profile most of the times and are welded together [3]. Material usually used to fabricate chassis is AISA 1018, AISI 1020 AISI 1026, AISI 4130.

Motor sports are one of several recreational activities that people can enjoy. Professionals must drive bikes, automobiles, and F-1 racing cars. But what if there existed a motor sport that did not necessitate driving professionalism, such as GO-KART, for driving a go-kart it is not necessary that the one should be a professional driver [4]. The main objective is to create a low-cost, light-weight vehicle construction with increased safety efficiency. Several GO-KART parameters can be changed to improve the performance in other forms of motor racing.

A GO-KART is made up of several different parts.

1. Department of Chassis
2. Department of Steering
3. Department of Brakes and Tyers

The Chassis is the frame or base on which the kart is constructed. It gives a go-kart ability to absorb the stresses and vibrations generated due to the lack of suspensions it can be both static and dynamic [5].

One of the most significant departments is the chassis, which provides all of the vehicle's necessary support. As a result, this frame must be strong and reliable enough to withstand unexpected hits, allowing the GO-KART to operate more effectively. AISI 1018 is employed in all fronts, rear, and side dynamic impact tests in the current study.

MATERIALS AND METHOD

The chassis is designed in CAD programmed Solidworks and uses the finite element method to compute deformation and stress, which is calculated using ANSYS Workbench.

AISI 1018 has high machinability and inexpensive [8], hence it can be a good option to manufacture but AISI 4130 has higher strength to weight ratio as compared to 1018.

AISI 1020 was rejected due to lack of arability and high cost. Race car industry has high demand of AISI 4130. AISI 4130 has high carbon content which makes it less machinable as its hardness ability increases. Hence the material that our team chose to fabricate is AISI 1018.

The advantages of using the AISI 1018 is that it is easily machinable. The AISI 1018 has the same young's modulus of Elasticity (E) and density as that of AISI 4130. The 1018 carbon steel offers a well-adjusted toughness, strengthen ductility. Considering the above factors, we choose AISI 1018 for our chassis material.

The elastic characteristics of the materials utilized, as well as the chassis design and specifications, are listed below.

- | | |
|---|--------------------------|
| 1. Young' Modulus of elasticity - 200 GPa | 2. Poisson's Ratio- 0.29 |
| 3. Tensile Strength - 370 MPa | 4. Density - 7850 Kg/m |

Safety Factor = Yield Strength Von/Mises Stress

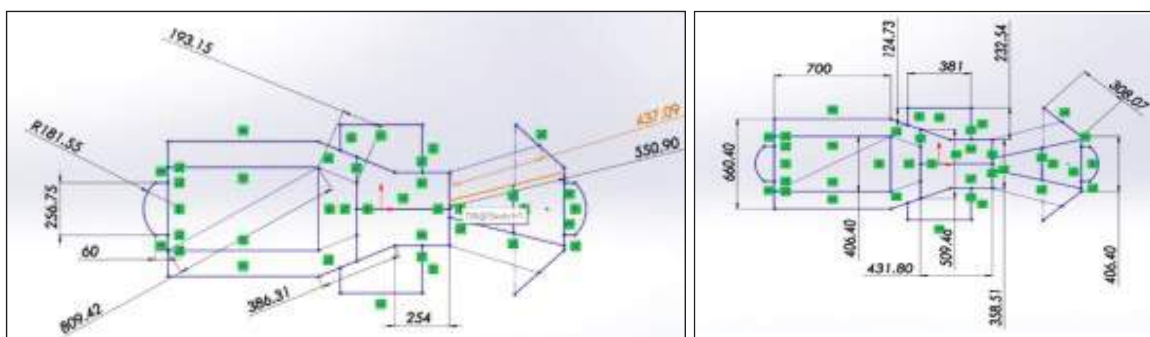


Fig. 1: Chassis Design with All Dimensions are in (millimeter)

Table 2: Go-Kart Chassis Details

Details	Value
Overall Length	1843 Mm
Overall Width	660.4Mm
Wheelbase	1448 Mm
Front Track Base	1075 Mm
Rear Base	1104 Mm
Ground Clearance	75.3 Mm

Front Dynamic Impact Test: For the front dynamic impact test, we have assumed that the vehicle of mass 200 Kg mass (calculated with driver) is running at a speed of 40 km/hr. and colliding with the impact force of 8023 N for one second in the front part of the chassis.

$F = 8023 \text{ N}$

$M = 200 \text{ KG}$

$V = 40 \text{ Km/hr.}$

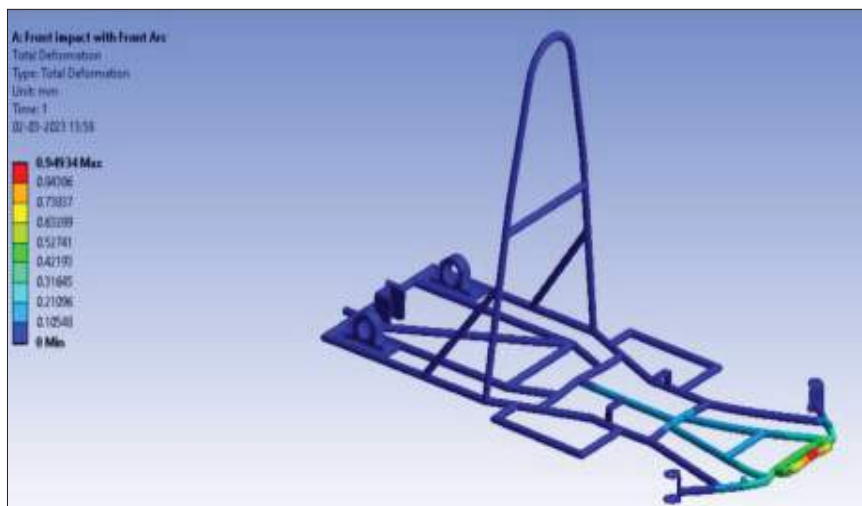


Fig. 2: Ansys Workbench Front Impact Loading Condition Load of 8023 N is applied.

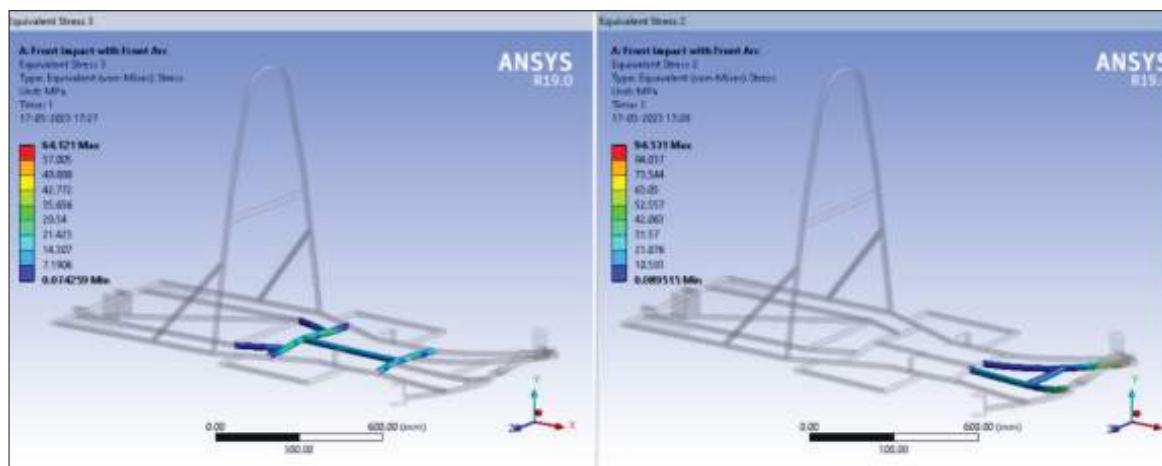


Fig. 3: Ansys Workbench Front Impact Stress

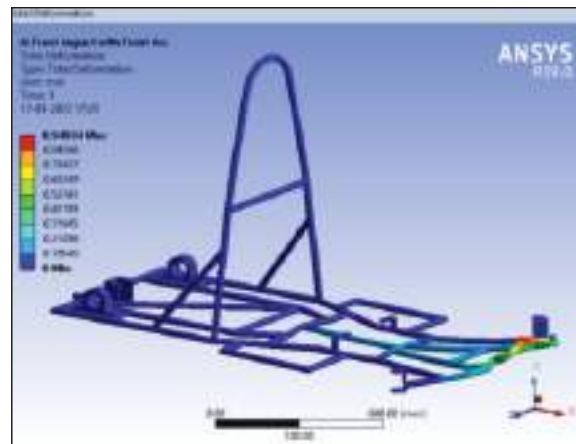


Fig. 4. In Ansys Workbench, Front Impact Total Deformation

Maximum Deformation of 0.949.14 mm is Obtained.

Side Dynamic Impact Test: For the side dynamic impact test, we have assumed that the vehicle of mass 200 Kg mass (calculated with driver) is running at a speed of 20 km/hr and colliding with the impact force of 3130 N for one second in the side part of the chassis.

$$F= 3130 \text{ N}$$

$$M = 200\text{KG}$$

$$V= 20 \text{ km/hr}$$

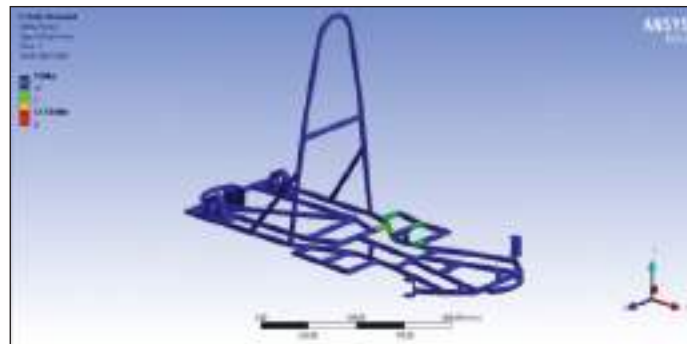


Fig. 5. Ansys Workbench Front Impact Loading Condition Load of 8023 N is Applied

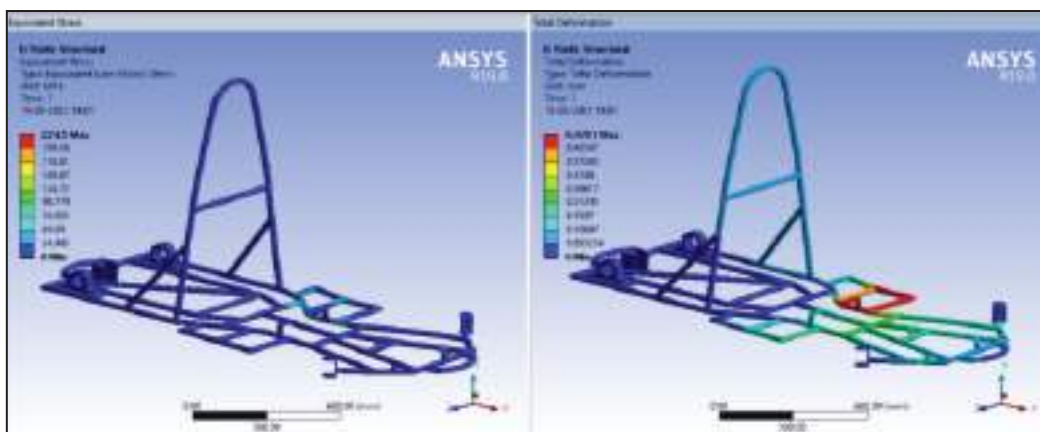


Fig. 6. Ansys Workbench Front Impact Stress

Rear Dynamic Impact Test: For the rear dynamic impact test, we have assumed that the vehicle of mass 200 Kg mass (calculated with driver) is running at a speed of 40 km/hr and colliding with the impact force of 8023 N for one second in the rear part of the chassis.

$F = 8023 \text{ N}$

$M = 200 \text{ KG}$

$V = 40 \text{ km/hr}$

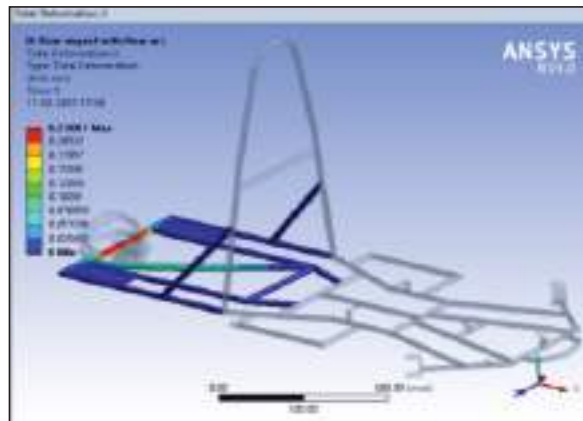


Fig. 7. Ansys Workbench Front Impact Loading Condition Load of 8023 N is applied.

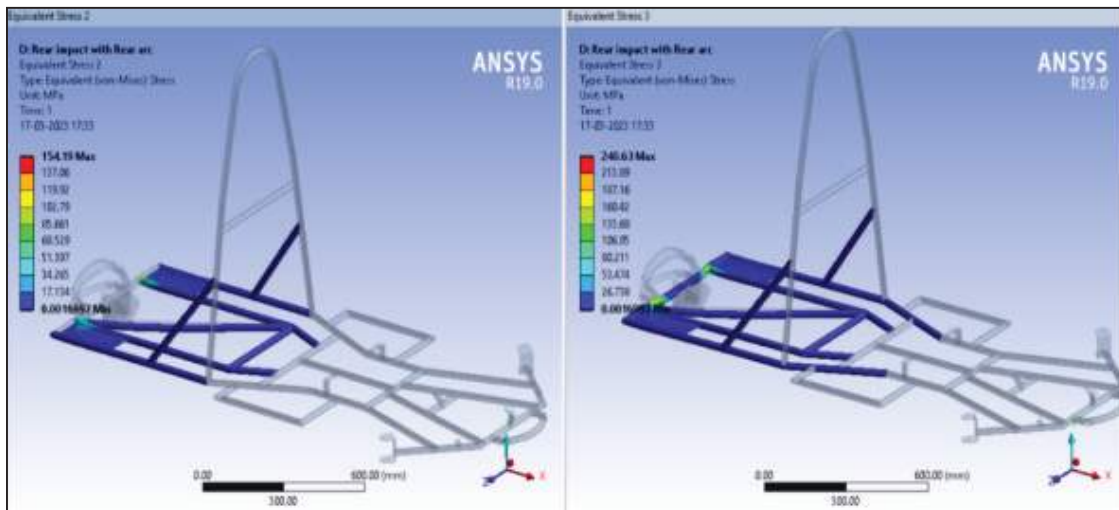


Fig. 8. Ansys Workbench Front Impact Stress

Discussion of the Findings: In the following table, the values of loads in numerous dynamic impact tests with generated stress, maximum de-flection, and safety factor are shown, and it is clarified whether the designed vehicle is safe for the driver or not.

Factor of Safety must be greater then one for a vehicle to be safe

Table. 3: Impact Test Values with Induced Von-Mises Stress, Total Deformation and F.O.S.

Property	Front Impact	Side Impact	Rear Impact
Total Deformation	0.94934 Mm	0.4791 Mm	1.0976 Mm
Von-Mises Stress	94.531 Mpa	224.5 Mpa	154.19 Mpa
Factor Of Safety	2.6446	1.11	1.0389
Remark For Design	Pass	Pass	Pass

CONCLUSION

The work is explained in such a way that everyone may comprehend and follow the report. In this article, the methods to complete the work are outlined for all of the objectives completed.

The calculation is performed to obtain the ideal values for wheelbase and track width, which has aided us in the construction of a go-kart frame or chassis.

The scope of the study is reached in the design portion, where the design is created in such a way that weight of the chassis is low while simultaneously providing a significant edge over your competitors in real-world settings.

The design part is done in SolidWorks, while the analysis is done with ANSYS WORKBENCH.

The analysis was carried out in order to analyses, build, and alter the optimum vehicle design to accomplish its objectives.

The main objective was to minimize weight in order to increase the vehicle's performance.

The general design goal is to make the vehicle as light as possible without losing performance.

Final weight of the chassis come out to be 25.137 kg.

In this field we can further compare the chassis on the basis of material of the pipes used and profile of the pipe whether it is circular ,rectangular or I shaped

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Design and Analysis of Disk Brake Rotor of Different Materials for Maximum Heat Transfer and Variation in Temperature

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▶ ABSTRACT ◀

The braking systems are the part of the automotive industry that are most important. It is used to stabilize and control the vehicle's speed. Finding a material that can continue to eliminate heat while withstanding more mechanical stress is essential. The maximal heat transmission for various materials (structural materials) is examined in this research. Structural Steel, Tungsten, and cast iron were investigated based on a Steady-state Thermal study performed in the disc brake. This study compares the properties of three brake disc materials i.e., structural steel, tungsten, and cast iron with different grooves patterns. The author has investigated vented disc brake rotors for vehicles. This study focuses on how heat and temperature are distributed throughout disc brake rotors. In this research, a finite element analysis approach has been employed to determine the temperature distributions of the disc brake rotor. The thermal analysis of disc brakes was carried out using ANSYS as the finite element's programmer. This study helps the automobile industry build the most ideal and efficient disc brake rotor by educating us on the thermal characteristics of disc brake rotors.

Keywords: *Disc Brake, Materials, Temperature, Heat flux, FEA, ANSYS.*

INTRODUCTION

The car can be stopped at the least amount of distance with the help of the brakes with small distance. Additionally, brakes need to be in line with maximum safety. During panic braking, the rider should maintain control of the bike. The car shouldn't slide off the road while applying the panic brake. The brakes should have appropriate antifade properties and their efficiency shouldn't diminish with use. A rotor that rotates with the

wheel, a caliper assembly attached to the steering knuckle, and disc pads attached to the caliper's assembly are all parts of a disc brake assembly. Due to the failure of the brake, due to superheating of the disc brake, many real cases happen, one of them being Hyundai Ceria: brake failure real cases. [1]. Louis Renault wrote the first study on automobile brakes, which was published in 1902. The publication, "Improvements in Motor Car Brakes," described improvements in braking systems for cars. Brake research has been ongoing for more than a century. When the brake is applied, a friction force is produced on the disc, which in turn produces a friction torque. The revolving disc surface's sliding friction force produces work that is converted to heat. The moving mass is slowed down by the torque on one side, and the temperature of the disc is raised by heat entering from the opposite side. Since pads are typically constructed of materials with low infusibility, it is thought that the majority of energy penetrates the disc. Therefore, the material used to create the disc must be able to absorb practically all energy without causing the pad surface to become too hot or causing excessive wear. Optimizing a good material disc breaker is very important in the braking system of the vehicle, many analyses are performed in the field of heat dissipation in disc brake rotors. Design and Finite Element Analysis (FEA) Analysis of Different Materials in a Disc Brake Rotor for maximum heat transfer comparison between the material is done with the help of the Finite Element method [2]. other research on suitable material for the brake disc by taking into account its weight, overall deformation, stress, and strain, compared in terms of the number of maximums von Misses. Stress, greatest possible deformation, and weight loss. When compared to cast iron and structural steel, al-Nico alloy and titanium alloy are ideal materials for braking discs, Brake disc analysis with the help of ANSYS software [3]. To install the ventilation system in autos, the geometrical design of the disc is utilized to determine the factor through the modeling of transient temperature in the disc. The contact pressure in brake pads is then ascertained using coupling and thermos structural analysis after the deformation established the Von Mises stresses in the disc, to examine the thermos-mechanical behavior of the dry contact between the brake disc and pads during braking [4]. Unexpected stress, temperature fluctuation, and rust backing happen while driving the car. There are various variations in the disc brake rotors like deformation, total stress, etc. are analyzed in non-vented material studying their thermal behavior of these solids using ANSYS [5]. Variation in the disc brake design either the standard disc brake rotor studying the properties of Thermal and Structural, in terms of stress generation, temperature distribution, and factor of safety in Computer analysis of redesigned disc brake rotors' structural thermal behavior Journal [6]. Additionally, calculations have been made to determine the optimal material for one of the suggested designs. The outcome offers a tangible understanding of the geometrically changed rotor's thermal and structural properties that can be applied in the automobile sector.

In this research author is analysis a modifies disc, which is different from the standard disc comparing the temperature variation and total heat flux of both modified disc brake and standard disc brake. A 3D model has been incorporated into the research to look into the total heat flux generated in the disc brake and the disc temperature variation that happened when a sudden brake is applied. After doing all necessary analyses and comparisons, the best material with good strength has been identified.

TYPES OF ROTORS

There are 4 types of rotors, depending upon the uses and load capacity.

1. Smooth Rotor



Fig 1: Smooth Rotor

2. Drilled Rotor



Fig 2: Drilled Rotor



Fig 3: Slotted Rotor



Fig 4: Drilled and Slotted Rotor

(Source of photos is Google- <http://speed.academy/>)

METHODOLOGY

The disc brake is drawn Solidworks with a diameter of 203.3, the analysis is in the ANSYS with various boundary parameters like temperature variation and total heat flux in different material.

Modelling of Disc Brake Rotor

SOLIDWORKS is design automation software. When creating 3D models with Solid Works, you can explore and use different designs. Solid Works is used by educators, designers, engineers, and other experts to produce straightforward and complex pieces, assemblies, and drawings. Because SOLIDWORKS is designed and thought of by engineers, it has swiftly found success. Engineers and drafters remark that by utilizing the capabilities offered by this one piece of software, it is easy to use and gives them access to a model that they can have great confidence in being manufactured and that will work. Solid work is powerful work.



Fig 2.1: Design of Disc Rotor Thickness 5 mm Design in Solidworks

Table 2.1: Brake Rotor Specification

Sr. No	Description	Unit	Value
1	The outer diameter of the rotor (OD)	mm	203.3
2	Inner diameter disc of the rotor (ID)	mm	180
3	Hub diameter	mm	130

Material Selection

To analyze the thermal effect and total heat flux, the materials to be selected are ANSYS the following material:-

1. Tugustan
2. Stainless Steel
3. Cast iron

Calculation

- Model No: Apache RTR 180 (Disc Brake)
- Type: Plain Brake

Table 2: Disc Brake Given Values

DIAMETER(D)	203.3
INITIAL VELOCITY(U)	22.22M/sec
MASS(M)	140kg
FINAL VELOCITY(V)	0km/hr
AXLE HEIGHT DISTRIBUTION(y)	0.35
ACCELERATION DUE TO GRAVITY	9.81
COEFFICIENT OF FRICTION	0.4
KINITE ENERGY EFFIENCY (f)	90%

Kinite Energy

$$\begin{aligned}
 KE &= 1/2 \times f \times y \times m (u-v)^2 / 2 \quad (1) \\
 &= 1/2 \times 0.9 \times 0.35 \times 200(22.22-0)^2 / 2 \\
 &= 7776.095J
 \end{aligned}$$

Where KE represented as Kinite Energy, f is kinit energy effiency, y is axle height distribution, m is mass and u, v is initial and final velocity respectively

Stopping Distance

$$\begin{aligned}
 X &= U^2 / 2ug \quad (2) \\
 &= (22.22)^2 / 2 \times 0.4 \times 9.81 \\
 &= 0.062m
 \end{aligned}$$

X is represented by stopping distances and g is gravitation force

Deacceleration Time

$$\begin{aligned}
 V &= U + AT \quad (3) \\
 T &= 3.2sec
 \end{aligned}$$

T is time for deacceleration of vehical

Brake power

$$P = KE/t \quad (4)$$

$$P = 7776.09/3.2$$

$$P = 2430.02 \text{ W}$$

P is represented by brake power

Heat Flux

$$Q = Pn/A \quad (5)$$

$$= 2430.02/0.012$$

$$= 29.16.24 \text{ W/m}^2$$

Q is heat flux and A is area of disc brake

Boundary Condition In Ansys

Disc brake analysis and optimization can be done using the robust simulation tool ANSYS. To deliver dependable and consistent stopping power, disc brakes are widely used in automotive and industrial applications. This simulation can shed light on the system's behavior, including how the brake rotor's temperature changes over time, how the pressure distribution in the brake pads and calipers changes, and how the stresses in the brake rotor and other parts vary when Brakes is applied.

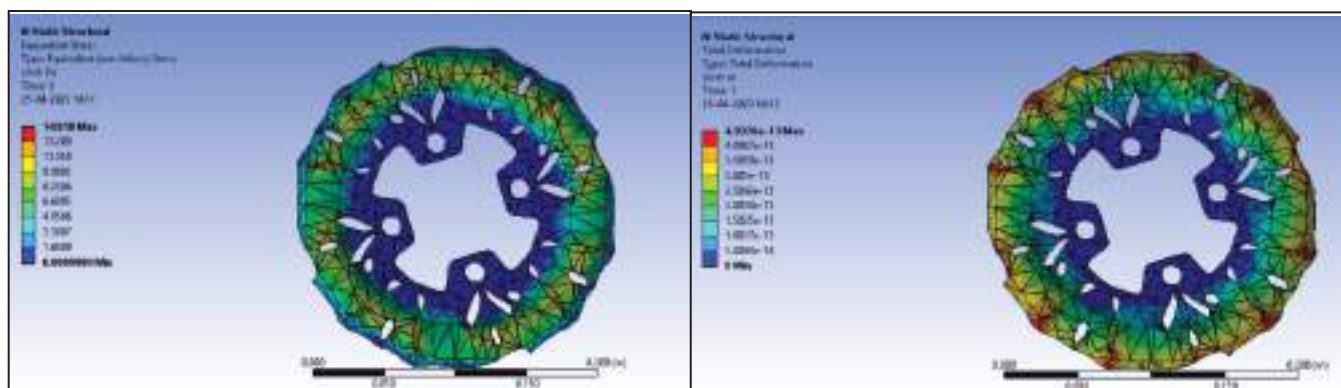


Fig. 2: Analysis of the Disc Brake in ANSYS

Thermal Boundary Condition

The conduction equations and boundary conditions applied to the model's boundaries are used by ANSYS Simulation to solve the temperature distribution in the solid. There are several thermal boundary conditions available in ANSYS Simulation that can be used for thermal research.

- **Temperature:** Act on a certain part of the rotor
- **Convection:** Apply a boundary condition for convection to the chosen faces. The heat lost by convection is automatically estimated given the convection coefficient and ambient temperature.
- **Heat Flux:** Heat applied on the surface or Face
- **Radiation:** allows radiation from surfaces or the surrounding environment. Since every face in this model will be exposed to the air, convection will be applied to every face. In addition, we'll use heating power on the brake pads' contact surfaces.

Total Heat Flux Conditions

In ANSYS, heat flux boundary conditions are used to describe the rate of heat transfer across a thermal analysis model's boundary. The amount of heat energy moved per unit area per unit of time is referred to as heat flux.

The following procedures can be used by engineers to apply a heat flux boundary condition in ANSYS:

1. Decide which surface or boundary will receive the heat flux.
2. Using the relevant ANSYS command or graphical interface, define the heat flux value as a function of time or temperature.
3. Assign the chosen border the heat flux boundary condition.
4. launch the simulation to get the outcomes.

RESULTS DISCUSSION

The outcome of the real experimentation and analysis is examined, and the conclusions are drawn as follows. The temperature and the temperature gradient are the two primary solutions that are determined in ANSYS. First, an evaluation of the ANSYS findings is done.

The following are the contour diagrams for the profiles. The software analysis's key benefit is that it discretizes the entire model into a small-scale component. Before adding additional nodes to the final solution, the boundary conditions are first applied to the nodes. As a result, the software's results are more accurate than the experimental value. The experimental value and the baseline value will differ slightly.

Result of Cast Iron Design

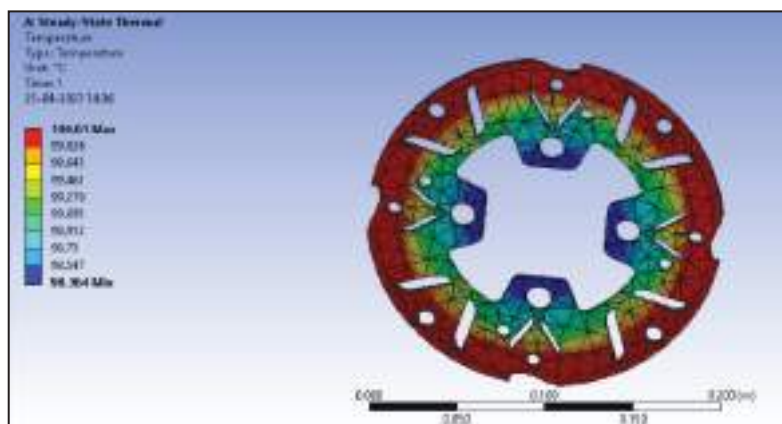


Fig 3.1 Temperature Variation in Cast Iron Rotor Showing Minimum Temperature 98.364 °C Showing Minimum Temperature Variation at the Out Diameter of the Disc

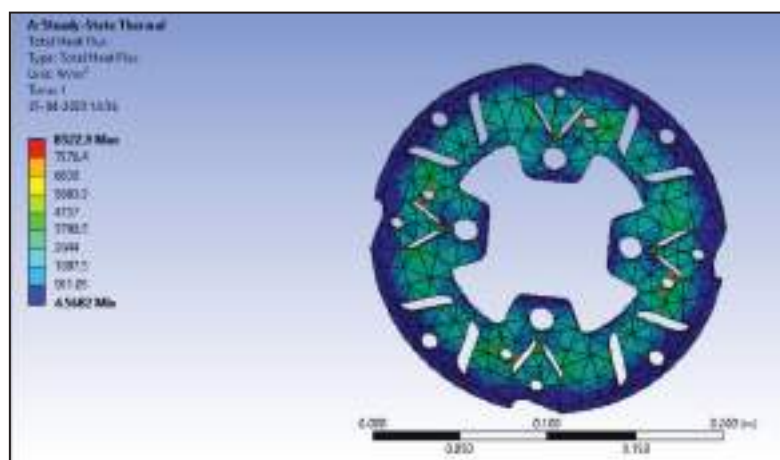


Fig. 3.2: Total Heat Flux Variation in Cast Iron Rotor Where Heat Flux is 4.5682 W/m² Minimum Heat Flux is at the Outer Diameter of the Disc

3.2 Results for Stainless Steel Rotor of Design

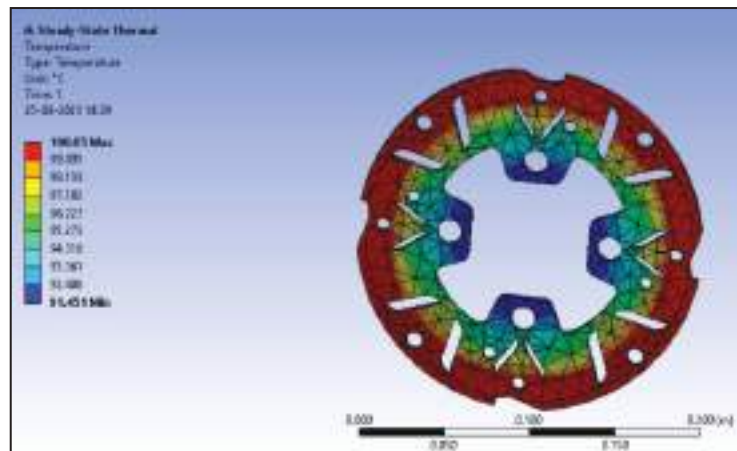


Fig 3.3 Temperature Variation Stainless Steel in Rotor Showing Minimum Temperature 91.451 °C Minimum Temperature Variation at the Outer Diameter of the Disc.

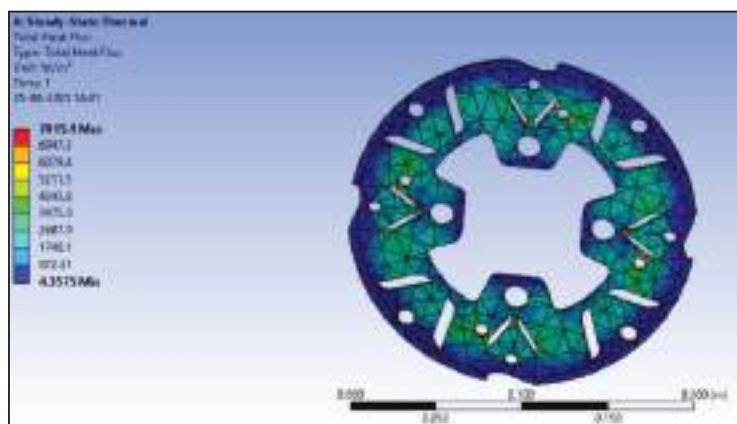


Fig. 3.4: Total Heat Flux Variation in Stainless Steel Rotor Where Heat Flux is 4.3575 W/m² Minimum Heat Flux is at the Outer Diameter of the Disc.

RESULT FOR TUNGSTEN ROTOR OF DESIGN

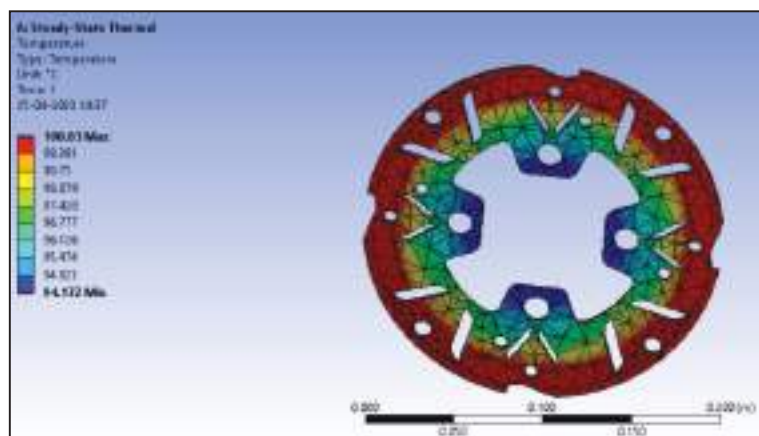


Fig. 3.5: Temperature Variation Tungsten in Rotor Showing Minimum Temperature 94.172 °C Minimum Temperature Variation at the Outer Diameter of the Disc.

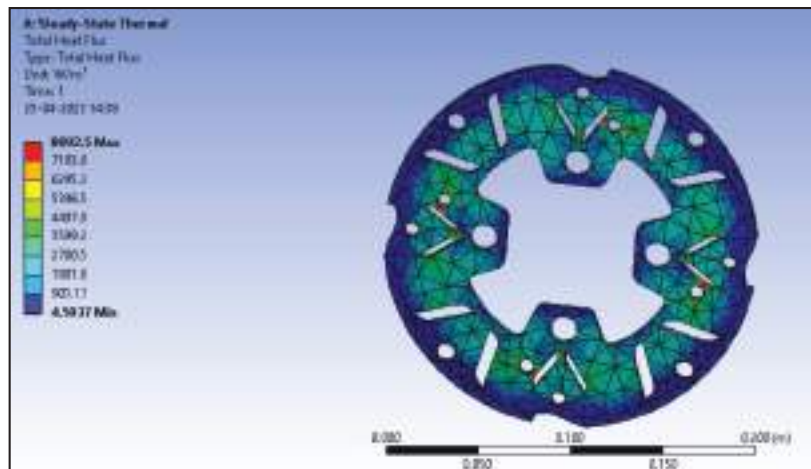


Fig 3.6 Total heat flux variation in Tungsten rotor where heat flux is 4.5037 W/m² Minimum temperature variation at the outer diameter of the disc.

Table 3.1: Result of Different Material Disc Brake Rotor

	Material	Standard Disc Brake	Modified Disc Brake	Differencese
Temperature In °C(Min)	Cast Iron	97.652	98.364	0.712
	Stainless Steel	95.23	91.451	3.779
	Tungsten	96.568	94.172	2.396
Heat Flux In (W/ Mm ²)(Min)	Cast Iron	3.456	4.5682	1.112
	Stainless Steel	2.365	4.3575	1.99
	Tungsten	2.565	4.5037	1.94

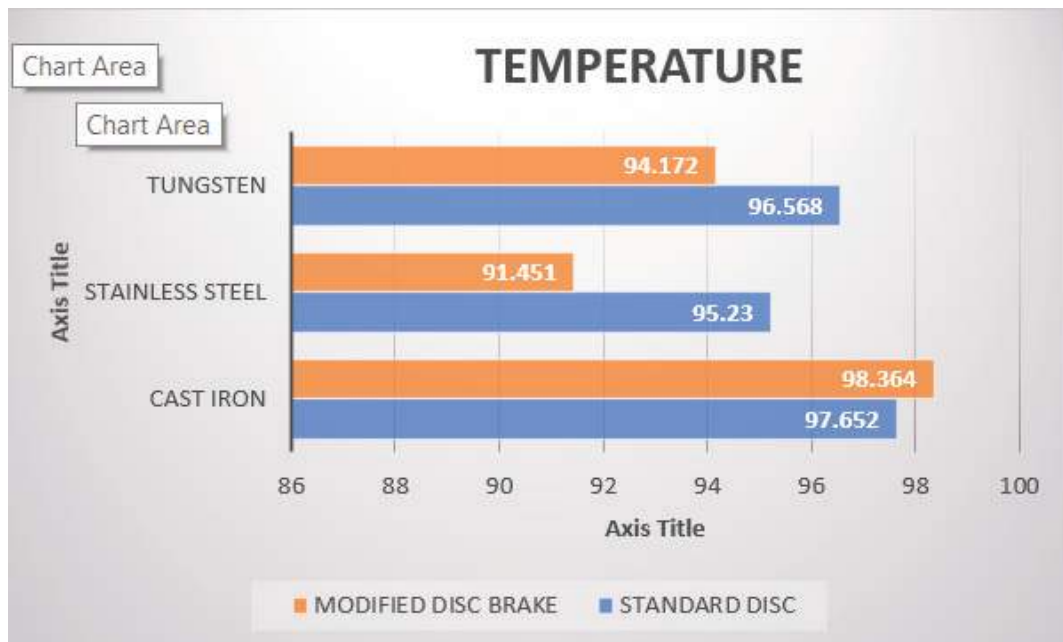


Fig. 3.7: The Variation in Temperature in the Disc Brake Rotor

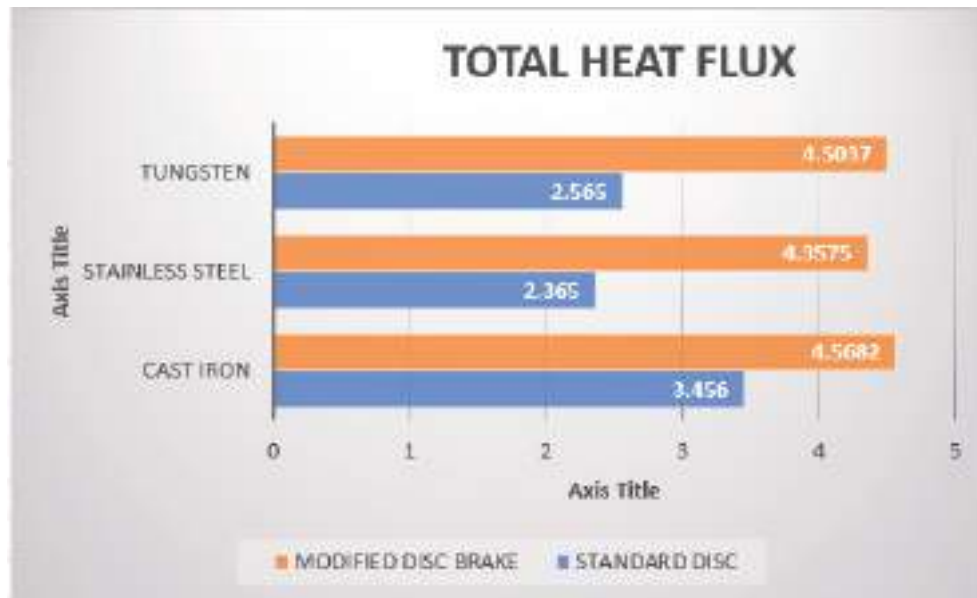


Fig. 3.8: The Variation Total Heat Flux in the Disc Brake Rotors

CONCLUSION

As we can see, the temperature variance ranges from 100 °C to 98.684 °C for tungsten alloy discs and from 100 °C to 97.572 °C for stainless alloy. When it comes to heat flux, tungsten-based discs have the highest value (0.2634 W/m²) while stainless-steel alloy discs have the lowest (0.11077 W/m²)

The following consolations are drawn from this paper are as follows:

1. From all the variations in the experiment cast-iron disc with high total heat flux with a thickness of 5mm
2. Minimum heat flux of 4.5682W/m² of cast iron design is appropriate for disc brake production.
3. According to a structural study, all stresses are within permissible limits, however, cast iron with a 5 mm thickness has a higher heat flux, making the combination preferable for disc brake rotors.

Future Scope

We may examine different brake features, such as temperature distribution, deformation, tension, and wear, by running the simulation. With the use of these models, possible brake systems problems like hot spots, material fatigue, or thermal cracking can be identified and successfully fixed. We may examine variations in the thickness of the disc brake rotors.

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Performance Evaluation of Solar Still Using Phase Change Material and Nanoparticles

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▶ ABSTRACT ◀

Ultimate main purpose of this experiment is to enhance efficiency of passive solar still by adding phase change material (PCM) namely, Polyethylene Glycol (PEG 600) at the basin surface, along with Copper Oxide nanoparticles (CuO) mixed with water. The increase in efficiency was compared relatively with simple passive solar still along CuO nanoparticles mixed in water and no use of PCM. This study was carried out in April 2023 on the Madhav Institute of Technology and Science campus, Gwalior (Latitude 26.2183, N, 78.1828 E). The water depth in SS was kept at 40 mm (about 1.57 in) with the basin area being 1m² and the tilt angle of the transparent condensing cover was 26°. It is seen that the performance of SS has been enhanced remarkably with PCM along with Nanoparticles with water when compared to simple SS by 90.03%.

INTRODUCTION

Only 3% of the water on the surface of the world is fresh, and the remaining 97% cannot be used for human needs since it is not potable. Particularly in countries where there is a shortage of water, the dramatic increase in the global population over the past ten years has raised the demand for pure water. A further lack of clean, potable water is caused by the fact that as temperatures rise because of global warming, water is evaporating from ponds and rivers. Multiple Stage Flash (MSF) distillations, Vapor Compression (VC), Multiple Effect Distillation (MED), Electrodialysis (ED), and Reverse Osmosis are just a few of the techniques that have been developed to make water available for consumption (RO). All these techniques need a lot of energy or use

electricity to filter the water. But we must employ a technique that does not require energy, such as the Solar Still (SS). Research have been done to examine the effectiveness and output of solar stills (SS).

Solar Still (SS) relies entirely on renewable energy to transform slightly salty and impure water into drinkable water. Preferably an ecofriendly as well as economically apparatus. The construction cost of the solar still is minimal, and is straightforward, making it easy to use without requiring complex skills [1]. However, the main drawback of traditional solar still is its low productivity and efficiency. Thus, improving the performance of solar stills poses a significant challenge. Enhancement in the water's rate of evaporation in the basin is crucial for increasing the performance, which could be preferably achieved by raising the basin water's temperature. [2]. Natural and structural factors still affect solar performance. Natural factors like wind speed, atmospheric temperature, climate, solar radiation intensity, etc.; construction factors like body material, insulation material, condensing cover angle, and glass cover thickness; and operational factors like a solar still orientation, basin water grade, and water deepness [3]. D.B. Singh [4], V.K. Thakur and M.K. Gaur [5], and H. Panchal and I. Mohan [6] examined the operating conditions of SS with and without nanoparticles and heat storage materials and produced a thorough evaluation. It was discovered that SS based on nanoparticles performs better than SS not based on nanoparticles. Passive solar stills without and with CuO nanoparticles were explored by Sahota and Tiwari [7]. It was discovered that the fecundity of CuO nanofluids was 37.78% elevated than to that of conventional still, B. Gupta [8] created and evaluated an experimental setting. With CuO nanoparticles, the scientists investigated the production of solar stills at 5 cm (about 1.97 in) and 10 cm (about 3.94 in) of water depth. Compared to the typical solar still, yield increased by 30.1% with the water depth was 5 cm (about 1.97 in) and by 22.42% with the water deepness was 10 cm (about 3.94 in). Due to its low bulk, water heats up more quickly and begins to evaporate extremely quickly. Al₂O₃, ZnO, and SnO₂ were the three distinct nanoparticles that Elango et al. [9] examined in terms of performance. Al₂O₃ nanoparticles outperformed the two nanoparticles and the water found solar still in terms of productivity. Due to their excellent thermal conductivity, Al₂O₃, ZnO, and SnO₂, all outperformed conventional SS in terms of productivity by 29.95%, 18.63%, and 12.2%, respectively. S.W.Sharshir [10] examined the performance of graphite and copper oxide nanoparticles. Copper oxide and graphite nanoparticles both produced 32.35% more output than solar still not based on nanoparticles. Graphite has a better thermal conductivity than copper oxide nanoparticles, hence it is more productive. Subhedar et al. merged SS with a PTC (Parabolic trough collector) and employed Al₂O₃ nanoparticles in the basin water. [11]. PTC allowed the setup to run under active heating settings that increased daily result, and nanoparticles were employed to speed up the base fluids heat transfer. The highest increase yield is shown to be 69.48% greater than the standard SS. Thermoelectric cooling modules (TEC) have been employed by Nazari et al. [12] to cool air current on top the glass cover. Chilly air increased temperature differential betwixt water and the liquidized surface, which enhances condensation rate and productivity. In comparison to typical stills, output was shown to rise by 23.7% and 39.2% at 0.04% and 0.08% concentration, respectively. Navale et al. [13] used two nanoparticles in three different fixations of (0.1%, 0.2%, and 0.3%) to study the masonic solar still. It was discovered that CuO and Al₂O₃ produce the highest results at 0.3% concentration, increasing production by, respectively, 89.42% and 45.19%. CuO nanoparticles were more productive than Al₂O₃ nanoparticles because of their high thermal conductivity. Alter SS produced 17.35% more in contrast to traditional SS, on average. The carrying out of SS was examined by M.K. Phadatare. [14] at various water depths (2 cm (about 0.79 in), 4 cm (about 1.57 in), 6 cm (about 2.36 in), 8 cm (about 3.15 in), 10 cm (about 3.94 in), and 12 cm). Lower water depths were shown to have better productivity, and as water depth increases, setup efficiency rises from 10% to 34%. The ideal water depth was proposed by Tiwari et al. [15] after researching the four levels of water depth (2 cm (about 0.79 in), 4 cm (about 1.57 in), 8 cm (about 3.15 in), and 12 cm). It was discovered that a day's worth of distilled water could be produced at water deepness of 2 cm (about 0.79 in), 4 cm (about 1.57 in), 8 cm (about 3.15 in), and 12 cm (about 4.72 in), respectively. It has been claimed that the 4 cm (about 1.57 in) water depth produces the most output compared to the other water deepness. Caused by shallow water mass at lower water deepness (2 cm), heat is released from water quickly, but heat is released more slowly at higher water depths. decreased water deepness and extra water depth hence resulting in decreased production Bouchekima

[16] investigated the carrying out of SS over the summer and winter seasons at various tilt angles (10°, 15°, 20°, 30°, 35°, and 45°). According to one theory, the glass cover's lower tilt angle maximizes output in the summer, and its higher tilt angle maximizes productivity in the winter. Dev et al. built and tested three different SS tilt angles (15°, 30°, and 45°). [3]. It has been proposed that just insulating the bottom of the still will not stop the heat from seeping in [17] even though little research has been done to examine how the heat lost from the bottom of the still may be employed. Putting in sensible or latent heat storage devices can help increase the effectiveness of solar stills. This technique makes use of the heat lost through the still's bottom. Systems for storing thermal energy that rely on latent heat have an extremely high energy density per unit space and can discharge and charge at nearly constant temperatures. [18]. In solar energy based systems, like solar cookers [19,20], home warm water systems [21,22], it has been proved that PCM may be employed as a storage medium to make up for a temporal imbalance between solar energy supply and demand. A significant quantity of heat will be kept within the PCM instead of being lost by laying a skinny layer of PCM bottom in the basin liner of the SS. The heat is released while the PCM solidifies to have the basin water warm enough to create fresh water all sunset time. Phase change materials (PCMs) have been discovered to significantly increase production, particularly at night, when used as storage mediums in solar stills. Few research [17, 23] have looked at this idea. Research on solar stills with integrated latent heat thermal energy storage was

done by Radhwan [23] with the goal of heating and humidifying an agricultural greenhouse. The effectiveness of the setup was examined by changing paraffin wax PCM's thickness and air mass flow rate. The results revealed that lowering air flow rate considerably affected the still's enhancement while lowering the heat load in the greenhouse. The system had a 57% efficiency and produced a total production of 4.6 L/m².

According to research, adding PCM and nanoparticles to the water in the basin boosts solar still's production. The system has been built and tested in a summer climate based on literature. The output of SS along with nanoparticles and without nanoparticle and PCM is examined in the current experimental effort. Due to the better thermal conductivity of nanoparticles and the PCM's ability to store and release energy, base fluid evaporation is increased, which boosts solar panel productivity. CuO nano size particles perform better than ZnO nano size particles and water because of their strong heat conductivity.

Table 1: PEG 600 Properties

S. No.	Properties	Values
1.	Thermal Conductivity	0.53W/mK
2.	Melting Point	22°C
3.	Enthalpy of Fusion	128 kJ/kg
4.	Specific Heat	2.135 kJ/kg°C
5.	Density	1131 kg/m ³

Table 2: CuO Nanoparticles Properties

S. No.	Properties	Values
1.	Appearance	Black
2.	Specific Heat	531 J/kg K
3.	Thermal Conductivity	40 W/m K
4.	Size	30-50 nm
5.	Density	6400 kg/m ³

Experimental Setup

The configuration depicted in Fig. 1a and 1b comprises a single slope SS with obliquity angle of 26° of glass cover and a conventional SS at 26°. Both SSs were created and placed in the Solar Energy Lab at M.I.T.S., Gwalior

(26.2183° N, 78.1828° E), India. To reduce heat loss from the bottom and side walls, both solar stills are composed of 20 mm (about 0.79 in) thick wood and 20 mm (about 0.79 in) thick Polystyrene (Thermocol). A stainless-steel sheet is used to cover the solar still's interior and exterior surfaces. To increase its absorptivity, the SS basin, which has a surface area of 1 m², is painted black. The tilt angle in both stills is 26°, which equals Gwalior's latitude. For 26° solar stills, the front of the still has a height of 200 mm (about 7.87 in), while the rear height is supported at 700 mm (about 2.3 ft). In one of the solar stills, the bottom is covered with 24 plastic packets measuring 230 x 150 mm. Each packet is filled with an equal amount of Polyethylene Glycol 600, totaling 5 kg of PCM. The liquidized cover of the SSs is made of 4 mm (about 0.16 in)-thick toughened glass, and it is appropriately sealed

By use of aluminum foil tape to stop air and water vapor escaping. A trough is supplied in still to accumulate condensate from the glass. For storing fresh water from the SS trough, an aspirator borosilicate container with exact markings every 100 mL has been employed. A adequate water tank with 10 L adequacy is provided to compensate for the water deepness in the SS during the experimentation. CuO nano size particles mixed to improve thermal conductivity of water. For the getting ready of nanofluids, a magnetic stirrer and ultrasonic vibrator is used. Since nanoparticles cannot be kept suspended in water for a longer period, a DC agitator was put in use to keep the nanoparticles hanging in water rather than settling in the basin water therefore agitator runs each 1-hour interval for 300seconds (about 5 minutes)

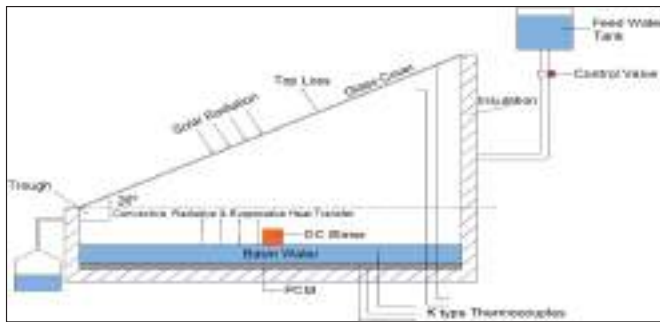


Fig. 1(a)

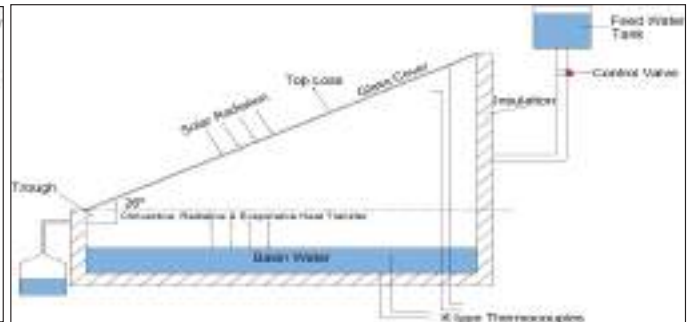


Fig. 1(b)

Nanofluid Preparation

The current experiment uses Copper oxide (CuO) nanoparticles, which are selected for their affordability and excellent thermal conductivity. These nanoparticles are hydrophobic and do not dissolve in water. To overcome this, researchers commonly use surfactants to keep the nano size particles in water without settling down. However, employ of surfactants raises the flash of the main fluids, and when the main fluid evaporates, the surfactant also fades contemporary. To achieve a concentration of 0.0625% of nanoparticles in water by mass, the required amount of nanoparticles is measured using a weighing machine. The subsequent steps are followed to make the nanoparticles hydrophilic: firstly, the water and nano size particles are agitated using a magnetic agitator for 50 minutes followed by sonication with ultrasonic vibrator machine for 1 hour. The temperature of the stove coil in the ultrasonic is fixed to 40°C. As a result of the high rapid vibrations and temperature, the nano size particles gain hydrophilic properties for a duration of 24 hours.



Fig. 2: Nanofluid Preparation

METHODOLOGY

The investigation was managed in the summer of April. During the experiment, the ambient air temperature (T_a), inner and outer glass surface temperatures (T_{gi} & T_{go}), water vapor temperature (T_v), basin water temperature (T_w), PCM temperature (T_{pcm}) and basin liner temperature (T_b) are measured using K kind thermocouples. Solarimeter used for radiation measurement and the output collected in the borosilicate sealed container. Both the conventional and modified SSs are used simultaneously for a period of 24 hours from 9 am to 9 am the following day and hourly readings of temperatures and solar radiation are recorded.



Fig. 3

RESULTS AND DISCUSSIONS

The tests were conducted on April 18th and 19th, 2023. As can be seen, the solar still supported by PEG 600 and CuO nano sized particles performs better than the traditional still. Good thermal conductivity allows CuO to work better than other materials. Fig. 4(a) shows the modified and the standard still's hourly temperature variations and solar radiation. Additionally, Fig. 4(c) illustrates the hourly output for the traditional still and the still with modification. From the graphs, the maximum of the temperature and production curves of the modified stills occurred behind the high of the solar radiation curve. This is because some of the heat from the Solar Still is still stored as sensible and latent heat in the PCM, which requires more time and energy. As can be seen in Fig. 4(a, c), the temperatures and production of the conventional still are higher from roughly 9:00 am to 2:00 pm. In the meantime, it can be shown from Fig. 4(b) that the PCM causes the water temperature to drop in the modified still more slowly in the afternoon than it does in the traditional still. As seen in Fig. 4(c), the PCM has an impact after sunset (about 6:00 pm). A significant amount of fresh water is created during the night using PCM and nanoparticles (after sunset and before sunrise).

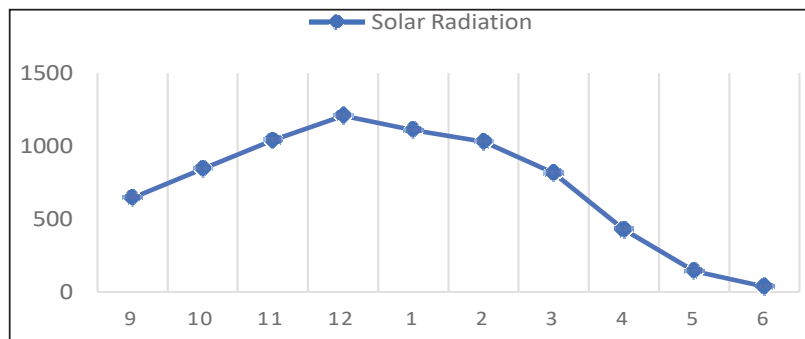


Fig. 4(a) Variation in Solar Radiation Intensity With Time

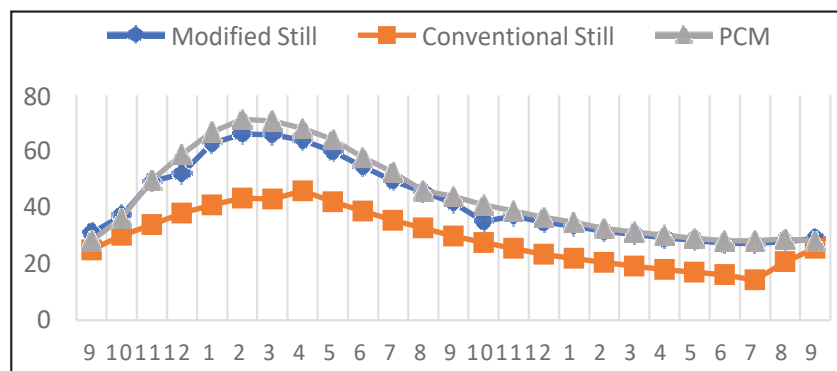


Fig. 4(b) Variation in Basin Water and PCM Temperatures for Conventional and Modified Solar Still with Time

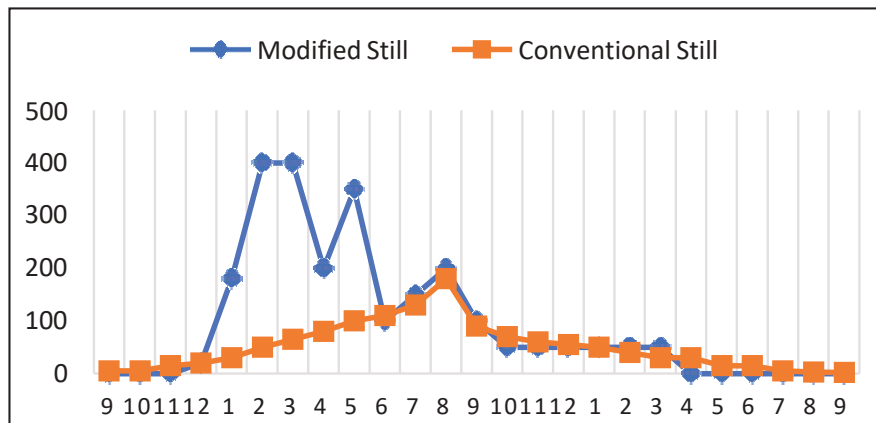


Fig. 4(c) Hourly Production Rates for Conventional and Modified Solar Stills

A total of 2400 mL/day, or 47.5% more than 1260 mL/day productivity of the typical solar still, was produced every day from 9:00 am to 8:00 pm. In addition, regardless of the water depth, the still with alteration had a bigger increase in production than the still without modification.

CONCLUSION

Solar still generally supplies its maximum output during the daytime. This out is incredibly low if nothing is mixed in SS. When CuO nanoparticles are mixed there is a significant increase in productivity. But generally Solar Still can clean a good amount of water during the daytime to overcome this phase materials can be added to the construction of SS so that it can produce water at night. Some of the major conclusions are:

- When an experiment is done on SS without CuO and nanoparticles, it gives about 1260 mL/day.
- Addition of Phase Change Material, Polyethylene Glycol 600 and CuO Nanoparticles has shown a significant rise in productivity i.e., 2400 ml/day, which is 90% when compared with SS without nanoparticles and Phase Change Material.
- Temperature of PCM reached 58.9°C when solar intensity was at maximum i.e., 1208 W/m² at noon.
- Highest temperature of PCM (T_p) was 71.4°C when the ambient temperature was 44.4°C which was the highest on that day.

All these data were experimentally calculated on solar still having a tilt angle of 26° in April.

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