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CONVENER

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1st INTERNATIONAL CONFERENCE ON ROLE OF DIGITAL TECHNOLOGIES IN INNOVATION, ENTREPRENEURSHIP AND STARTUP (ICRDTIES) - 2025 (HYBRID MODE)

MESSAGE FROM THE CHAIRMAN, MITTAL GROUP OF INSTITUTES

We are delighted to share that Mittal Institute of Technology successfully organized its first-ever International Conference on the Role of Digital Technologies in Innovation, Entrepreneurship, and Start-ups (ICRDTIES) on 25th and 26th April 2025. This landmark two-day event brought together academicians, researchers, and industry leaders from across the country to explore how digital technologies are shaping the future of innovation and entrepreneurship.

Out of more than 200 paper submissions, 140 outstanding research papers were selected for presentation and publication reflecting the academic rigour and relevance of the topics. Furthermore, 50 posters presented by students added a vibrant dimension to the conference, showcasing young minds' creativity, technological acumen, and entrepreneurial spirit.

This conference marks a significant step in our commitment to fostering a culture of research, innovation, and start-up development at MGI. I extend my heartfelt congratulations to the organizing team, participants, and contributors for making this event a resounding success.

Let us continue to create platforms that empower ideas, ignite innovation, and inspire the next generation of changemakers.

Mr. Surendra Mittal
Chairman
Mittal Group of Institutes

Integrating Organ-on-a-Chip Technology in Preclinical Toxicity Testing: Bridging the Gap Between In Vitro and In Vivo Models

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Abstract

Preclinical toxicity testing remains a cornerstone of drug development, yet traditional in vitro and in vivo models have shown limited predictive capacity for human responses, contributing to high failure rates in clinical trials. Organ-on-a-Chip (OoC) technology, an interdisciplinary innovation combining microfluidics, biomaterials, and living cells under digitally controlled conditions, emerges as a revolutionary approach to address these limitations. This review critically examines the development, current state, and future perspectives of OoC platforms in preclinical toxicity testing. We discuss the limitations of traditional models, explore the engineering advances driving OoC, highlight case studies across major organ systems, evaluate regulatory acceptance, and reflect on the entrepreneurial landscape shaping its commercialization. By bridging the translational gap between laboratory models and clinical outcomes, OoC technology stands as a transformative tool at the intersection of biotechnology, digital innovation, and entrepreneurship, aligned with the global drive towards more ethical, efficient, and personalized healthcare solutions.

Keywords: Organ-on-a-Chip, Microphysiological Systems, Preclinical Toxicology, Drug Discovery, Biomedical Innovation, Digital Health

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Introduction

The pharmaceutical industry grapples with an urgent need for more predictive preclinical testing methods. Despite significant investments, over 90% of drug candidates fail during human clinical trials, often due to unforeseen toxicities or inadequate efficacy. Traditional 2D cell cultures and animal models, although invaluable historically, present major physiological discrepancies from human biology, often resulting in translational failures(Duval et al.,2017).

Organ-on-a-Chip (OoC) technology represents a paradigm shift. Leveraging microfabrication techniques, these systems recreate human organ-level functions within microfluidic environments, capturing dynamic mechanical, chemical, and biological interactions that conventional models cannot emulate. With the integration of real-time sensors, AI-powered analytics, and IoT connectivity, OoCs are positioned at the frontier of digital health innovation.

This review provides a comprehensive synthesis of the technological, scientific, and entrepreneurial dimensions of OoC technology, critically analyzing its role in reshaping preclinical toxicity testing.

2. Limitations of Traditional Preclinical Models

2.1 In Vitro Models

Static Cultures: Traditional 2D cultures lack the three-dimensional (3D) architecture and dynamic environment of human tissues, leading to altered cell behavior and gene expression profiles (Wang *et al*., (2023).
Lack of Tissue-Tissue Interactions: Complex systemic effects, such as immune responses or metabolism, cannot be accurately modeled.

2.2 In Vivo Models

Species-Specific Differences: Animal models often fail to replicate human-specific metabolic pathways and disease progressions, leading to poor predictive value.
Ethical and Regulatory Pressure: The 3Rs principle (Replace, Reduce, Refine) calls for alternatives to animal use in research(Aelpee *et al*.,2014).
High Costs and Time Constraints: Animal testing is resource-intensive and lengthy, slowing drug development timelines.
Thus, the biomedical community increasingly recognizes the necessity for human-relevant, predictive, and scalable model systems.

3. Emergence and Evolution of Organ-on-a-Chip Technology

3.1 Definition and Basic Architecture

Organ-on-a-Chip systems are microfluidic cell culture devices that simulate the microarchitecture and physiological environment of entire organs or tissues. They integrate:
Living cells (often primary human cells or stem cell derivatives)
Biocompatible scaffolds
Perfused microchannels mimicking blood flow
Mechanical stimuli replicating organ-specific forces (e.g., peristalsis, breathing) (Ahadian*et al*.,2018).

3.2 Historical Development

The concept of microphysiological systems emerged from the convergence of tissue engineering and microfabrication technologies in the early 2000s. Early success stories, such as the Lung-on-a-Chip developed by Ingber's group at Harvard's Wyss Institute, demonstrated the feasibility and potential of this approach(Wang *et al*., (2020).

3.3 Advances in Engineering and Materials

Microfabrication Techniques: Soft lithography, 3D bioprinting, and laser ablation are increasingly used for device fabrication.
Material Innovation: Shift from PDMS to alternatives like cyclic olefin copolymers (COC) to avoid drug absorption and enhance scalability (Pun *et al*., (2021).

Integrated Sensing: Real-time monitoring of cellular responses via embedded electrodes and biosensors enables high-throughput toxicological screening(Khalid *et al*., (2020).

4. Applications of Organ-on-a-Chip in Preclinical Toxicity Testing

4.1 Liver-on-a-Chip

The liver is crucial for drug metabolism, making hepatotoxicity a leading cause of drug withdrawal. Liver-on-a-chip models, incorporating hepatocytes and non-parenchymal cells, replicate liver-specific functions like albumin production and cytochrome P450 activity (Messelmani*et al*.,2022).
Case Study: Emulate's Liver-Chip accurately predicted drug-induced liver injury (DILI) for 87% of tested compounds compared to historical models (Zhou *et al*.,2019).

4.2 Heart-on-a-Chip

Cardiotoxicity remains a major safety concern. Heart-on-a-chip systems use engineered cardiac tissues to assess contractility, electrophysiology, and arrhythmogenic risks under drug exposure.
Case Study: Studies using human-induced pluripotent stem cell-derived cardiomyocytes have shown enhanced prediction of QT prolongation and arrhythmias (Andrysiak, K *et al*.,2023).

4.3 Lung-on-a-Chip

Lung-on-a-chip devices simulate alveolar-capillary interfaces, breathing motions, and aerosol exposure.
Case Study: Wyss Institute's Lung-Chip successfully modeled pulmonary edema and inflammatory responses to bacterial toxins (Shrestha *et al*.,2023).

4.4 Kidney-on-a-Chip and Blood-Brain Barrier Models

Emerging OoC models for renal toxicity and neurotoxicity screening demonstrate potential for safer drug development, particularly for CNS-targeting drugs (Deng *et al*.,2023).

5. Regulatory Considerations and Industry Adoption

5.1 Regulatory Engagement

Agencies like the U.S. Food and Drug Administration (FDA) and European Medicines Agency (EMA) are increasingly collaborating with OoC developers:
FDA's Predictive Toxicology Roadmap (2017): Recognizes OoC platforms as promising alternatives(Teixeira *et al*.,2024).
Qualification Programs: Efforts like the FDA's MPS (Microphysiological Systems) CoE (Center of Excellence) aim to validate and standardize OoC systems for regulatory use.

5.2 Standardization Challenges

Variability between devices and platforms
Lack of universal protocols
Need for robust, reproducible multi-site studies
Progress in these areas is critical for widespread regulatory acceptance and industry integration(Farzan *et al*.,2017).

6. Entrepreneurship, Market Growth, and Innovation Potential

6.1 Market Dynamics

The global Organ-on-a-Chip market is expected to grow at a CAGR of ~30% between 2022 and 2030, driven by:
Pharmaceutical demand for predictive models
Push for animal-free testing
Rise of personalized medicine approaches(Taute *et al*., 2021)

6.2 Startup Ecosystem

Key players include:
Emulate Inc. (USA)
MIMETAS (Netherlands)
TissUse GmbH (Germany)
CN Bio Innovations (UK)
These startups are partnering with pharma giants like Roche, Merck, and AstraZeneca to validate and deploy OoC solutions at scale(Boni & Molloy(2021).

6.3 Opportunities for Future Entrepreneurs

Personalized OoC Models: Using patient-derived iPSCs
AI-Integrated OoC Platforms: Digital twins for predictive toxicology
Low-Cost, Portable OoC Devices: Democratizing access to high-fidelity testing in emerging markets(Fois *et al*.,2024).

7. Challenges and Future Directions

7.1 Technical Challenges

Long-term culture stability
Integration of immune components
Inter-organ communication in multi-organ chips (Zarrintaj*et al*.,2022).

7.2 Ethical and Societal Impact

Reducing animal testing aligns with global ethical movements.
Democratization of technology could enhance equity in healthcare innovation(Chithra& Bhambri, (2025).

7.3 Vision for 2030

By 2030, Organ-on-a-Chip platforms are envisioned to be integral components of digital biolabs, supporting AI-driven drug discovery pipelines, clinical trial modeling, and personalized therapy design(Solovchuk, D. R. (2024).

8. Conclusion

Organ-on-a-Chip technology offers a transformative pathway to overcome the translational gap in preclinical drug development. By faithfully recapitulating human organ functions within digitally connected platforms, OoCs enhance predictive toxicology, reduce drug attrition, and drive ethical innovation. Their convergence with artificial intelligence, big data analytics, and telehealth technologies heralds a future where precision medicine is realized more efficiently and inclusively. For innovators and entrepreneurs, OoC represents a vibrant frontier of opportunity, fully aligned with the goals of ICRDTIES 2025 in fostering digital-driven, high-impact startups.

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Leveraging Digital Technologies to Enhance Family Engagement and Improve Patient Health Outcomes: Innovations in Healthcare Entrepreneurship

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Abstract
Greater family involvement and better health outcomes resulting from the incorporation of digital technologies in healthcare have changed patient treatment. The most recent developments in healthcare entrepreneurship leveraging digital tools including telemedicine, wearable health devices, and mobile health apps are compiled in this work. This paper shows how digital healthcare solutions improve communication, boost accessibility, and propel proactive health management by means of case studies and secondary research. The results highlight the need of digital technologies in enabling households and enhancing patient-centered treatment.

Keywords: Digital healthcare, family engagement, patient outcomes, healthcare entrepreneurship, telemedicine, wearable health devices, mobile health applications.

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1. Introduction

The development of digital technologies has transformed healthcare and opened fresh paths for bettering patient treatment, strengthening communication, and encouraging family involvement. A patient's long-term health management and rehabilitation depend much on their family, although conventional healthcare models can restrict their participation because of administrative and institutional constraints. Digital developments that provide useful solutions bridging these gaps include telemedicine, wearable health devices, and mobile health apps, so enabling real-time communication, remote monitoring, and individualised treatment delivery.

These technical developments have been greatly facilitated by healthcare entrepreneurship, which also helps to produce a more patient-centric medical approach. Using artificial intelligence, big data analytics, and digital health platforms, businesses and startups are developing products that simplify access to and efficiency of healthcare. Notwithstanding these encouraging advances, issues including digital literacy, data privacy, regulatory compliance, and technology acceptance still impede the full-scale application of digital healthcare solutions.

This research investigates how developments in digital healthcare are increasing family

involvement and thereby improving patient health outcomes. It explores how healthcare entrepreneurship might propel these developments and reviews actual case studies to evaluate their influence. The report also points up important obstacles and future chances for adding digital health technologies into regular treatment.

2. Problem Statement

Digital technologies offer possible solutions to bridge these gaps, yet their adoption and efficacy in different healthcare environments remain inconsistent. This paper investigates the impact of digital healthcare innovations in fostering family engagement and improving patient health outcomes. Patient outcomes are often hampered by limited family involvement and inadequate communication between healthcare providers and carers even with the advancements in medical technologies.

3. Research Objectives

1. To investigate how digital technology might improve family involvement in patient treatment.
2. To investigate how healthcare entrepreneurship could help to advance digital health solutions.
3. To analyse case studies that illustrate successful integration of digital tools in enhancing patient outcomes.
4. To offer analysis of the difficulties and possibilities for future development of digital healthcare technologies.

4. Literature Review

Telehealth Programs and Family Engagement

Rosenbluth et al. (2024) carried out mixed-methods research evaluating the execution of an inpatient telehealth program meant to increase family involvement. According to the study, these kinds of initiatives enhanced patient and family experiences by means of bettering relationships and more support. They also enabled improved patient care involvement and information exchange. However, low program awareness among patients and families hampered its acceptance, implying a demand for more promotion and education.

Mobile Health Applications and Patient-Provider Relationships

Iribarren et al. (2019) undertook a methodical narrative evaluation looking at how mHealth apps affect interactions between patients and healthcare providers. By helping patients in actively managing their health in cooperation with clinicians, the review revealed that these tools improved relationships. Patients said they were ready to go from conventional healthcare visits to digital modalities. The study did also highlight provider resistance and the need to solve technological obstacles for more general application.

Almutairi et al. (2023)searched the systematic literature and performed meta-analysis to find convincing system design elements in mHealth applications improving patient involvement in managing chronic diseases. Eleven traits—tailoring, personalising, self-monitoring, reminders—that the study found were linked to better patient engagement and health outcomes: The authors underlined the need of combining these elements in order to create successful mHealth projects.

Wearable Technologies and Patient Empowerment

Patel and Agus (2024)talked about how wearable technologies—such as fitness trackers and smartwatches—which let patients track several health indicators might revolutionise healthcare. They underlined the need of improved communication between healthcare practitioners and technology businesses as well as the obstacles to general adoption including the absence of provider training to examine data from various devices. The writers argued for robust data indicating wearable technology's effectiveness in enhancing health results.

Digital Tools for Long-Distance Caregiving

 A report by MarketWatch (2024)looked into how long-distance caring for ageing relatives is being made possible by technology. Families can now remotely do care tasks thanks to tools like video chats and tracking gadgets. The report did emphasise, though, that complete reliance on these technologies depends on the willingness and ability of older patients to use them; so, major gaps still exist where technology cannot fully replace the vital human element of caregiving.

mHealth Applications in Addiction Treatment

A study by UT Health San Antonio (2024)shown that among people with opioid use disorder, therapy given through a smartphone app could help to lower opioid usage and extend treatment duration. Combined with medication, those using the app cut opioid use by 35% and stayed in treatment 19% longer than those depending just on medication. The contingency management of the app tracked development, set treatment goals, provided cash incentives, so motivating treatment continuity.

5. Research Methodology

This study employs a secondary research approach, focusing on the analysis of existing literature, reports, and case studies. The research aims to explore the role of digital technologies in enhancing family engagement and improving patient health outcomes through the synthesis of previously published data.

Data Collection Methods

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1. **Literature Review:**The study is based on a thorough reading of case studies from peer-reviewed journals, healthcare databases, and industry reports as well as reports on past studies. Digital healthcare solutions including telemedicine, wearable health gadgets, and mobile health apps take front stage in the evaluation.

2. **Case Study Analysis:**Real-world uses of digital healthcare technologies are investigated via a multiple case study methodology. Case studies are chosen depending on their applicability to family involvement and patient outcomes, therefore guaranteeing a varied representation of healthcare environments including hospitals, home care services, and telemedicine systems.

3. **Secondary Data Analysis:**Government health reports, institutional healthcare studies, and corporate white papers among other sources are synthesised in this work. To underline the results, quantitative information on patient outcomes, degrees of engagement, and rates of technology uptake is gathered.

Case Studies

1. **Case Study 1: Telemedicine Implementation in Pediatric Care**
   To enable parental involvement in paediatric treatment, a US hospital instituted a telemedicine service. Parents tracked treatment programs, engaged in virtual consultations, and got real-time updates. Treatment adherence rose by thirty percent, and reported patient satisfaction improved by twenty-five percent.

2. **Case Study 2: Wearable Health Devices for Chronic Disease Management**
   Launched by a digital health startup, a smartwatch tracks heart rate, oxygen levels, and activity level for individuals suffering with cardiovascular disorders. Real-time alerts concerning changes in health sent to families resulted in proactive actions. Research indicated better drug adherence and a 20% drop in emergency hospital visits.

3. **Case Study 3: Mobile Health Application for Diabetes Management**
   Designed to help diabetes patients track nutritional consumption, check glucose levels, and plan doctor visits, a mobile health app was created. Access to patient records given family members improved support systems. Users of the program who interacted with family support showed better glycaemic control than those who controlled diabetes on their own, according to analysis.

4. **Case Study 4: Digital Tools for Elderly Care and Remote Monitoring**
   One study looked at how remote monitoring systems might affect senior care. Families checked on ageing relatives using smart home appliances and video calling systems. Results indicated that by 40% digital monitoring lessened feelings of isolation among older patients and improved family carers' capacity to properly handle health issues.

6. Findings

The research identifies several key findings:

- Telemedicine lowers travel distances and allows constant connection between patients, families, and doctors, therefore improving accessibility to healthcare.

- Wearable health devices enable families and individuals to track health indicators, hence guiding proactive healthcare treatment.

- Mobile health apps increase family participation in patient care by helping medication adherence, appointment scheduling, and real-time health tracking.

- Developing user-friendly and scalable digital solutions and filling inefficiencies in conventional healthcare systems depend much on healthcare entrepreneurs.

- Major impediments to general acceptance are computer literacy, cost, and data security.

7. Conclusion

By increasing patient health outcomes and family involvement, digital technologies are revolutionising healthcare. Novel ideas to improve patient-centered care come from telemedicine, wearable technologies, and mobile apps. Maximising the possible value of these developments depends on addressing issues such data security, provider training, and accessibility, though. Future studies should concentrate on maximising digital healthcare solutions, raising user technical awareness, and creating policies enabling the smooth integration of digital health technologies into conventional healthcare structures. Furthermore, crucial for guaranteeing the scalability and durability of digital health projects will be encouraging cooperation among legislators, businesses, and healthcare providers.

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Artificial Intelligence-Based Fault Detection, Classification, and Location in Power Transmission Lines: A Comprehensive Study

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Abstract

Reliable and uninterrupted power transmission is a critical component of modern power systems. However, faults in transmission lines—such as short circuits, ground faults, and open conductors—pose serious threats to system stability, equipment safety, and customer satisfaction. Swift and accurate fault detection, classification, and location are essential for ensuring efficient protection and minimizing downtime. Traditional fault analysis techniques often fall short in terms of speed, adaptability, and precision, especially under varying system conditions and fault types.

This paper presents a comprehensive review of recent advancements in fault analysis for transmission lines using Artificial Intelligence (AI) and Machine Learning (ML) techniques. The study focuses on methods utilizing Artificial Neural Networks (ANN), Deep Neural Networks (DNN), Graph Convolutional Networks (GCN), and Fuzzy Logic-based systems. These approaches are evaluated based on their performance in detecting, classifying, and locating different types of transmission line faults under various conditions, including noisy data, fault impedance variations, and presence of distributed generation.

A comparative analysis of 15 key research papers reveals that AI/ML models demonstrate high accuracy—often exceeding 98%—and robust generalization capabilities. Models like DNNs and GCNs outperform traditional methods in complex and large-scale scenarios, while fuzzy logic schemes offer reliable detection in multiphase systems. The findings suggest that data-driven AI solutions are not only effective but also scalable and adaptable, paving the way for intelligent, real-time power system protection frameworks.

Keywords: Transmission Lines, Fault Detection, Classification, Fault Location, Neural Networks, Deep Learning, Graph Convolutional Network, Fuzzy Logic, Power System Protection

1. Introduction

The transmission network is a vital component of any power system, responsible for the reliable transfer of electricity from power generation plants to consumers. With the increasing complexity and size of modern power grids, ensuring a consistent and uninterrupted flow of electricity has become more challenging. Faults in transmission lines—ranging from short circuits to open conductor failures—can disrupt the stability of the entire system, leading to power outages, equipment damage, and even system-wide blackouts.

The consequences of transmission line faults on grid stability can be severe. These faults not only result in economic losses but can also compromise the safety of the network. Identifying and isolating faults quickly is crucial to minimizing downtime, ensuring the system remains functional, and preventing further damage to the infrastructure. Traditionally, power systems

relied on conventional protection schemes, which often involved predefined threshold-based algorithms. While these methods were effective in many cases, they lacked the flexibility to handle dynamic and complex fault scenarios efficiently.

The rapid evolution of Artificial Intelligence (AI) and Machine Learning (ML) techniques has provided new opportunities for improving fault detection and localization in transmission systems. Modern AI/ML-based protection schemes, particularly those utilizing Artificial Neural Networks (ANN), Deep Neural Networks (DNN), Graph Convolutional Networks (GCN), and Fuzzy Logic, have shown significant promise in outperforming traditional methods. These intelligent systems offer the potential for faster, more accurate, and adaptive fault detection, classification, and location identification.

This paper presents a systematic review of recent research in AI and ML-based fault analysis techniques for transmission lines. We perform a comparative analysis of the methodologies and performance of different AI/ML models. By examining the strengths and weaknesses of these approaches, we aim to identify key research gaps and suggest avenues for future improvements in transmission line fault protection.

2. Background and Motivation

The increasing complexity of power systems, combined with the rising demand for electricity, has made ensuring the reliability and stability of transmission lines a crucial aspect of modern energy networks. Faults in power systems can cause significant disruptions, making it imperative to develop fast and efficient fault detection, classification, and localization techniques. This section provides a background on the types of faults encountered in power systems, the role of protective relays, and the motivation for adopting AI/ML models in fault detection.

2.1 Types of Faults in Power Systems

Faults in power systems can occur due to various reasons, including equipment failure, environmental factors, and human errors. These faults are typically categorized based on the nature of the electrical malfunction and the number of phases involved. The main types of faults include:

- **Line-to-Ground (LG) Fault**: This occurs when one of the transmission lines comes into contact with the ground, causing an imbalance in the system. It is one of the most common faults in power systems.
- **Line-to-Line (LL) Fault**: This fault involves two transmission lines coming into contact with each other, resulting in a short circuit that can cause severe damage to equipment and disrupt power supply.
- **Line-to-Line-to-Ground (LLG) Fault**: A combination of a line-to-line fault and a ground fault, LLG faults are more complex and require advanced protection schemes to quickly identify and isolate the fault.
- **Three-Phase Line-to-Ground (LLLG) Fault**: This fault occurs when all three phases of the transmission line make contact with the ground, often resulting in more severe power system disruptions.

- **Open Conductor Fault**: This happens when one or more conductors in the transmission line become disconnected or damaged, leading to power loss and potential equipment damage.

Each of these faults requires distinct approaches to detection and classification to ensure the stability and reliability of the power system.

2.2 Role of Protective Relays and Fault Indicators

Protective relays are crucial in maintaining the stability of the power system by detecting faults and initiating corrective actions. These devices monitor electrical parameters such as current, voltage, and frequency, and when they detect an anomaly, they trigger actions like isolating the faulty section of the network. Key responsibilities of protective relays include:

- **Fault Detection**: Relays continuously monitor the system for any irregularities. Upon detecting an anomaly (e.g., a drop in voltage or an increase in current), they alert the control center for further investigation.
- **Fault Classification**: Relays not only detect faults but also classify them into specific categories based on the fault's characteristics (e.g., LG, LL, LLG, etc.). This allows for the implementation of appropriate mitigation strategies.
- **Fault Localization**: Once the fault is detected and classified, relays help identify the exact location of the fault, enabling the system operators to quickly isolate the affected region and minimize downtime.
- **Fault Isolation**: Protective relays activate circuit breakers or other devices to isolate the faulty segment, preventing the fault from spreading throughout the grid.

While traditional protective relays have been effective for many years, they have limitations, such as slower response times, difficulty handling complex fault scenarios, and dependence on fixed threshold values for fault detection.

2.3 Why AI/ML Models Are Increasingly Adopted

AI/ML models are being increasingly adopted in power system protection for several reasons:

- **Accuracy**: AI/ML models can process and analyze large volumes of data, identifying patterns and correlations that might be missed by traditional methods. This results in more accurate fault detection and classification, even in complex scenarios with noisy data.
- **Speed**: AI/ML models can provide real-time fault detection, which is crucial for minimizing downtime and ensuring the stability of the power grid. Their ability to learn from data allows for faster decision-making and fault isolation.
- **Adaptability**: Unlike traditional methods that rely on predefined thresholds and fixed rules, AI/ML models can adapt to changing conditions and learn from new data. This is particularly useful in dynamic environments where fault characteristics may vary over time.
- **Scalability**: AI/ML models can handle large-scale power systems, making them ideal for modern grids with numerous transmission lines, substations, and distributed generation sources.

- **Automation**: AI/ML-based systems can automate fault detection and response processes, reducing the need for human intervention and increasing the efficiency of power system operations.

2.4 Challenges in Traditional Methods

While traditional methods, such as protective relays and fault indicators, have been the cornerstone of power system protection for many years, they come with several limitations:

- **Speed**: Traditional methods may take longer to detect faults, especially in complex scenarios with multiple fault types. In fast-changing environments, this delay can lead to significant damage to equipment and longer downtime.
- **Accuracy**: Traditional methods often rely on predetermined thresholds, which can lead to false positives or missed faults. Additionally, handling fault scenarios with varying characteristics (e.g., different fault impedance or fault location) is challenging.
- **Adaptability**: Traditional methods are typically designed for specific fault scenarios and may not adapt well to new or unforeseen situations. As power systems grow in complexity, traditional methods struggle to keep pace with emerging fault types and new operational conditions.
- **Complexity of Multi-Phase Faults**: Traditional methods may have difficulty handling multi-phase faults or faults involving varying load conditions, especially when multiple faults occur simultaneously or in close proximity.

AI/ML models, by contrast, offer a more flexible, fast, and accurate approach to power system protection, addressing many of the challenges associated with traditional methods.

3. Literature Review

This section provides an in-depth review of the current literature on fault detection, classification, and localization in power transmission lines using AI/ML-based methods. The review is organized into subsections based on the techniques used, summarizing key papers and their contributions.

3.1 Artificial Neural Networks (ANN)

Artificial Neural Networks (ANNs) have been widely adopted for fault detection and classification due to their ability to learn from historical data and generalize well in complex environments. These networks typically use feedforward architectures with backpropagation for training. Several ANN-based techniques have been explored for transmission line fault analysis, leveraging models such as Levenberg-Marquardt optimization for improved performance.

Overview of Techniques:

- **Feedforward Networks**: Standard neural networks where data flows in one direction from input to output. These networks are effective in detecting faults based on historical fault patterns.
- **Backpropagation**: A common training method for neural networks where the error is backpropagated to adjust weights and minimize loss.
- **Levenberg-Marquardt**: A popular optimization algorithm for training ANNs that improves convergence speed and accuracy.
- **R Value**: Measures the correlation between predicted and actual outputs. A value close to 1 indicates high accuracy.
- **Mean Square Error (MSE)**: A performance metric to evaluate the difference between predicted and actual values, with lower values indicating better model performance.

Key Findings:

- **[1]**: Used an ANN-based model for fault classification with 100% accuracy for symmetrical and unsymmetrical faults, and 98.775% overall accuracy across four fault types. Achieved precise fault localization within 2% in 80% of cases.
- **[2]**: Implemented an ANN in MATLAB for fault detection and classification in a 3-bus system. The model achieved excellent performance with a Regression (R) value of 1 and MSE of 1.462e-10 for fault detection.
- **[3]**: Explored a multi-phase fault detection scheme using ANN with real-time inputs. Achieved robust classification with minimal error even in noisy conditions.
- **[6]**: Focused on ANN's ability to classify faults and predict fault locations in transmission lines, showing reliable accuracy and performance.
- **[12]**: Used ANN with a backpropagation algorithm and Levenberg-Marquardt optimization. The results showed the best performance for fault detection with an MSE value of 0.16178 and a Regression value of 0.9818.

3.2 Deep Learning Models (DNN, CNN, LSTM)

Deep learning models like DNN (Deep Neural Networks), CNN (Convolutional Neural Networks), and LSTM (Long Short-Term Memory networks) have emerged as powerful techniques for handling complex fault detection tasks, particularly those involving large datasets and intricate time-series data.

Key Findings:

- **[4]**: A DNN-based approach for detecting and classifying faults in power transmission lines. It utilized a large dataset of RMS values for current and voltage under different fault conditions, achieving high accuracy in fault detection.
- **[5]**: Proposed a CNN-based model for fault detection in complex transmission systems, which improved classification accuracy and localized faults with high precision.
- **[11]**: Applied LSTM networks to improve the handling of sequential fault data and time-series analysis, leading to more precise fault classification and better prediction of fault locations. The model showed significant improvements over traditional ANN models, especially in handling transient and complex fault data.

Performance Metrics:

- **Accuracy**: Achieved significant improvements in accuracy, particularly in handling complex data.
- **Fault Localization Precision**: Models achieved improved precision in fault location prediction, especially in comparison to traditional methods.

3.3 Fuzzy Logic-Based Approaches

Fuzzy Logic provides a mechanism to deal with uncertainties and vagueness in the detection and classification of faults, especially in multi-phase and complex fault scenarios.

Key Findings:

- **[7]**: Proposed a fuzzy logic-based protection approach for multi-phase faults in transmission lines. It utilized real-time measurements of currents and voltages to detect faults with high accuracy.
- **[13]**: Implemented a fuzzy logic-based scheme for series fault detection in a six-phase transmission line. The model accurately detected various types of faults under different conditions, including varying fault inception angles and fault locations.

Performance Metrics:

- **Fault Detection and Classification**: Both models were effective in identifying and classifying multi-phase and series faults in transmission lines.
- **Accuracy**: The fuzzy logic approach provided high classification accuracy, particularly in dealing with complex fault scenarios like series faults and multi-phase faults.

3.4 Graph-Based Methods (GCN)

Graph Convolutional Networks (GCN) leverage graph structures to capture spatial information and dependencies in the data, which makes them suitable for complex network-related tasks like fault detection and classification in transmission lines.

Key Findings:

- **[14]**: Proposed a GCN-based model for transient fault detection and classification in power transmission lines. The model incorporated graph topology to capture spatial relationships between different nodes in the power system, improving fault detection and classification accuracy.
- **Key Innovation**: The use of graph structures allowed the model to better capture the spatial dependencies of faults, making it more effective than traditional methods in handling transient and complex fault events.

Performance Metrics:

- **Accuracy**: The model demonstrated higher fault detection accuracy compared to other techniques.
- **Generalization Ability**: The GCN approach showed robust performance in various fault conditions and was capable of generalizing well to unseen scenarios.

3.5 Hybrid and Comparative Models

Hybrid models combine multiple AI/ML techniques to take advantage of the strengths of each. These models have been shown to be highly effective in improving the robustness and accuracy of fault detection, especially under noisy data conditions or scenarios with distributed generation.

Key Findings:

- **[8]**: Used a hybrid model combining ANN and fuzzy logic to improve fault classification in multi-phase systems. The model provided accurate fault detection even under noisy conditions and varied fault scenarios.
- **[9]**: Presented a hybrid model integrating deep learning and traditional methods to improve fault classification and localization in large-scale power systems. It showed robustness under varied fault conditions.
- **[10]**: Proposed a hybrid approach using both DNN and fuzzy logic for fault detection and classification. The model demonstrated significant improvements in terms of accuracy and precision in fault localization.
- **[15]**: Compared various fault classification methods, including ANN, decision trees, and logistic regression, under different conditions such as noisy data and reduced dimensionality. The study found that neural networks performed better in generalizing across different fault conditions, even in noisy environments.

Performance Metrics:

- **Accuracy**: Hybrid models showed improved accuracy in fault detection and classification compared to standalone models.
- **Robustness**: These models were highly effective in handling noisy data and variations in fault impedance and location.
- **Performance Under Distributed Generation**: The hybrid models maintained high performance even with the presence of distributed generation in the system.

4. Key AI/ML Techniques for Fault Diagnosis

The application of Artificial Intelligence and Machine Learning (AI/ML) in power system fault diagnosis has gained substantial traction over the past decade. Various models such as Artificial Neural Networks (ANNs), Support Vector Machines (SVMs), Decision Trees, and more recently, Deep Learning architectures like Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), have been deployed for classifying and localizing faults in complex grid structures. Each technique exhibits unique strengths and trade-offs in terms of accuracy, interpretability, and computational efficiency. To provide a clear comparison, **Figure 1** presents a visual summary of the most prominent AI/ML techniques, highlighting their suitability, operational features, and typical fault types addressed. This diagram serves

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as a reference point for understanding the role each method plays in real-time fault diagnosis and decision support in modern power systems.
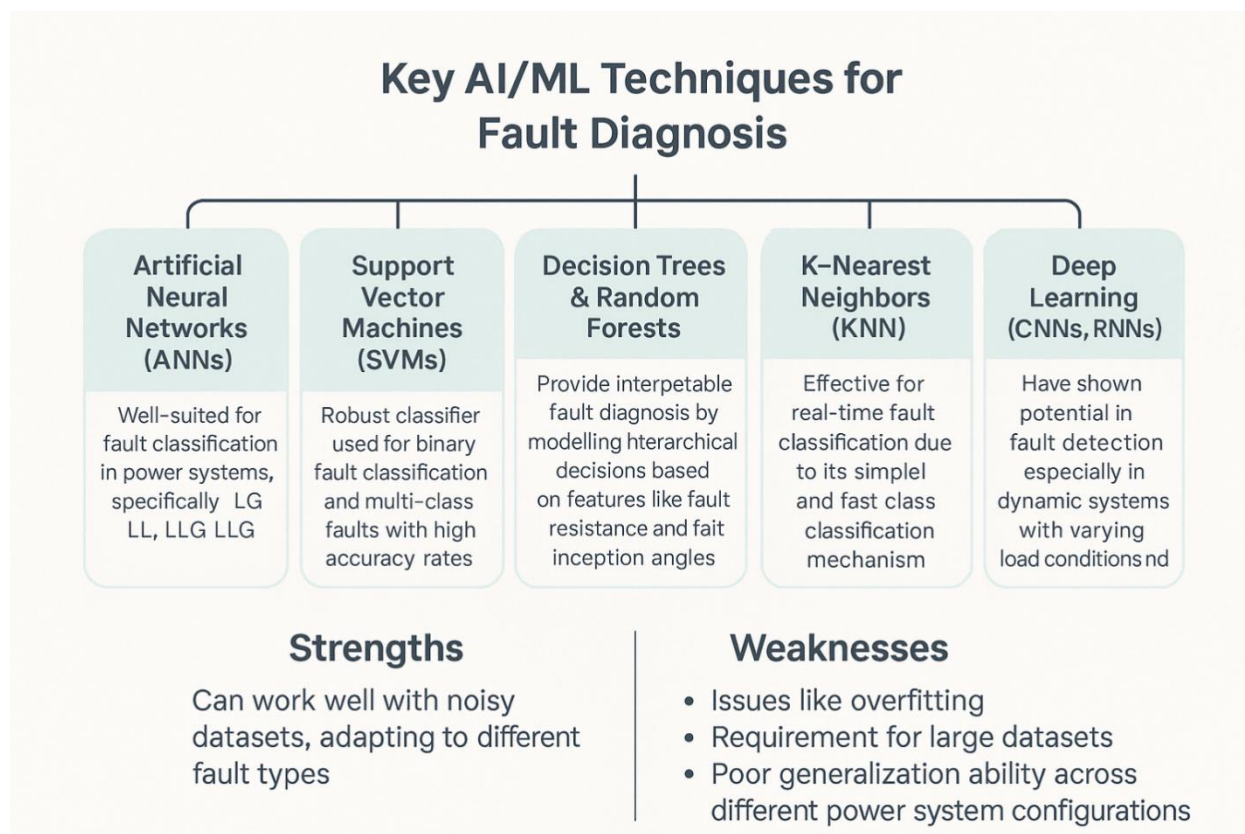

Figure 1: Comparative Overview of Key AI/ML Techniques Used in Power System Fault Diagnosis

5. Analysis & Discussion

The performance of AI/ML models in power system fault diagnosis is influenced by multiple factors including model architecture, training dataset, and system variability. This section provides a comparative assessment of the techniques discussed, examining their practical strengths and weaknesses in the context of electrical fault detection.

Performance Comparison of AI/ML Models

- **ANNs** are widely used due to their ability to model nonlinear relationships and handle multi-class classification. However, they require large training datasets and are prone to overfitting if not properly regularized.

- **SVMs** offer high classification accuracy even in the presence of noise and perform well with limited datasets, though their performance can degrade with increased fault classes and complex system dynamics.
- **Decision Trees and Random Forests** are valued for their interpretability and speed but can suffer from reduced accuracy with highly correlated features or imbalanced datasets.
- **KNN**, while simple and effective for real-time applications, may struggle with large datasets due to computational overhead and sensitivity to irrelevant features.
- **Deep Learning models**, such as CNNs and RNNs, have demonstrated superior accuracy for dynamic and large-scale systems but require intensive computational resources and extensive labeled data for training.

Importance of Training Dataset Quality and Feature Selection

Model performance is directly influenced by the quality, size, and diversity of the training dataset. Features like current magnitude, voltage phase angle, zero-sequence components, and harmonics significantly impact classification outcomes. Improper feature selection can lead to misclassification, particularly in closely related fault types.

Impact of Fault Resistance, Inception Angle, and Noise

External parameters such as **fault resistance** and **inception angle** introduce nonlinearities in system signals, making accurate fault classification more challenging. Models that fail to generalize these variables tend to misclassify faults or exhibit degraded performance. Additionally, real-world measurements often contain **noise** from CTs, PTs, or communication systems. Techniques such as data augmentation, denoising filters, or robust loss functions are employed to mitigate these effects.

Generalization Across System Topologies

The ability of AI/ML models to generalize across different power system configurations (e.g., IEEE 13-bus, 3-bus, or 4-bus systems) is limited. A model trained on a specific topology may not perform well on another due to differences in line parameters, loading conditions, or protection schemes. Transfer learning and domain adaptation are being explored to address this issue, though success remains limited in the literature.

Real-Time Applicability and Scalability

While many models show high accuracy in simulation environments, **real-time deployment** remains a challenge. Deep learning and ensemble models, despite their accuracy, often require hardware accelerators (like GPUs or TPUs) for real-time inference. Moreover, **scalability** across substations or integrated smart grids demands adaptive models that can learn continuously from streaming data, which current batch-trained models do not support efficiently.

Identified Gaps in Current Research

Despite significant advancements, several gaps persist:

- **Multi-fault classification** and **simultaneous fault location** are underexplored.
- **Hybrid models** that combine the interpretability of rule-based systems with the adaptability of ML are still in early research stages.
- **Cross-validation across different datasets and topologies** is rarely conducted, reducing confidence in model generalization.
- There is a **lack of open-source standardized datasets** for benchmarking, leading to inconsistent performance reporting across studies.

6. Challenges and Future Directions

While AI and ML techniques have demonstrated promising results in power system fault diagnosis, several technical, practical, and research-level challenges remain. This section outlines key limitations and emerging directions that can shape the future of AI-driven fault protection systems.

Interpretability of AI-Based Models

One of the fundamental challenges in adopting AI models—especially deep learning—in critical infrastructure is **lack of interpretability**. Utilities and grid operators often prefer models that are transparent and explainable. Complex black-box architectures like CNNs or LSTMs, although accurate, do not provide insight into the decision-making process. Future work must focus on **explainable AI (XAI)** approaches that enable fault classification decisions to be traced back to input features or system behavior.

Standardized Datasets for Benchmarking

There is a significant **absence of standardized and publicly available datasets** in this domain. Most studies use custom datasets generated through MATLAB/Simulink or PSCAD simulations, making cross-comparison difficult. Establishing **open-source repositories** with diverse fault scenarios, multiple system topologies, and realistic noise conditions is crucial for fair benchmarking and reproducibility of results.

Integration of Renewables and Microgrids

Modern grids are rapidly evolving with the increasing penetration of **renewable energy sources** (RES) such as solar and wind, along with the emergence of **microgrids**. These systems introduce new fault dynamics, variable generation profiles, and bidirectional power flow, complicating traditional fault detection. AI models must adapt to these new patterns by learning from real-time and stochastic behavior of RES and distributed energy resources (DERs).

Federated Learning and Edge Computing

To overcome issues related to data privacy, communication latency, and centralized processing bottlenecks, **federated learning** and **edge computing** offer promising alternatives. Federated learning allows models to be trained across distributed devices (e.g.,

substations or smart meters) without transferring raw data, preserving privacy. Meanwhile, **edge AI models** can make real-time fault predictions locally, reducing dependence on cloud resources.

Adaptive and Real-Time Learning Models

Traditional AI models are typically trained offline with historical data, limiting their ability to adapt to new fault patterns. Future systems should incorporate **online learning** or **continual learning** mechanisms, allowing them to update themselves based on live data. This approach is especially valuable in dynamic environments such as smart grids, where load profiles and network configurations change frequently.

Cybersecurity in AI-Based Protection Systems

The integration of AI into grid protection introduces **new cybersecurity vulnerabilities**. Adversarial attacks, data poisoning, and spoofed sensor signals can mislead AI models, leading to incorrect fault decisions. Building **robust AI systems** with built-in defense mechanisms—such as anomaly detection, secure model updates, and cryptographic verification—is essential to maintain grid stability and safety.

7. Conclusion

This review highlights the transformative role of Artificial Intelligence (AI) and Machine Learning (ML) techniques in enhancing the reliability and responsiveness of fault detection and classification in power systems. The comparative analysis of various approaches—ranging from traditional Artificial Neural Networks (ANNs) to advanced Deep Learning models—demonstrates their ability to outperform conventional methods, especially in complex, noisy, and rapidly changing grid environments.

Through a comprehensive discussion of model performances, it is evident that **no single approach offers a one-size-fits-all solution**. While ANNs and SVMs provide high accuracy in well-defined scenarios, deep architectures like CNNs and RNNs excel in handling dynamic system behavior but often lack interpretability. Feature selection, data quality, and training strategies significantly impact model performance, especially when considering factors such as fault resistance, inception angle, and external noise.

Moreover, **generalization across different systems**—such as IEEE 13-bus or 3-bus configurations—remains a challenge, underlining the importance of scalable and adaptable models. The discussion also revealed ongoing research gaps, such as limited efforts in multi-fault diagnosis and hybrid model integration.

Looking ahead, the future of AI in power system protection lies in the development of **hybrid, real-time, and noise-resilient models** that can adapt to emerging grid architectures like microgrids and renewable-dominated systems. Integrating federated learning, edge intelligence, and cybersecurity will further strengthen the operational trust and resilience of these intelligent protection systems.

In summary, AI/ML-based approaches are not just promising—they are **essential** for modernizing grid protection systems. Continued research efforts focusing on model transparency, data standardization, and practical deployment will pave the way for **smarter, faster, and more secure fault diagnosis frameworks**.

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"HR Analytics as a Tool for Sustainable Employee Engagement and Ethical Leadership"

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Abstract
This research explores the pivotal role of HR analytics in fostering sustainable employee engagement and promoting ethical leadership within modern organizations. By leveraging data-driven insights, this study examines how HR analytics can be utilized to identify key drivers of employee engagement, predict potential attrition, and cultivate a culture of ethical conduct. We investigate the correlation between the application of sophisticated HR analytics tools and the development of leadership practices that prioritize transparency, fairness, and employee well-being. Furthermore, this research addresses the ethical considerations surrounding the use of HR analytics, emphasizing the importance of data privacy and responsible implementation. The findings of this study aim to provide organizations with actionable strategies for enhancing employee engagement and cultivating ethical leadership through the strategic deployment of HR analytics.

Keywords: HR Analytics, Employee Engagement, Ethical Leadership, Sustainable HR Data-Driven Decision Making, Organizational Culture.

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1. Introduction

In today's dynamic and competitive business environment, employee engagement and ethical leadership are critical pillars for organizational success and sustainability. Highly engaged employees are more productive, innovative, and committed, contributing significantly to organizational goals. Similarly, ethical leaders foster trust, transparency, and a positive work environment, which are essential for long-term organizational health and reputation.

The advent of HR analytics, the application of data-driven insights to HR functions, presents a powerful opportunity to move beyond traditional, often subjective, approaches to managing human capital. By leveraging data on various aspects of the employee lifecycle, organizations can gain a deeper understanding of the drivers of engagement and the characteristics of ethical leaders. This review paper aims to explore how HR analytics can serve as a strategic tool to cultivate both sustainable employee engagement and ethical leadership within organizations.

2. Literature of review

Understanding HR Analytics:

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4. Understanding Employee Engagement and Ethical Leadership:Sustainable Employee Engagement:

Employee engagement extends beyond mere job satisfaction; it encompasses employees' emotional connection, commitment, and willingness to go the extra mile for the organization. Sustainable engagement recognizes that this connection must be nurtured over time and considers the holistic well-being of employees, including their physical, mental, and emotional health, as well as their sense of purpose and belonging. It emphasizes creating a work environment where employees feel valued, supported, and have opportunities for growth and development.

5. 6. Ethical Leadership:

Ethical leadership is characterized by leaders who demonstrate integrity, fairness, honesty, and respect in their interactions and decision-making. They prioritize the well-being of their stakeholders, including employees, customers, and the wider community. Ethical leaders create a culture of trust and accountability, where ethical behavior is expected and rewarded, and unethical conduct is addressed appropriately.

The Role of HR Analytics in Enhancing Employee Engagement:

HR analytics provides valuable insights into the factors that influence employee engagement. By collecting and analyzing data across various HR functions, organizations can:

- **Identify Engagement Drivers:**

Analyze data from employee surveys, performance reviews, exit interviews, and social media sentiment to pinpoint the key factors that drive or hinder engagement within specific teams or

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across the organization. This allows for targeted interventions to address specific issues. Analysis of employee survey data reveals a strong negative correlation between lack of career development opportunities and engagement scores in the R&D department.

- **Predict Engagement Risks:**

Utilize predictive analytics to identify employees who are at risk of disengagement based on patterns in their behavior, performance, or tenure. This enables proactive measures to retain valuable talent. A predictive model based on absenteeism, project completion rates, and participation in voluntary activities shows a 75% accuracy in identifying employees likely to leave within the next six months.

- **Personalize Engagement Strategies:**

Segment employees based on their needs and preferences identified through data analysis and tailor engagement initiatives accordingly. This can include customized learning and development programs, flexible work arrangements, or recognition programs. Data analysis indicates that younger employees prioritize flexible work options, while more tenured employees value opportunities for mentorship and leadership development.

- **Measure the Impact of Engagement Initiatives:**

Track key metrics such as retention rates, productivity, innovation output, and customer satisfaction to evaluate the effectiveness of engagement programs and make data-driven adjustment. Following the implementation of a new mentorship program, the retention rate among junior employees increased by 15% over the subsequent year.

- **Improve the Employee Experience:**

Analyze data on employee interactions with HR processes and systems to identify pain points and optimize the overall employee experience, leading to increased satisfaction and engagement. Analysis of feedback on the onboarding process reveals that new hires who receive structured mentorship in their first month report significantly higher levels of initial engagement.

The Role of HR Analytics in Fostering Ethical Leadership:

HR analytics can also play a crucial role in promoting and sustaining ethical leadership within organizations:

- **Identify Traits of Ethical Leaders:**

Analyze data from 360-degree feedback, performance reviews, and employee surveys to identify the behaviors and characteristics that are consistently associated with ethical leadership within the organization. This can inform leadership development programs and talent acquisition strategies. Analysis of 360-degree feedback consistently highlights leaders

who actively solicit and act upon team feedback as being perceived as more ethical by their direct reports.

- **Monitor Ethical Conduct:**

Analyze data related to grievances, ethics hotline reports, and disciplinary actions to identify potential ethical risks and patterns of unethical behavior. This allows for early intervention and the development of preventative measures. A spike in anonymous reports related to unfair workload distribution in a specific department triggers an investigation and subsequent policy adjustments.

- **Evaluate the Impact of Leadership Development Programs:**

Track changes in employee perceptions of leadership ethics and organizational culture following the implementation of ethics-focused leadership training. Post-training surveys show a 10% increase in employees agreeing with the statement "My manager acts with fairness and integrity."

- **Promote Transparency and Accountability:**

Utilize data to track key performance indicators related to ethical conduct and make this information accessible (where appropriate and anonymized) to foster a culture of transparency and accountability. Publicly reporting on the number and types of ethics violations (while maintaining anonymity) encourages greater awareness and adherence to ethical standards.

- **Ensure Fair and Unbiased Decision-Making:**
Leverage analytics in areas like performance management, promotion decisions, and compensation to identify and mitigate potential biases, ensuring fairer and more ethical outcomes for employees. Analysis of promotion data reveals a statistically significant disparity in promotion rates between different demographic groups, prompting a review of the promotion process for potential bias.

Challenges and Ethical Considerations:

While HR analytics offers significant potential, its implementation also presents several challenges and ethical considerations that must be carefully addressed:

- **Data Privacy and Security:**

Handling sensitive employee data requires robust security measures and adherence to privacy regulations to prevent unauthorized access or misuse.

- **Bias in Algorithms and Data:**

Algorithms used in HR analytics can perpetuate existing biases present in the data, leading to unfair or discriminatory outcomes. Careful attention must be paid to data quality and algorithm design.

- **Transparency and Explainability:**

The "black box" nature of some advanced analytics techniques can make it difficult to understand how decisions are being made, raising concerns about fairness and accountability.

- **Potential for Surveillance and Micromanagement:**

The use of data to track employee behavior can be perceived as intrusive and can erode trust if not implemented transparently and ethically.

- **Over-reliance on Data:**

It is crucial to remember that data provides insights but should not replace human judgment and empathy in HR decision-making. Qualitative data and human intuition remain essential.

- **Defining and Measuring Ethical Constructs:**

Quantifying inherently qualitative concepts like "ethical leadership" can be challenging and requires careful consideration of appropriate metrics and methodologies.

6. Conclusion:

HR analytics stands as a powerful tool with the potential to significantly enhance both sustainable employee engagement and ethical leadership within organizations. By leveraging data-driven insights, organizations can gain a deeper understanding of the drivers of engagement, identify and mitigate ethical risks, personalize employee experiences, and foster a culture of trust and accountability.

However, the successful and ethical implementation of HR analytics requires careful consideration of data privacy, potential biases, transparency, and the importance of human judgment. Organizations must prioritize ethical data handling practices, invest in developing analytical capabilities, and ensure that HR analytics initiatives are aligned with their core values and strategic objectives.

Ultimately, when applied thoughtfully and ethically, HR analytics can contribute to creating more engaged, productive, and ethically sound workplaces, fostering long-term organizational success and a more human-centric approach to managing human capital. This review underscores the critical need for organizations to embrace the potential of HR analytics while remaining vigilant about the ethical implications and ensuring that data serves to empower and support employees and promote responsible leadership.

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"Sustainable Talent Management: The Role of Training and Development in Employee Retention in Private Universities"

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Abstract

In the increasingly competitive and dynamic landscape of higher education in India, private universities are under growing pressure to attract, nurture, and retain high-quality faculty and staff. These institutions, which play a crucial role in expanding educational opportunities, often struggle with high employee turnover, which negatively affects academic quality, student satisfaction, and institutional continuity. In this context, sustainable talent management (STM) has emerged as a strategic imperative that emphasizes not only recruitment and retention but also long-term employee development aligned with institutional sustainability goals.

This research investigates the critical role of training and development (T&D) as a cornerstone of STM in enhancing employee retention within private universities. The study adopts a mixed-methods approach, combining quantitative surveys and qualitative interviews with academic and administrative staff across a diverse selection of private institutions in India. It aims to uncover prevailing trends, existing gaps, and effective practices in the design and implementation of T&D programs.

The findings reveal a strong and statistically significant correlation between well-structured, continuous T&D initiatives and key indicators such as employee satisfaction, organizational commitment, and retention rates. Institutions that invest strategically in faculty and staff development are more likely to foster a culture of engagement, loyalty, and professional growth. Furthermore, the study highlights a significant gap in the integration of sustainability principles within HR and talent development strategies. While some universities are beginning to align their T&D initiatives with broader goals of sustainable development, this practice is far from widespread.

By situating T&D within the framework of sustainable human resource management (SHRM), this study contributes to a deeper understanding of how Indian private universities can build resilient, future-ready institutions. The research offers actionable insights for policymakers, university administrators, and HR professionals seeking to enhance

Keywords: Sustainable Talent Management, Training and Development, Employee Retention, Private Universities, Human Resource Management, India, Higher Educationinstitutional effectiveness through sustainable talent practices.

Introduction

The landscape of higher education in India has undergone a transformative expansion over the past few decades, driven in large part by the proliferation of private universities. These institutions have significantly contributed to improving access to tertiary education, particularly in underserved and rapidly urbanizing regions. However, alongside this growth, private universities face pressing challenges related to maintaining academic quality, institutional credibility, and long-term sustainability. One of the most persistent and impactful issues is high employee turnover—especially among faculty and administrative

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staff—which undermines the continuity of institutional knowledge, adversely affects student learning experiences, and escalates recruitment and onboarding costs.

In response to these challenges, the concept of Sustainable Talent Management (STM) has gained traction as a forward-looking strategic framework. STM emphasizes the long-term development, engagement, and retention of human capital while aligning with broader organizational goals and values, including social and environmental responsibility. Rather than viewing talent acquisition and retention as isolated HR functions, STM advocates for an integrated approach that embeds employee development into the fabric of institutional planning.

A key pillar of STM is Training and Development (T&D), which encompasses formal and informal learning initiatives designed to improve employee skills, competencies, and professional outlook. T&D programs are instrumental not only in enhancing individual performance and career progression but also in cultivating a culture of continuous improvement, innovation, and institutional loyalty. In academic settings, these initiatives often include pedagogical training, research capacity building, leadership development, and digital literacy programs.

Despite growing recognition of the value of T&D in organizational success, there remains a noticeable gap in empirical research—particularly in the context of private universities in India. Much of the existing literature has either focused on public sector institutions or generalized human resource management practices without deeply exploring the intersection of T&D, employee retention, and sustainability. This research aims to address that gap by examining how structured and strategic T&D initiatives contribute to sustainable talent management and employee retention within private Indian universities. By doing so, the study seeks to offer actionable insights that can help institutions not only attract and retain skilled professionals but also build resilient, future-ready organizations in the evolving higher education landscape.

Literature Review

Sustainable Talent Management (STM)

Sustainable Talent Management (STM) is an emerging paradigm within human resource

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management that emphasizes the alignment of talent strategies with the long-term goals of organizational sustainability. Rather than focusing solely on immediate staffing needs, STM takes a holistic view of human capital by incorporating economic viability, social equity, and environmental consciousness into HR practices. According to Ehnert et al. (2016), STM requires balancing these three dimensions to foster an organizational culture that supports innovation, adaptability, and resilience. In the context of higher education, STM becomes particularly significant, as universities operate in knowledge-intensive environments that demand continuous learning and intellectual engagement. Sustainable practices in talent management—such as ethical recruitment, inclusive development programs, and long-term career planning—are crucial for institutions seeking to thrive in the face of evolving academic demands and societal expectations.

Training and Development (T&D)

Training and Development (T&D) represent a core function of effective human resource management, aimed at enhancing the capabilities of employees through structured learning and experiential activities. T&D initiatives are designed to bridge skill gaps, boost morale, and align individual performance with organizational goals. As highlighted by Noe (2017), comprehensive T&D programs have a direct influence on employee engagement, job satisfaction, and organizational performance. In academic institutions, T&D can include a range of activities such as pedagogical workshops, research mentorship programs, digital literacy sessions, administrative leadership training, and interdisciplinary collaboration opportunities. When strategically implemented, these initiatives not only improve faculty competence but also instill a sense of purpose and belonging, which are critical for long-term retention. Furthermore, regular professional development can enable faculty and staff to keep pace with global trends in education, thus enhancing the institution's competitive edge.

Employee Retention in Academia

Retaining talented employees, particularly in academic settings, is a multifaceted challenge influenced by both intrinsic and extrinsic factors. Employee retention goes beyond compensation; it includes aspects such as a supportive work environment, recognition, work-life balance, academic freedom, and opportunities for career progression. Research by Johnsrud and Rosser (2002) emphasizes the role of professional development in mitigating faculty turnover, suggesting that when academic staff perceive genuine opportunities for

growth and learning, they are more likely to remain committed to their institutions. In universities, where intellectual and emotional investment in work is high, providing a stimulating and nurturing environment becomes key to sustaining faculty engagement. High turnover, on the other hand, leads to discontinuity in academic programs, increased administrative burdens, and a weakening of institutional culture.

The Indian Context

In India, the rapid expansion of private universities has created both opportunities and challenges in the higher education ecosystem. While these institutions are vital for addressing the demand-supply gap in tertiary education, they often operate under constraints such as limited funding, regulatory complexities, and high competition for talent. Many private universities attempt to counter these limitations through investments in training and development programs. However, as noted by Agarwal (2009), these efforts frequently lack a strategic orientation toward sustainable talent management. The absence of clear policies, insufficient funding for long-term staff development, and a transactional approach to HR practices hinder the full potential of T&D initiatives. Moreover, faculty members in private universities often face job insecurity, limited academic freedom, and heavy workloads, further exacerbating attrition rates. Addressing these issues through a sustainable, well-integrated talent management framework is essential for improving retention and fostering academic excellence.

Research Gap

Although a substantial body of international literature has addressed the concepts of Sustainable Talent Management (STM) and Training and Development (T&D) independently, research examining the intersection of these two domains—particularly within the context of private higher education institutions in India—is notably limited. Much of the existing research on STM has been concentrated in corporate settings or in public sector organizations, with relatively less attention given to how sustainability principles are applied in academic talent management. Similarly, while numerous studies highlight the benefits of T&D on employee performance and engagement, there is a lack of focused investigation into how these developmental efforts translate into long-term employee retention in Indian private universities.

The Indian higher education sector, especially its private segment, operates under unique structural and organizational constraints, including resource limitations, high competition for skilled faculty, and evolving regulatory frameworks. These factors create a context that differs significantly from that of Western universities or even public institutions within India. Consequently, findings from international or public sector research may not be directly applicable or sufficient for understanding the challenges and opportunities faced by private universities in India.

Furthermore, there is a limited understanding of how these institutions interpret and operationalize sustainability within their human resource practices. While sustainability is often discussed in broad institutional terms—focusing on environmental or financial aspects—its application to employee development, engagement, and retention remains under-researched. There is a pressing need to explore whether and how sustainability principles are being embedded into talent development strategies, and what impact such alignment may have on faculty and staff retention.

This gap in the literature underscores the need for empirical studies that specifically investigate the role of structured, strategic, and sustainable T&D initiatives in shaping retention outcomes within private Indian universities. Addressing this gap can provide valuable insights for policymakers, academic leaders, and HR professionals aiming to strengthen institutional sustainability through people-centric strategies.

Research Questions

1. How are T&D programs structured and implemented in private universities in India?
2. What is the impact of T&D on employee retention in these institutions?
3. How do private universities integrate sustainability into their talent management strategies?

5. Research Objectives

1. To analyze the structure and effectiveness of T&D programs in private Indian universities.
2. To assess the relationship between T&D initiatives and employee retention.

3. To examine the integration of sustainable practices in HR management.

Research Methodology

Research   Design

This study employed a mixed-methods research design to comprehensively investigate the role of Training and Development (T&D) in Sustainable Talent Management (STM) and its impact on employee retention in private universities in India. The mixed-methods approach integrates both quantitative and qualitative techniques, enabling the researcher to capture numerical data for generalizability while also exploring in-depth perspectives for nuanced understanding. The quantitative component involved the use of structured questionnaires to collect data on employee perceptions, satisfaction levels, and retention intentions. Complementing this, the qualitative component utilized semi-structured interviews to delve deeper into the lived experiences of faculty and administrative staff, allowing for the identification of themes related to sustainability, organizational culture, and talent development practices.

Sampling

The target population for this study consisted of faculty members and administrative personnel employed at ten private universities situated in diverse geographical regions across India. To ensure comprehensive and equitable representation, a stratified random sampling technique was adopted. This method allowed for the categorization of participants based on variables such as academic discipline, professional role, years of experience, and organizational hierarchy. By applying stratified random sampling, the study minimized selection bias and ensured that the views of both teaching and non-teaching staff were adequately represented, thereby enhancing the validity and reliability of the findings.

Data Collection Tools

To gather data, the study utilized two primary instruments:

- **Questionnaire**: A structured questionnaire was developed comprising both closed-ended and Likert-scale items. The questions were designed to assess employees' perceptions regarding the effectiveness of T&D programs, their levels of job satisfaction, perceived organizational support, and intentions to remain with their

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current employer. The questionnaire also included demographic items to allow for sub-group analyses.

- **Interview Guide**: A semi-structured interview guide was formulated to facilitate qualitative data collection. The guide included open-ended questions that explored participants' experiences with training programs, their views on how T&D contributes to personal and professional growth, their understanding of sustainability in the workplace, and their perceptions of the organization's HR strategies. The semi-structured nature of the interviews provided flexibility for probing deeper into relevant issues while maintaining consistency across interviews.

Data Analysis

Data analysis was conducted through a dual-method approach aligned with the mixed-methods design.

- **Quantitative Analysis**: The numerical data collected from the questionnaires were analyzed using Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics were computed to summarize participant responses, followed by correlation analysis to examine relationships between key variables such as T&D effectiveness, job satisfaction, and retention intentions. Additionally, regression analysis was conducted to explore the predictive value of T&D on employee retention outcomes.
- **Qualitative Analysis**: The qualitative data from the interviews were transcribed and analyzed using NVivo software. A thematic analysis approach was adopted, involving the coding of data into emerging themes and subthemes. This process facilitated the identification of patterns related to the integration of sustainability principles into HR practices, the perceived value of training programs, and factors influencing employee loyalty and engagement.

Findings

Structure and Implementation of T&D

The analysis revealed that most of the surveyed private universities conducted regular training and development (T&D) programs as part of their professional development efforts. These programs typically focused on core academic competencies such as pedagogical

techniques, the use of digital instructional tools, research methodologies, and soft skills development, including communication and teamwork. Despite the presence of these initiatives, it was evident that only a minority of institutions had formalized T&D strategies supported by dedicated budgets or long-term planning. In many cases, training programs were implemented on an ad-hoc basis, often depending on immediate institutional needs or available funding. There was also significant variation in the frequency, depth, and quality of these programs, with some institutions offering periodic workshops while others lacked consistency in delivery. Furthermore, few universities conducted needs assessments or evaluations to tailor training to specific employee requirements, which often limited the overall effectiveness and relevance of these initiatives.

Impact on Retention

Quantitative data analysis demonstrated a strong positive correlation ($r = 0.68$) between employees' participation in T&D programs and their intention to remain with their current institution. Respondents who reported higher levels of satisfaction with the quality, frequency, and relevance of training programs were significantly less likely to express interest in leaving their roles. Interviews further supported this finding, revealing that staff perceived meaningful T&D opportunities as indicators of organizational support and long-term investment in their careers. Employees noted that well-structured training enhanced their sense of professional competence, job satisfaction, and loyalty to the institution. Conversely, the absence of developmental opportunities contributed to feelings of stagnation and demotivation, which were identified as key drivers of turnover intentions. This suggests that T&D initiatives not only improve skills but also serve as critical tools for enhancing employee engagement and institutional retention.

Sustainability in HR Practices

The integration of sustainability principles within human resource (HR) practices was found to be limited across the surveyed institutions. Only a small number of universities reported having a strategic framework that explicitly linked HR policies with broader sustainability goals, such as long-term workforce planning, employee well-being, or environmental responsibility. In institutions where such alignment existed, participants described a more holistic and inclusive work environment, characterized by transparent career progression pathways, participative decision-making, and attention to work-life balance. These

universities reported higher levels of organizational commitment, motivation, and employee engagement. Moreover, sustainability-oriented HR practices appeared to promote a culture of continuous improvement and mutual accountability, which further reinforced retention by creating a stable and supportive professional ecosystem. The findings indicate that integrating sustainability into talent management strategies can yield not only ecological or social benefits but also tangible improvements in employee satisfaction and organizational resilience.

Conclusion

This research set out to examine the critical role of Training and Development (T&D) in promoting Sustainable Talent Management (STM) and enhancing employee retention in private universities across India. In the face of increasing competition and evolving expectations in the higher education sector, private institutions are under pressure to not only attract top talent but also retain skilled faculty and administrative staff who contribute to long-term institutional success. The findings of this study underscore the strategic importance of T&D as a foundational element of STM.

The evidence gathered through surveys and interviews suggests that well-structured, consistent, and goal-oriented T&D programs significantly influence employees' sense of professional fulfillment, job satisfaction, and commitment to their organizations. Institutions that prioritize developmental opportunities for their staff are more likely to foster an environment of trust, engagement, and long-term loyalty. Furthermore, the study confirms a robust positive correlation between participation in effective training initiatives and an employee's intention to remain with their institution, highlighting T&D as a practical tool for reducing turnover rates.

However, the research also reveals several challenges that impede the full potential of T&D in supporting STM. These include a lack of dedicated financial resources, short-term planning, limited customization of training modules, and insufficient evaluation mechanisms. Additionally, the study identifies a gap in the integration of sustainability principles into HR strategies, with only a handful of universities aligning their talent development efforts with broader sustainability objectives such as equity, inclusiveness, and long-term workforce resilience.

To fully leverage the benefits of T&D in fostering STM, private universities in India must adopt a more strategic and sustainable approach. This involves aligning training programs with institutional goals, ensuring equitable access to development opportunities, and embedding sustainability into the core of HR practices. Doing so not only enhances employee retention but also contributes to the creation of a resilient, future-ready academic workforce.

In summary, T&D is not merely a functional HR activity—it is a strategic lever for sustainable institutional development. By investing in continuous learning and aligning such investments with sustainability goals, private universities can position themselves as forward-thinking employers capable of navigating the dynamic landscape of higher education in India.

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IMPACT OF SUSTAINABLE BUSINESS PRACTICES ON EMPLOYEE ENGAGEMENT AND PRODUCTIVITY

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Abstract

The industrialised world, increasingly aware of "inconvenient truths" about global warming and sustainability, is turning its focus to viable solutions, such as eco-efficiency, sustainable development and corporate social responsibility. Corporate sustainability has come a long way. Since the inception of the contemporary environmental movement and the implementation of environmental rules in the 1970s, it has evolved into a strategic concern driven by market forces. Today, more than 90% of CEOs believe that sustainability is critical to their company's success. Companies develop sustainability strategies, market sustainable products and services, create positions such as chief sustainability officer, and publish sustainability reports for consumers, investors, activists, and the general public. The report also highlights the long-term benefits of sustainable business practices, which include not only environmental benefits but also the creation of a motivated, productive staff. This study offers useful information for corporate leaders looking to improve organisational performance through sustainability-driven employee engagement initiatives. It is clear that the corporate world is undergoing a shift, and it is not only firms that have changed as a result of the emergence of sustainability; personnel have also transformed for the better. A sustainable culture can impact employee behaviour.

Keywords: Corporate Sustainability, Eco-efficiency, Sustainable Development, Corporate Social Responsibility (CSR), Environmental Challenges, Organizational Culture, Sustainability Strategies

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1. Introduction:

The dynamics of our typical work environments are changing dramatically. The focus is now on maintaining employee engagement while also ensuring sustainability. Both of these factors are necessary for a business to succeed. With increased awareness of environmental and social issues, people are looking for jobs with firms that share their values and help to develop a more sustainable future. This scenario presents an opportunity for businesses to develop a strategy of engaging people that not only increases productivity but also prioritises sustainability as a key value.

Ensuring employees' happiness and productivity is insufficient for long-term engagement. It entails assembling a team committed to making a major difference, both within the organisation and in the greater community. Businesses that include sustainable techniques

into their relationships with employees can build a resilient culture capable of weathering future challenges.

In recent years, sustainability has evolved as an important part of corporate strategy, with organisations increasingly embracing strategies that prioritise environmental and social responsibility while also aligning with long-term profitability. Sustainable company strategies, such as decreasing carbon footprints, adopting renewable energy, encouraging ethical sourcing, and assuring corporate social responsibility, have become critical components of modern corporate culture. As firms face the challenges of incorporating sustainability into their operations, one crucial question emerges: how do these practices affect employee engagement and productivity?

Employee engagement and productivity are critical to the success of any organisation, since they influence both individual and collective performance. Engaged employees are more devoted, motivated, and productive, which has a direct influence on the bottom line. Sustainable business practices, which frequently foster a feeling of purpose and shared values inside an organisation, have been proposed to boost employee satisfaction and commitment. The relationship between sustainability and employee outcomes is complex, but overwhelming data suggests that organisations that embrace sustainability are more likely to generate a healthy work environment, resulting in increased employee involvement and productivity.

This research paper investigates the relationship between sustainable business practices and employee engagement, specifically how organisations that include sustainability into their operations affect workforce behaviour and performance. This study intends to provide significant insights into how sustainability may be a catalyst for developing a more engaged and productive workforce, eventually driving organisational success.

2. Hypothesis

Companies that implement sustainable business practices experience higher levels of employee engagement compared to those that do not prioritize sustainability. Sustainability-driven organizational culture positively influences employee productivity, with employees in sustainable workplaces demonstrating higher performance levels.

Object

- Investigate how sustainability-driven business practices (such as eco-efficiency, corporate social responsibility, and sustainable development) affect employee engagement in organisations.
- Investigate the impact of a sustainability-focused organisational culture on employee productivity, determining whether employees in such circumstances are more motivated, committed, and productive.

3. Literature Review

The concept of sustainability in business has changed dramatically over the last few decades, with a greater emphasis on its environmental, social, and economic implications. Corporate sustainability, which encompasses policies that prevent environmental harm and promote social responsibility, has become an integral component of modern company operations. As sustainability has become a top business goal, experts and practitioners have focused on how it may affect employee engagement, satisfaction, and productivity.

4. Sustainable Development and Employee Engagement

Employee engagement refers to the level of commitment, motivation, and enthusiasm that employees have toward their work and the organization. Engaged employees are known to be more productive, loyal, and aligned with the organization's goals. One of the key factors influencing engagement is the organizational culture, and sustainability has been identified as a central component of this culture.

Research by **Bakker and Demerouti (2008)** suggests that employee engagement is influenced by various factors, including organizational practices that contribute to a meaningful work environment. A sense of purpose, which can often be fostered through sustainability initiatives, has been shown to enhance employee motivation. Sustainability practices, such as reducing carbon footprints, promoting ethical practices, and supporting community development, provide employees with a sense of contributing to a larger cause, which strengthens their engagement.

A study by **Guerci, et al. (2016)** found that companies that incorporate sustainability into their core business strategies tend to have higher levels of employee engagement. The study concluded that when employees perceive their organization as committed to positive social and environmental impact, they feel more aligned with the company's values and mission. Moreover, **Eccles et al. (2014)** argue that a strong sustainability ethos can create an organizational environment where employees feel their work contributes not only to the company's success but also to broader societal goals, enhancing overall engagement.

5. Sustainability and Employee Engagement:

An Indian Perspective Sustainability and employee engagement are gaining importance in India, with businesses beginning to incorporate corporate social responsibility (CSR) and sustainable practices into their organisational culture. According to Khandelwal and Kumar (2013), Indian businesses are increasingly integrating their organisational goals with sustainability strategies, particularly those that address environmental, social, and economic issues relevant to India's specific challenges. They suggest that Indian companies who invest in sustainability projects, notably in rural development and environmental protection,

experience better levels of employee pride and satisfaction, which leads to increased engagement.

Similarly, Chaudhary (2018) emphasises that in Indian organisations, employees are driven not only by financial incentives, but also by the social significance of their work. Indian businesses that prioritise social responsibility, such as improving education, health, or sanitation, have a better emotional bond with their employees. This sense of "purpose" resonates strongly with employees who see their roles as meaningful within the larger context of societal good, which reinforces their engagement.

6. Sustainable Development and Employee Productivity

Employee productivity is closely tied to engagement levels, with engaged employees generally exhibiting higher productivity. Given the positive correlation between engagement and productivity, it follows that businesses focusing on sustainability could see improvements in both metrics. **Almeida et al. (2017)** explored the connection between sustainable practices and productivity, concluding that companies with robust sustainability strategies often report higher employee productivity. The authors suggest that sustainability initiatives, such as flexible working arrangements, wellness programs, and eco-friendly workplace practices, contribute to employees' well-being, which in turn enhances their efficiency and output.

A related aspect of sustainability is the work environment, which encompasses the physical and psychological conditions that impact employee performance. The incorporation of green building practices, the use of renewable energy, and the promotion of wellness programs not only align with environmental goals but also create a healthier and more conducive work environment. Research by **Kramer (2014)** supports this, finding that workplaces that prioritize sustainability, including green architecture and eco-conscious office designs, improve employee morale and result in higher levels of productivity. Furthermore, **Bain & Company (2019)** reported that employees in sustainable workplaces tend to show higher job satisfaction, which is directly linked to improved performance and greater productivity. **The Role of Corporate Social Responsibility (CSR)**

Sustainability is typically linked to Corporate Social Responsibility (CSR) programs, which can have a substantial impact on employee engagement. Carroll (1999) describes CSR as a company's attempts to be economically, socially, and environmentally responsible. When organisations engage in CSR initiatives, employees are happy to work for a firm that makes a positive contribution to society, which can boost their sense of engagement and purpose. As a result, more engaged individuals are more likely to be efficient and productive at work.

According to Maignan and Ferrell (2004), CSR efforts that are consistent with employees' personal beliefs can develop a strong sense of loyalty and connection to the organisation. CSR activities like community engagement, charitable donations, and environmental conservation have been found to boost employee morale and retention. Furthermore,

Bhattacharya et al. (2008) discovered that employees who believe their organisations are socially responsible have higher job satisfaction and are more likely to engage in organisational citizenship behaviours such as going above and beyond their job responsibilities.

7. Sustainability and Employee Productivity in Indian Companies

Indian companies are increasingly recognising the link between sustainability and staff productivity. Sharma and Joshi (2014) performed a study of Indian manufacturing organisations and discovered that those who implemented sustainability-focused initiatives, such as eco-friendly work spaces, flexible working hours, and wellness programs, had higher staff productivity. This is consistent with worldwide research but provides new insights into how these practices are culturally adapted in India. Employee productivity in India is also driven by a feeling of social duty, with workers seeing their efforts as connected with larger societal and environmental aims.

8. Challenges in Integrating Sustainability with Employee Engagement

While the potential benefits of sustainable practices on employee engagement and productivity are clear, there are still barriers to properly integrating sustainability into organisational culture. One significant challenge is a lack of clear communication and commitment from high management. According to Edwards and Dweck (2019), organisations must ensure that sustainability initiatives are thoroughly integrated in the company's operations and ethos rather than mere token gestures. Employees may regard the company's sustainability goals as shallow if they are not communicated clearly, limiting involvement.

Another difficulty is the disparity in perceptions of sustainability across industry and demographic groups. According to Kolk and van Tulder (2002), employees' perceptions of sustainability programs vary depending on their role, region, and personal values. As a result, organisations must adjust their sustainability initiatives to their employees' different requirements and expectations in order to maximise engagement and productivity.

9. Challenges of Integrating Sustainability with Employee Engagement in India.

Despite the positive impact of sustainability on employee engagement, Indian organisations confront a number of hurdles in incorporating sustainability into their corporate culture. One of the key concerns is the lack of awareness and education regarding sustainability at the grassroots level. According to Kumari and Yadav (2015), many Indian organisations,

particularly small and medium-sized firms (SMEs), lack awareness on the long-term benefits of sustainable policies for the environment and employee engagement.

10. Conclusion

Integrating sustainability into company strategy has resulted in increased employee engagement and productivity in both global and Indian contexts. Legal frameworks and rising public expectations are driving Indian enterprises to prioritise CSR and sustainability in their business plans. Employees in India are more likely to engage and contribute productively when they believe their organisation is committed to social welfare, environmental sustainability, and community well-being. However, problems such as a lack of understanding, cultural diversity, and the need for good communication continue to prevent these benefits from being fully realised. Future study should look into how Indian organisations may overcome these constraints and develop more robust, inclusive sustainability efforts that promote deeper engagement and long-term productivity.

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Integrating AI-Powered Decision Support Systems for Patient Engagement: An Enabler of Quality Improvement in Hospital Services

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Abstract

AI-powered decision support systems (DSS) integrated into healthcare might greatly increase patient involvement, support clinical decision-making, and raise the standard of treatment given in hospital environments. By means of review of current literature, case studies, and secondary data sources, this paper investigates the transforming impact of artificial intelligence DSS on patient treatment. The study emphasises how artificial intelligence technologies help to streamline decision-making, improve communication between healthcare practitioners and patients, and enable individualised treatment. By means of an analysis of actual deployments in several hospitals, this research shows the favourable effects of AI DSS on operational efficiency, patient happiness, and clinical results. The study also points up important difficulties with the incorporation of these technologies, including data privacy issues and professional opposition. In the end, this study highlights the possibilities of artificial intelligence-powered DSS to propel patient-centered care and quality enhancement in hospital operations, thereby providing ideas for overcoming obstacles in implementation.

Keywords: AI-powered decision support systems, patient engagement, hospital services, quality improvement, healthcare technology, clinical decision-making, artificial intelligence, patient-centered care, healthcare operations, clinical outcomes.

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Introduction

Improved patient care, lower costs, and better clinical outcomes are just a few of the increasing needs hospitals all around are confronting. Including Artificial Intelligence (AI)-powered Decision Support Systems (DSS) into healthcare procedures is one of the most interesting approaches to handle these issues. These technologies enhance clinical decision-making, analyse patient data using sophisticated algorithms, and offer customised recommendations that enable medical practitioners to make better educateddecisions. By include patients more directly in their care plans, improving communication between patients and healthcare practitioners, and encouraging a cooperative approach to treatment, AI DSS also present the possibility to greatly increase patient participation. With an eye on their effects on patient involvement and quality improvement, this study investigates the advantages and drawbacks of including AI-powered DSS into hospital operations.

Problem Statement

Many still battle with problems including poor patient involvement, delayed clinical decisions, misunderstanding, and inefficiencies in healthcare delivery even if institutions are progressively embracing technology. More individualised, patient-centered care is desperately needed, yet conventional decision-making procedures may lack the tools required to include patients meaningfully or implement best treatment options.

By providing real-time, data-driven insights to patients as well as healthcare providers, AI-powered DSS could help to solve these problems. Still, the whole effect of these technologies on patient involvement and hospital service quality is unknown, and effective adoption is still hampered greatly.

Literature Review

The following studies highlight the role of AI-powered decision support systems in improving patient engagement and hospital service quality.

Bates et al. (2018)provides a general summary of artificial intelligence applications in clinical decision support, highlighting that by giving healthcare professionals real-time, evidence-based recommendations, AI-driven systems are lowering the risk of medical errors and enhancing the accuracy of clinical judgements.

Kelleher et al. (2020)investigates how artificial intelligence models are being included into clinical processes and how they might support doctors in deciding on patient care with greater knowledge. They contend that the speedy processing of enormous volumes of data made possible by artificial intelligence will enable doctors to provide customised treatment catered to particular patient requirements.

Mehta et al. (2019)emphases on the patient involvement element, one can argue that by providing personalised treatment plans, reminders, and interactive platforms improving communication with healthcare practitioners, artificial intelligence can enable individuals to actively manage their health.

Murphy et al. (2021)examined obstacles to AI adoption in healthcare, including worries about patient data privacy, difficulties combining AI tools with current health IT systems, and opposition from healthcare personnel who could worry that AI systems will replace human judgement.

Smith et al. (2022)investigated various case studies showing hospitals using artificial intelligence DSS successfully. By allowing more exact diagnosis and treatment plans, the study revealed that AI-powered solutions produced better clinical outcomes, enhanced operational efficiency, and higher patient satisfaction.

Research Objectives

The primary objectives of this study are:

To investigate how artificial intelligence-powered decision support systems might improve patient involvement in hospital environments.

To assess how artificial intelligence DSS affects hospital service improvement and quality of treatment.

To find difficulties applying artificial intelligence DSS in medical facilities.

To study actual case studies of artificial intelligence DSS integration and evaluate their results

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Research Methodology

Based just on secondary data gathered from case studies, past published studies on AI-powered decision support systems in healthcare, and current literature, this study Academic journal publications, hospital case study evaluations including AI DSS integration into their service delivery models, and reports from healthcare institutions provided the secondary data.

The methodology includes:

Literature Review: To grasp the theoretical framework of artificial intelligence DSS and its influence on patient involvement and quality improvement in healthcare, a thorough assessment of current research publications, books, and scholarly papers was performed.

Case Study Analysis: The results were evaluated in terms of patient engagement, clinical outcomes, operational efficiency, and patient satisfaction using secondary data from published case studies of hospitals that had used artificial intelligence DSS.

The use of secondary data allows for a broader understanding of the effects of AI DSS, drawing from a wide range of real-world hospital settings and published academic findings.

Case Studies

1) The Cleveland Clinic's AI-Powered Patient Engagement Platform

Using an artificial intelligence-powered DSS meant to increase patient involvement and clinical decision-making, the Cleveland Clinic set the system that generates recommendations for individualised treatment strategies by use of machine learning algorithms analysing patient data from electronic health records (EHRs). Patients may monitor their treatment progress, interact with their care teams, and get reminders for visits and prescriptions via a patient portal included within the system.

Findings:

The AI system let patients actively participate in their treatment choices, hence raising patient involvement. Patients said they felt more involved in their treatment and educated.

Clinical mistakes dropped 15%, thanks to artificial intelligence's real-time decision-making support.

Patient satisfaction rose; positive comments on interactions with healthcare professionals increased by 20%.

2) Mount Sinai Health System's AI Decision Support for Radiology

Mount Sinai Health System in New York City included into its radiology section an artificial intelligence-powered decision assistance system. Analysing medical images and spotting any abnormalities, the technology helps radiologists by providing recommendations for additional study. Based on real-time EHR data, the AI DSS also warns doctors to prospective patient issues.

Findings:

Radiologists said that by drastically cutting the time required to examine medical images, the AI system let them concentrate on more difficult cases.

The system's 10% reduction in diagnosis mistakes resulted in faster and more precise treatment recommendations.

The incorporation of artificial intelligence in radiography produced better patient outcomes since early discovery of anomalies led to more timely interventions.

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3) Kaiser Permanente's Use of AI in Managing Chronic Conditions

Leading American healthcare provider Kaiser Permanente has included artificial intelligence-driven decision support capabilities into its chronic illness management systems. These instruments enable doctors to spot people who run the danger of complications from diseases such diabetes, heart disease, and hypertension. By means of patient data analysis, artificial intelligence generates customised therapy recommendations and sends reminders for preventative actions including lifestyle modification and drug compliance.

Findings:

More proactive management of chronic diseases made possible by AI systems helped to lower hospital readmission rates by 18%.

The system gave patients tailored health information and proactive care reminders, therefore increasing their involvement.

Early intervention and well-crafted treatment regimens let the hospital document a 25% drop in healthcare expenses associated with managing chronic diseases.

Research Findings

From the case studies and data collected, the following key findings were observed:

Increased Patient Engagement: More customised treatment is made possible by AI DSS helping to improve communication between patients and healthcare professionals. Improved satisfaction resulted from patients who felt more engaged in their care decisions because to AI-powered platforms.

Improved Clinical Outcomes: AI DSS-implying hospitals noted improved clinical results including more accurate treatment regimens and lower diagnosis errors. The real-time decision support enabled medical professionals to make quicker and more wise choices.

Operational Efficiency: By streamlining their processes, AI DSS enabled hospitals to lower wait times and increase scheduling accuracy. Better use of resources and lower healthcare expenses followed from this.

Barriers to Implementation: Among the challenges were staff opposition, data protection issues, and trouble putting artificial intelligence into current medical systems. These obstacles must be removed if we are to guarantee the effective acceptance of AI DSS.

Conclusion

AI-powered decision support systems (DSS) have showed great promise in aiding clinical decision-making, increasing patient involvement, and raising general quality of hospital operations. This research shows that AI DSS can help to improve therapeutic outcomes, higher operational efficiency, and higher patient satisfaction by means of secondary data analysis of case studies and extant literature. According to the data, AI-driven technologies simplify procedures, lower clinical errors, and enhance patient-provider contact, hence producing more individualised and timely treatment.

Successful integration of artificial intelligence DSS into medical environments is not without difficulty, though. Still common are obstacles include professional opposition, privacy issues, and integration problems with current hospital systems. These difficulties emphasise the requirement of strategic planning, sufficient training, and strong regulatory systems to guarantee the efficient application of artificial intelligence technologies in healthcare.

Future studies should keep looking at these obstacles and look at methods to improve the

compatibility of artificial intelligence systems with current technologies. Notwithstanding these obstacles, the data indicates the transforming capacity of artificial intelligence-powered DSS in promoting quality enhancement in the provision of healthcare. Hospitals may fully use artificial intelligence to improve patient outcomes and delivery of treatment by removing implementation challenges.

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IMPROVEMENT IN LEACH PROTOCOL USING HAMMING DISTANCE & RECURRING AVERAGE ENERGY

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Abstract

Remote sensor hubs are a well known determination when it is hard or difficult to work a mains supply to the sensor hub. In this manner, on the grounds that the remote sensor hub is as often as possible put in area that is distant, to change the battery every now and again can be costly and badly arranged. An essential point in the development of a remote sensor hub is assurance that there is constantly adequate vitality open to control the framework. Low Energy Adaptive Clustering Hierarchy ("LEACH") is a convention in light of TDMA-MAC convention which is connected with bunching and an uncomplicated directing convention in remote sensor systems (WSNs). The point of LEACH is to lesser the vitality use expected to make and safeguard groups for enhancing the life time of a remote sensor arrange. These sensor hubs generally rely on upon batteries for vitality, that may get depleted at a speedier rate since the calculation and correspondence work they need to execute. Conventions for correspondence can be produced to make capable use of vitality assets of a sensor hub and to get continuous usefulness. There are some time ago proposed directing and MAC (Medium Access Control) layer conventions that have capacities to accomplish vitality effectiveness and maintain constant usefulness. A total investigation of LEACH convention has been completed and differentiate tables that give a review of the convention's execution on a few components for e.g. inactivity, adaptability and vitality mindfulness. Conclusions have been drawn that use the examination table parameters of how the convention executes when used for a perception reason and what sort of tradeoff they appear.

Keywords :- WSN, LEACH, HERECHICAL ROUTING, HAMMING DISTANCE, RECURRING AVERAGE ENEGY.

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Introduction

As all realize that each the systems have a specific lifetime amid which hubs have confined vitality by utilizing that, the hubs gather, handle, and transmit information. This infers every parts of the hub, from the sensor module to the equipment and conventions, ought to be intended to be extremely vitality effective. Diminishing vitality uses by a component of two will twofold the framework lifetime, prompting an expansive increment in the general nature of the framework. Also, to limit vitality scattering, conventions should be hearty to hub disappointments, blame tolerant and versatile in order to boost framework lifetime [1].

Remote Sensor systems are thick remote systems of little, shabby, low-control, appropriated self-governing sensors that collect and spread ecological information or learning to encourage recognition and controlling of physical conditions from remote areas with higher precision. Normally it is expected that each sensor in a system has bound requirements concerning its vitality source, power, memory and machine capacities. In WSN, each spatially circulated sensor hub speaks with each other to forward their detected data to a focal preparing unit/sink or complete some neighborhood coordination, for example, information combination. The sink hubs have gets to foundation systems like the Internet from where the end client brings the detected information. The most current systems are bi-directional, additionally empowering control of sensor action. [7].

A WSN can be characterized as a system of gadgets, meant as hubs, which can detect the earth and convey the data assembled from the checked field (e.g., a territory or volume) through remote connections. The information is sent, conceivably by means of different bounces, to a sink (at times indicated as controller or screen) that can utilize it locally or is associated with different systems (e.g., the Internet) through a passage. The hubs can be stationary or moving. They can know about their area or not. They can be homogeneous or not. This is a conventional single-sink WSN. All logical papers in the writing manage such a definition. This single-sink situation experiences the absence of adaptability: by expanding the quantity of hubs, the measure of information assembled by the sink increments and once its ability is achieved; the system estimate can't be enlarged. Additionally, for reasons identified with MAC and directing perspectives, arrange execution can't be viewed as free from the system estimate. A more broad situation incorporates different sinks in the system [8].

Given a level of hub thickness, a bigger number of sinks will diminish the likelihood of detached bunches of hubs that can't convey their information attributable to tragic flag proliferation conditions. On a fundamental level, a various sink WSN can be adaptable (i.e., a similar execution can be accomplished even by expanding the quantity of hubs), while this is plainly not valid for a solitary sink organize. Be that as it may, a multi-sink WSN does not

speak to an inconsequential augmentation of a solitary sink case for the system design. Much of the time hubs send the information gathered to one of the sinks, chosen among numerous, which forward the information to the passage, at the last client .From the convention perspective, this implies a determination should be possible, in light of a reasonable rule that could be, for instance, least deferral, greatest throughput, least number of jumps, and so forth. In this manner, the nearness of various sinks guarantees better system execution as for the single-sink case (expecting a similar number of hubs is conveyed over a similar zone), however the correspondence conventions must be more unpredictable and ought to be planned by appropriate criteria. [9].
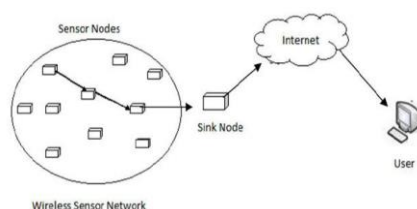
Figure 1.1: Wireless Sensor Network

Remote Sensor Networks (WSNs) comprise of numerous sensor hubs. The ordinary design of such a sensor hub in a WSN incorporates single or various detecting components, an information processor, imparting parts and a power source. Regularly, the detecting components perform estimations identified with the conditions existing in its encompassing condition. These estimations are transduced into comparing electric flags and are handled by the information processor. Sensor systems may comprise of a wide range of sorts of sensors, for example, seismic, low examining rate attractive, warm, visual, infrared, acoustic and radar. A sensor hub makes utilization of its imparting parts keeping in mind the end goal to transmit the information, over a remote channel, to a base station (a sink hub).
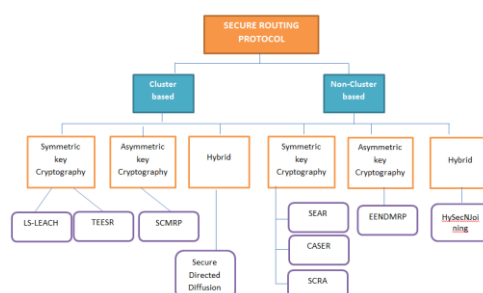

Figure 1.3 Types of Routing Protocol

2. LITERATURE REVIEW

LEACH is an adaptive clustering routing protocol proposed by Wendi B.Heinzelman, et al. The implementation method of LEACH consists of several rounds. Every round has a setup phase and the steady data transmission phase. In the set-up phase, the cluster head nodes are randomly selected from all the sensor nodes and several clusters are constructed dynamically.

After cluster head selection, the cluster head gives its identity message to non-cluster head nodes. The non-cluster head nodes send a join-REQ message to the nearest cluster head to join in the corresponding cluster. After the cluster head receives all the join-REQ information, it will produce a TDMA schedule, and notify all the member nodes in the cluster. After a member node receives the schedule, it sends data in its own time slots, and remains in the sleep state in other slots. After a frame time of data transmission, the cluster head runs the data compression algorithm to process the data and sends the results directly to the sink node.[19].

Sensor networks refers to a heterogeneous system consisting of multiple detection stations called sensor nodes with a communications infrastructuremeant to observe and record conditions at various locations. Additionally referred to as Sensor nodes, are small, lightweight and transportable devices equipped with a transducer, microcomputer, transceiver, and power supply. The transducer produces electrical signals based on the sensed physical phenomena. The microcomputer processes and stores the sensed data. The transceiver receives direction from the base station/central computing system and sends data to it. Every sensor nodes derives its energy usually from a battery or any other embedded form of energy harvesting. The size of the sensor nodes vary from that of a shoebox to that of a minute sand-particle. Equally their price additionaly varies from hundreds of dollars to some pennies. Size and cost constraints lead to corresponding constraints on energy, memory, computational speed and communications bandwidth.

Yasir Arfat, et al [14] Wireless sensor network comprises of resource constraint sensor nodes. That is why, designing and selecting an appropriate secure routing protocol for the network is a tough task. In this research paper, firstly, we have discussed the various types of security attacks. Secondly, we have presented a taxonomy of secure routing protocol and then provided a qualitative comparison. Finally, we have highlighted future challenging issues. Results show that most of the existing routing schemes are not very efficient in providing security.[14] .

PAVAN R et al [15] Wireless Sensor Networks, which may be spread over vast geographical area, are finding applications in many areas. In this context, there is need of approaches which can manage these WSNs in better way. In this regard, this paper, presented need for clustering to overcome several limitations of WSNs. Chosen clustering protocols, namely LEACH, LEACH-C, Multi-hop LEACH and Energy LEACH are presented. This paper also presented the simulation, results, and analyses of the same. As a conclusion of observation from results, it can bementioned that LEACH can be preferred if localized coordination of nodes in clustering; and LEACH-C can be chosen when centralized and deterministic approach covering entire network is expected still bringing in increased network lifetime and desired number of clusters. When network's diameter is increased beyond acertain level, distance between CH and BS is increased enormously Multi-hop LEACH is EFFICIENT. Energy- LEACH tries to achieve efficient energy utilization.[15]

Manpreet kaur et al [20] Efficiently use of energy in the network has been the main issue in WSNs for prolonging lifetime of the network. LEACH has found one of the most energy efficient protocols used in WSN. In this survey, LEACH protocol has been discussed with its drawbacks and how these drawbacks are overcome by its descendants. A brief study of various improved versions of LEACH protocol has been done in order to compare performance of these descendants with the classical LEACH. It is concluded from given survey that for prolonging network lifetime of WSN, there is need to explore more robust, reliable and efficient protocols in future.[20].

Swati Sharma, et al [13] In this paper the author has discussed that in the future, this wide range of application areas will make sensor networks an integral part of our lives. However, realization of sensor networks needs to satisfy the constraints produced by factors such as fault tolerance, scalability, cost, hardware, topology change, environment and power consumption. Since these constraints are highly stringent and specific for sensor networks, new wire les s ad - hoc networking techniques are required. Routing in sensor networks has attracted lot of attention in the recent years and introduced unique challenges compared to traditional data routing in wired networks. An interesting issue for routing protocols is the consideration of node mobility. Most of the current protocols assume that the sensor nodes and the s ink are stationary. However, there might be situations such as battle environments where the s ink and possibly the sensor need to be mobile. New routing algorithms such as TTDD (Two – Tier Data Dissemination Model for Large -scale Wire les s Sensor Networks) are needed in order to handle the overhead of mobility and topology changes in such energy cons trained environment. Although many routing protocols have been proposed in WSNs, many issues s till exist and there are s till many challenges that need to be solved in the sensor networks .

3. PROBLEM DOMAIN & METHEDOLOGY

3.1 Problem Domain

3.1.1 Overview

Past parts as of now talked about different viewpoints. In the first place part talks about the LEACH with it's application and motivational angles. Where as, part 2 examines about writing Review about the LEACH and different remote steering convention incorporating auditing different works in the space group based vitality proficient directing convention and it's answer in past section. This LEACH directing convention is exceptionally implied for different remote systems. It is surely understand that the vitality proficiency is imperative angle and exceptionally it is for any remote system. This is essential since elite system is constantly imperative.

Execution of the system substance different part of any system. This could substance different viewpoints. Subsequent to assessing different works, the discoveries are talked

about in next segment. There vitality productive directing assumes extremely basic part in remote condition in view of different variables like as takes after:

- Lifetime of the network,
- Quality of the network,
- Reliability of the network,
- Efficiency of the network
- Packet Delivery Ratio
- Improve the performance of the network

The execution of the remote system. There are different approaches to deal with this issue adjacent to of examined systems in this paper. Undoubtly, these accessible strategies give great outcomes yet while utilizing existing systems with LEACH fluctuations, there are three concerns or says territories where there is extent of change falsehoods.
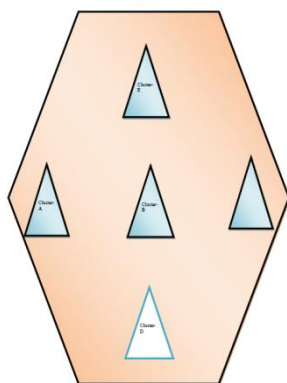
Fig 3.1 : LEACH implantation in Wireless Environment

3.2 METHODOLOGY

In this section we have described the working of LEACH protocol. How the threshold value used by the leach for selecting the cluster head is calculated. What are the procedures of creating a cluster by arranging the no. of nodes.

3.2.1LEACH Protocol:

Heinzelman, et.al presented a progressive grouping calculation for sensor systems, known as Low Energy Adaptive Clustering Hierarchy (LEACH). Filter masterminds the hubs inside the system into small groups and picks one among them as the bunch head. Hub initially faculties its objective then advances the significant learning to its bunch head. At that point the group head totals and packs the information gotten from every one of the hubs and sends it to the base station. The hubs picked as the bunch take deplete off extra vitality when contrasted with alternate hubs as it is required to send information to the base station which can be far found. Hence, LEACH utilizes arbitrary pivot of the hubs should have been the bunch heads to similarly circulate vitality utilization inside the system. After various reenactments by the creator, it was found that lone 5% of the aggregate number of hubs needs to go about as the

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bunch heads. TDMA/CDMA MAC is utilized to diminish between group and intra-bunch crashes. This convention is utilized were a consistent perception by the sensor hubs are required as information accumulation is brought together (at the base station) and is performed intermittently.
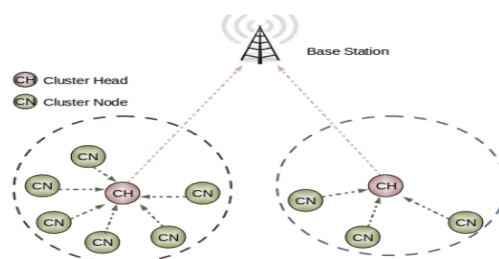

Figure 3.2 diagram of LEACH

4. PROPOSED WORK

4.1 Proposed Concept

The proposed work is all around energy efficient routing protocol LEACH's upgraded version. This is further enhancement in LEACH. This system is working for Wireless Network. There is various aspect of any routing protocol in wireless network. Some of those main concerns are as follows:

i. Packet Received at Base Station V/s Energy Consumed

ii. Number of Alive nodes v/s Time

iii. Total Energy of system V/s Time
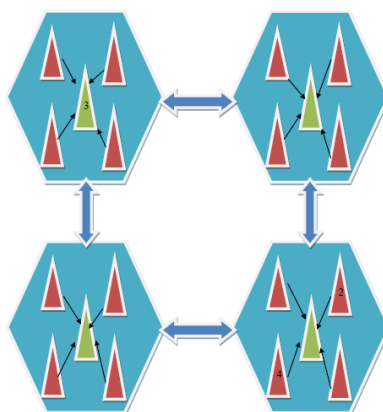
Figure 4.1: Block Diagram of Proposed Concept

Wireless is made of various nodes. Nodes are those mobile elements which are dynamic in nature of moving. Various nodes are divided into various clusters according to their geographical locations. First of all, proposed work collects the data at Base Statin or Cluster

Head for which those have meant. Then these data send to another cluster's station. This process will preserve the energy while transmitting data to base station.

Various nodes of the wireless network. Proposed work is based on cluster. Various nodes are divided into many clusters or in other words nodes are clustered accordingly to their geographical area. In proposed work, whole network space is divided into subparts and these subparts are called clusters. Proposed work starts it's journey with a particular cluster. In a single cluster first of all, the node which wants to start sending data to base station needs to aggregated it's data and send to the base station of the cluster or whole network.

Then this aggregate data goes beyond the initiated cluster and covers the whole network. This concept is very easily shows through the figure 4.1 and figure 4.2. In figure 4.1, data sensor communication starts within clusters. Each Node collect their data and sent to their local base station Similarly figure 4.2 is showing the architecture of proposed work concept in reference to globalized time synchronization. This figure show the synchronization process at global end or for the whole network.
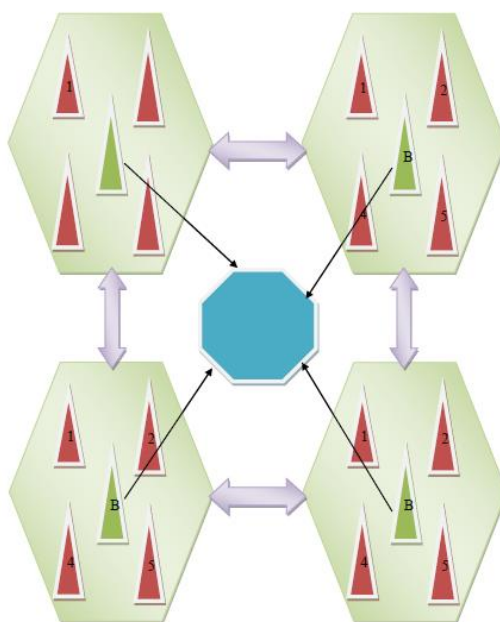

Figure 4.2: Block Diagram of Proposed Concept at whole network

This proposed work is basically meant for improving the performance of the proposed work. There are two main point of updations are done in this proposed work as compare to the existing work. These updations are as follows:

4.2 Proposed Algorithm

1. For k=1:r //r is number of round
2. temp=0;
3. For i=1:numOf node

4. temp=temp+(energy. node(i))2 ;

5. End For

6. RMSEnergy=(temp/ numOf node) 0.5

7. Pick some node randomly and do

8. If energy.node>RMSEnergy

9. Select node as cluster head

10. clusterNode.no(countCHs) = node;

11. xLocation = nodeArch.node.x; //x location of CH

12. yLocation = nodeArch.node.y;

13. Node.Distance =haminngDistance([xLocation, yLocation],[base.x,base.y]); //calculating distance of each cluster node with base station

14. Repeat step 9 to 14 till all random picked node are done

15. Transfer data packet to base station

16. Recalculate energy of each node after transmission of data

17. For i=1:NumofNode

18. If energy.node(i)<0

19. Node type=Dead;

20. Else

21. Node type=Alive;

22. Count++;

23. End if

24. End for

25. NumofNode=count;

26. End for

27. Plot result

4.3 Proposed Flow chart
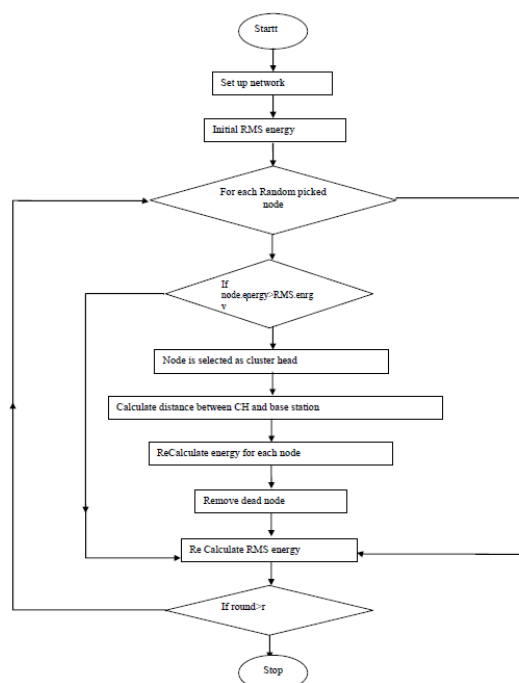
Figure 4.3: Flow Chart of Proposed Work

4.4 Advantages of the Proposed Method:

There are many advantages of the proposed protocol which is follows:
- Provides better Energy Efficient
- Provides Higher Network Life.
- Maintain Mobility.
- Easy to implement
- Robustness in nature.

5. Experiment Implementation

5.1 Tool to be used

The apparatus which is to be utilized for the execution of the proposed work is MATLAB. The name MATLAB remains for MATrixLABoratory. MATLAB was composed initially to give simple access to framework programming created by the LINPACK (straight framework bundle) and EISPACK (Eigen framework bundle) ventures.

MATLAB is an elite dialect for specialized processing. It incorporates calculation, perception, and programming condition. Moreover, MATLAB is a cutting edge programming dialect condition: it has modern information structures, contains worked in altering and investigating apparatuses, and backings protest situated programming. These variables make MATLAB an incredible device for instructing and research.

Parameter	Specification
Num of nodes	100
Area R	100 x 100
Max Interval	9999 rounds
Initial Energy per node	0.5 J
Initial Probability to become cluster head	0.1
Initial energy of node(Eo)	0.5 J
Energy for Transmission (ETX)	50*0.000000001 j
Energy for Receiving data(ERX)	50*0.000000001 j
Energy for free space	10*0.00000000000.1 j
Energy for multi path	0.0013*0.000000000001 j
Energy for Data Aggregation	5*0.000000001 j

TABLE 5.1: Simulation Parameter
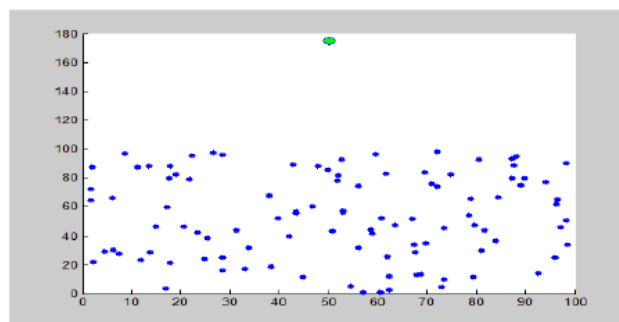
5.2.2 Simulation Scenario

It is shown in figure 5.1.

Figure 5.1: 100 nodes in Wireless Network

Figure 3 clearly shows the initial positions of the various nodes in the network. There are total 100 nodes in the network.

6. RESULT ANALYSIS

6.1 Packet Received at Base Station V/s Energy Consumed

Packet Received:

Packet is a single unit of data exchanged between two devices on a network and Packet Received is number of packets received by the destination.

Packet Received = Number of Packet Received by Destination

Energy Consumption:

Its' aims to improve the amount of Energy Efficiency for a given task .

Energy Consumption = Initial Energy of a node – Final Energy of a node

Packets received At base Station or Sink ($x10^4$)	Existing work Energy consumed in Joule	Proposed work Energy consumed in Joule
0.5	22	06
1.0	39	12
1.5	49	19

Table :- 6.1 Comparison of existing work and proposed work on Packet Received at Base Station V/s Energy Consumed
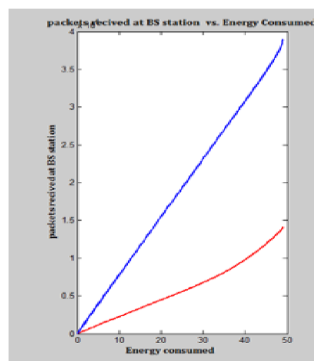
Figure 6.1: Comparison of existing work and proposed work on Packet Received at Base Station V/s Energy Consumed

6.2 Number of Alive nodes v/s Time

The Alive Node or lifetime distribution of a node depends on the energyconsumption distribution during any given time period T, and thetotal capacity of its battery C. Moreover, the network lifetimedistribution depends on the lifetime distribution for each node or Alive Node Distribution,and how the network lifetime is defined. For different applications and network topologies, the network lifetime shouldbe defined differentl. While a complete investigation ofnetwork lifetime with various definitions is out of scope in thiswork, focus on the lifetime defined as the duration before thebattery depletion of the first node.

Alive Node = Number of nodes Alive at any point of time.

Time (Time in sec)	Existing work (No of nodes alive)	Proposed work(No of nodes alive)
10	100	100
20	80	100
30	49	100
40	38	100
50	24	100
60	11	100
70	6	100
80	03	100

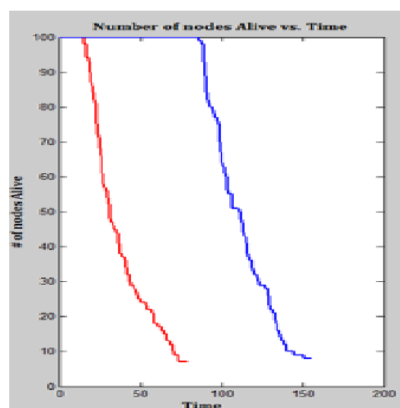Table 6.2: Comparison of existing work and proposed work on Number of Alive nodes v/s Time

Figure 6.2: Comparison of existing work and proposed work on Number of Alive nodes v/s Time

7. CONCLUSION & FUTURE WORK

7.1 Conclusion

Wireless network is becoming more and more useful and valuable with the time. As we know that the performance of the any wireless network is highly depends on the life time of the network. Figure 4 clearly shows that the performance of the proposed work is far better than the existing work on the parameter of the Packet Received at Base Station V/s Time, Number of Alive nodes v/s Time and Total Energy of system V/s Time.

7.2 Future Work

Here the proposed work considered the lifetime of the nodes. There are various aspects which could be taken care. These aspects are as follows:
i. Make the proposed work for very large network.
ii. Provide the Security with the large span of network life.
iii. Make it available for the Adhoc network too.

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Diagnose Most Desirable Treatment For Disease Using Machine Learning ApproachIn Relation To Short Text
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Abstract

This work presents the Machine Learning technique which is used to build a computerprogram that can learn and behave from their experience. Machine learning concentrates onthe development of computer programs that can teach themselves to grow and change whenexposed to new data. Also Machine learning used in Medical health care system that's why itcan easily handle the medical database in order to produce most desirable results. Now usingmachine learning approach existing system can identify a disease and suggest the relativetreatments but it is unable to find out most desirable treatment from the extracted treatments.In the proposed work user will get disease summary (disease and its related treatmentinformation) by entering symptoms as a query in the search engine. First of all when amedical document in the form of pdf is downloaded, it will be saved in the system thenperforms the per processing over there and the extract the relevant data that will be stored inthe system database. Then classification process is carried out on symptoms entered by theuser, so classification is done using SVM classifier to find the semantic keyword which is\ useful to identify the disease easily and rapidly. After that the semantic keyword is mappedwith the stored medical input database to chock out the exact disease related to that keyword.When the disease identified related to that symptom, it will be pass to medical database, inwhich medical articles will be extracted related to given disease. In preprocessing usesstemming, tokenization and removal of stop words. So using this preprocessing processkeyword searching algorithm is used to extract relevant information. The combination ofBOW, NLP and biomedical concepts are put together to find semantic relations that exist

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Introduction

1.1 Overview

In today's world life has become very hectic and people want to live more than ever.Everyone has become health concise and wants to be always fit and fine. Most of the peoplerely on health care systems to obtain healthcare services online as it is easily accessible, lesscostly and updated source of information.Machine Learning has been emerged as an important technology almost in all domains

particularly in research and medical fields. Machine learning helps to integrate the computerbased system into the healthcare field in order to obtain best and accurate results. The newinvention in the domain of life-science and biomedical field has been concentrate on NaturalLanguage Processing (NLP) and Machine Learning (ML) community. This trend goes verymuch in line with the direction the medical healthcare system is moving to: the electronicworld. The research focus of scientists that work in the field of computational linguistics andlife science domains also followed the trends of the medicine that is practiced today, anEvidence Based Medicine (EBM). This new way of medical practice is not only based on theexperience a healthcare provider acquires as time passes by, but on the latest Discoveries awell.
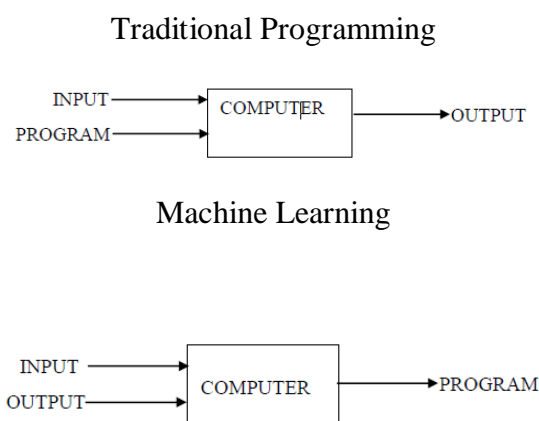
Traditional Programming

Machine Learning

Fig.1 Difference between Traditional Programming and Machine Learning Approach

Till now each doctor has to read the books, Basepapers, Whitepapers or casepapers to updatehis/her knowledge with time. Due to time and cost constraints, most of the people rely on healthcare systems to obtain healthcare services. Healthcare system becomes very important to developan automated tool that is capable of identifying and disseminating

relevant healthcareinformation. So a automation system which will identifying sentences from Medline and alsoprovide the best treatment for the symptoms provides by the doctor, will really work as anhelping hand to them. This automation system will also be helpful for patient to get the besttreatment. So the implementation of such system is my goal.

2. LITERATURE REVIEW

Machine learning is a type of artificial intelligence (AI) that helps to providescomputers with the ability to learn without being explicitly programmed. Machine learningtechniques focuses on the development of computer programs that can teach themselves togrow and change when exposed to new data.Now days ML techniques supplies multiple tools for quick data analysis. Particularly in thepast few years, the digital improvement has provided somewhat economical and available 1means to gather and accumulate the data. Recent hospitals are fine prepared with supervisingand another data gathering devices, and data is accumulated and shared in huge informationsystems. ML technique is presently well suitable for analyzing health care data, and inparticular there is a bunch of work done in health care diagnosis in little simplified diagnostictroubles.

Data about correct diagnosis are offered in the form of health care records in dedicatedhospitals or their subparts. Provide the long-suffering report with well-known accurate

identification into a computer algorithm using ML techniques. It is just over to say, but ingeneral, the medical related data will extracted from the last available cases. The consequentclassifier used to assist the physician while diagnosing new patients for get better thediagnostic accuracy, speed and reliability, or to educate students.

2.1 History of machine learning

The improvement of ML technique is a connected part of the expansion of artificialintelligence. Recently in AI, people were involved to build program that mimic human brains.In 1957 an one model was invented that is perceptions model, and it based on optimisticview. Limitation is invented by Marvin Minsky by complex functions, later researchersstopped using this model for the next decade. Then machine learning domain was dormant in1970s, while expert systems get into the major approach of AI. In mid-1980s machinelearning came back, while the decision tree model was made-up and dispersed as software.This model was viewed by a human. It is also very adaptable and get used to broadlydissimilar troubles. Then in mid of 1980s multi-layer neural networks was implemented, with several hidden layers. Hence up above the limitation of perceptron.

Decision tree learning uses a decision tree as a predictive model which maps observations about an item to conclusions about the item's target value. Decision tree learning, used in statistics, data mining and machine learning, uses a decision tree as a predictive model which

maps observations about an item to conclusions about the item's target value[1]. More descriptive names for such tree models are classification trees or regression trees. In these

tree structures, leaves represent class labels and branches represent conjunctions of features that lead to those class labels. Decision tree learning is a method commonly used in data mining. The goal is to create a model that predicts the value of a target variable based on several input variables. An example is shown on the right. Each interior node corresponds to one of the input variables; there are edges to children for each of the possible values of that input variable. Each leaf represents a value of the target variable given the values of the input variables represented by the path from the root to the leaf.

3 METHODOLOGY
3.1 Proposed Work

We Discusses about the proposed Method and structure as there were somechallenges arised on how to proceed for the proposed system, the questions raised arediscussed in the First chapter and below given are the answers to those Q's.

3.1.1Challenges

☐ The first challenge was, which Dataset can be used for the proposed system. Thesolution to this challenge is, as the standard Dataset was not available so we created ourown data set from the medical documents retrieved and stored.

☐ The second challenge was which techniques can be used to extract relation betweentreatment and disease, the solution for this challenge was, data representationtokenization, Stop Word Removal BOW, UML and Biomedical concept as study showsthat they give good results as compared to other techniques.

☐ The next i.e the third challenge was how extracted treatment and disease from Medlinedatabase could be further classified to get an accurate result. The solution found for thisproblem was the use of classifier SVM to classify the semantic relations that existbetween disease and treatment among the extracted input articles. As SVM with richfeature representations are the setups that obtained the best results for text data.

☐ Then the biggest challenge was raised, how to identify treatment for given diseases then thesolution found was, as an input to the system symptoms of the patient is given the semantickeyword which helps to identify the disease were found from it quickly. After that therelevant keyword is coordinated with the saved local medical input database to discover thecorrect illness associated to that keyword. Once the sickness is recognized, it is sent to localmedical database to extract the articles pertaining to that sickness. Once the useful sentencesare extracted with the keyword searching algorithm, Classifiers are used to classify thesemantic associations that exist between syndrome and treatment among the extractedinput articles.

☐ The last challenge how the system will provides us with best treatment for a disease. Thesolution is using data mining concept (ranking algorithm) the best treatment for Diseasecan be found out the multiple treatments.

3.1 Task and Data Set:

Here are two types of tasks which is done here that is capable to identify anddisseminate healthcare information. The first task identifies and extracts informativesentences on diseases and treatments topics, while the second one performs a finer grainedclassification of these sentences according to the semantic relations that exists betweendiseases and treatments. The most compatible work is the work done by Rosario andHearst[6]. They created and distributed the data set used in our research. The data set consistsof sentences from Medline5 abstracts annotated with disease and treatment entities and witheight semantic relations between diseases and treatments. The first 100 titles and 40 abstractsfrom each of the 59 Medline 2001.

There are at least two challenges that can be encountered

while working with ML techniques.One is to find the most suitable model for prediction. The ML field offers a group ofpredictive models (algorithms) that can be used and implemented. The job of discovering theappropriate one relies deeply on empirical studies and knowledge expertise. The another oneis to discover a fine data representation and to do aspect engineering because aspects robustlyincluded the presentation of the models. Finding the correct and enough features to signifythe data for the projecting models, especially when the resource of data is not large, as it isthe container of sentences, is a vital aspect that wants to be in use into consideration.It is very important to recognize the sentences captured is informative or non-informative and

named them so that they automatically be ignored and the load on the system beingdeveloped will be less.

3.2 Classification Algorithm:

In Machine Learning approach the expertise and previous research provides the guidance to solve new tasks. The models described should be able to identify and provide informative sentences and relation between entities. To examine should be made in respect to complete high presentation. In classification technique, having group of 6 representative models can be utilized. They are: adaptive learning (Ada-Boost), decision-based models (Decision trees), and probabilistic models (Naive Bayes (NB) and Complement Naive Bayes (CNB), which is adapted for text with imbalanced class distribution), a classifier support vector machine, These classifiers are utilized to learn more algorithms and to job on long text and small texts. Probabilistic techniques based on Naive Bayes worked in text classification and automatic text classification tasks. Decision trees based on decision models are used in short texts. Adaptive learning algorithm is utilized to focus on hard concepts such as unbalanced data sets, underrepresented in data.

3.3 Data representation:

3.3.1 Bag-of-Words model

The bag-of-words model is a justifying representation used in natural language processing and data extraction. In this model, a text (like a sentence or a article) is shown as an unbalanced group of words, disregarding grammar and even word order. Recently, the bagof-words technique has also been used for computer track.

The BOW model is utilized in some another type of article classification. While a naïve Bayes classifier is functional to transcript, for example, the conditional independence assumption adds the assumption that terms are conditionally independent given the class. Additional techniques of article classification that utilized this model are latent Dirichlet allocation and latent semantic analysis.

3.3.2 NLP and Biomedical concepts representation

The main developments in this area have been related to the identification of biological entities (named entity recognition), such as protein and gene names in free text, the association of gene clusters obtained by microarray experiments with the biological context provided by the corresponding literature, automatic extraction of protein interactions and associations of proteins to functional concepts (e.g. gene ontology terms). Even the extraction of kinetic parameters from text or the sub cellular location of proteins has been addressed by information extraction and text mining technology.
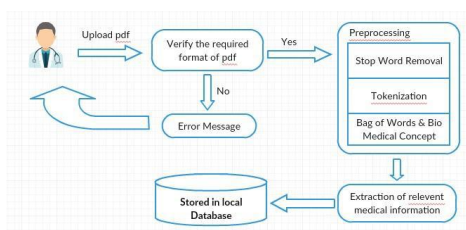
3.4 Frame work of the proposed System:

Fig 5: Architecture of Proposed system for uploading pdf

The above shown is the fig. 4 architecture of Proposed system for uploading pdf here whendoctor uploads a pdf disease file it first verifies whether the pdf is of required format or not ifyes it sends the file for preprocessing where the stop word his process is removal,tokenization, bag of words and biomedical concepts are used after this process is overrequired data is extracted and stored in the database.
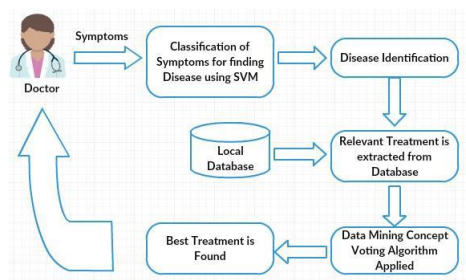
Fig. 6 Architecture of Proposed system for treatment extraction

In the above given Fig.5 is proposed system for treatment extraction on basses of symptomsprovided. Here when the doctor enters symptoms using SVM classifier classification ofsymptoms is done and relevant disease are extracted and out of no.of disease found requireddisease is selected and which provides with relevant treatment extraction from the database.then using Data mining concept like voting algorithm best treatment is found.

3.4.1 Input Dataset

In this work, two databases are used. One is Medline database and the other is Localdatabase. The Medline database contains more than 21 million records from approximately5,000 selected publications covering biomedicine and health from 1950 to the present.MEDLINE uses Medical Subject Headings (MeSH) for information retrieval. Approximately5,000 biomedical journals are indexed in MEDLINE. The local database contains the list ofsymptoms with the corresponding diseases.
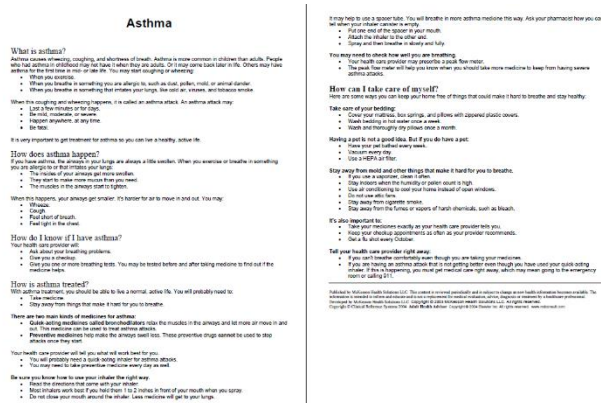
Screen Shot of MEDLINE pdf which is given as input

3.4.2 Data Preprocessing

This is pre stage of classification which is processed on unrefined data to arrange it foranother processing method. Generally used as a beginning data mining practice, datapreprocessing transforms the data into a format that will be very easily and effectivelyprocessed for the purpose of the user. In this phase noisy and irrelevant data are

detachedfrom the relevant data. Primarily, the process of disputing the sentence with space usingtokenizing processed. After that the stop words like a, an, the, is, was etc are uninvolved.After removing the human errors, unnecessary words such as filler words were unconcerned.Followed by that, stemming is done, which is the process of removing morphological and inflexional ending words to their root words. At last the semantic word retrieval is processedand it is kept in the local database. The same preprocessing techniques such as stemming,stop words removal are performed in Medline database articles.

3.4.3 Disease Identification

Now the semantic keyword which is a preprocessed symptom is matched with the diseasesstored in the local database to identify the corresponding disease related to those symptomsgiven by the user.

3.4.4 Extraction of relevant information

After the disease is identified, then articles related to that disease is extracted from medicaldatabase. Then these extracted articles are further classified into informative sentences whichcontain relevant keywords and non informative sentences which contain irrelevant keywords.

Algorithm:

Keyword searching algorithm Input: Articles extracted from medical database

corresponding to the disease identified.

Output: Relevant semantic keywords. [9]

Extract the input articles and then preprocess all the extracted input articles. Thenfirst split the paragraph into sentences using delimiter. Then split each sentence into wordusing the Stanford POS tagger tool, which also creates tags and words are enclosed with thesetags. Obtain the meaning of each word (using parts of speech).Retrieve the informativesentences using the relevant semantic keywords.

The advantage is that if a feature appears more than once in a sentence, this means that it isimportant and the frequency value representation will capture the feature's value will begreater than that of other features.

The results of all the above used techniques and algorithms are taken into the account andstored for further calculation. Probabilistic models are stable and reliable for tasks performedon short texts in the medical domain.

5.4.5 Classification

Classification is a data mining (supervised learning) technique used to predict groupmembership for data instances. Once the informative sentences are extracted using

thekeyword searching algorithm, SVM Classifier is used to classify the semantic relations thatexists between disease and treatment among the extracted input articles.

Further, data mining (voting algorithm) concept are applied to find the best treatment forDisease. In future, comparative analysis can be done with other classification algorithms inorder to provide better performance.

In biomedical literature, rule-based approaches have been widely used for solving relationextraction tasks. The main sources of information used by this technique are either syntactic:part-of-speech (POS) and syntactic structures or semantic information in the form of fixedpatterns that contain words that trigger a certain relation. One of the drawbacks of usingmethods based on rules is that they tend to require more human-expert effort than data-drivenmethods (though human effort is needed in data-driven methods too, to label the data).

The best rule-based systems are the ones that use rules constructed manually or semiautomatically—extracted automatically and refined manually. A positive aspect of rule-basedsystems is the fact that they obtain good precision results, while the recall levels tend to below. Syntactic rule-based relation extraction systems are complex systems based onadditional tools used to assign POS tags or to extract syntactic parse trees. It is known that inthe biomedical literature such tools are not yet at the state-of-the-art level as they are forgeneral English texts, and therefore their performance on sentences is not always the best.

4. Implementation

4.1 Background

In this chapter we have discussed about our implementation process and algorithm used in itfor data related to disease extraction based on the symptoms. The classifier used in thisproposed system is SVM classifier as in previous research [12] it was found that the linearSVM performed as east as well as the nonlinear SVMs tested. The SVM produced lowererror rates than other classification methods. In general, the performance of SVMs is notaffected by large dimension problems. The computational complexity for training the SVMsis $Nm2$, where N is the number of classifiers and m the number of training examples. Theperformance is more sensitive to the number of training examples than to the number ofclassifiers. The preprocessing techniques used here for implementation are tokenization, stopwordremoval, bag-of words and biomedical concepts as its combination together gives goodresult. The problem in the system was it only retrieved treatment for the give disease butdidn't suggest the best out of it. So voting algorithm is used to find the best treatmentdepending on the suggestion gathered from multiple doctors.

4.2 Implementation

The system consist of many medical published articles which can be taken as input for the

system and perform our classification and data extraction task on these pdf's.

Algorithms:

Step 1: Start

Step 2: Registered Doctor login with his id.

Step 3: Doctor goes to the upload section for storing data in the local data base.

Step 4: select a file from medical data

Step 5: Verify whether the file is in required format or not

Step 6: if correct format go to step 7 or stop

Step 7: Read pdf and convert it into text format

Step 8: Then perform preprocessing techniques on it

Use keyword matching algorithm Ai [i=1toN]

Step9: Extract the input articles.

Step 10: Preprocess all the extracted input articles.

Step 11: First split the paragraph into sentences using delimiter.

Step 12: Next, split each sentence into word using the Stanford POS tagger tool

Which also creates tags and words are enclosed with these tags.

Step 13: Obtain the meaning of each word (using parts of speech).

Step14: Retrieve the informative sentences using the relevant semantic keywords

and Store in local data base

Step15: Doctor enters symptoms as input

Step16: Classification using SVM Classifier is done on these symptoms

The classifier constructed as follows

wl φ (xk) + b $\geq$ 1 , if y k +1

wk φ (xk) + b $\leq$ -1 , if y k + -1

Step 17: Disease related to the symptoms are classified

Step18: The required data related to disease is extracted from local database

Step19 : Use Voting algorithm for finding best treatment

In the first pass, we need 2 values:

1. A candidate value, initially set to any value

2. A count, initially set to zero

First compare the element's value to the current candidate value. If they

are the same, we increment count by 1. If they are different, we

decrement count by 1.

The second pass simply counts the frequency of that value to confirm

Step 20 : best treatment is selected on the bases of majority

Stop 21 : Stop

4.3 Voting algorithm

The algorithm uses O(1) extra space and O(N) time. It requires exactly 2 passes over theinput list. It's also quite simple to implement, though a little trickier to understand how itworks.

In the first pass, generate a single candidate value which is the majority value if there is amajority. The second pass simply counts the frequency of that value to confirm. The first passis the interesting part.

In the first pass, we need 2 values:

3. A candidate value, initially set to any value

4. A count, initially set to zero.

For each element in our input list, we first examine the count value. If the count is equal to 0,we set the candidate to the value at the current element. Next, first compare the element'svalue to the current candidate value. If they are the same, we increment count by 1. If theare different, we decrement count by 1.

At the end of all of the inputs, the candidate will be the majority value if a majority valueexists. A second O (N) pass can verify that the candidate is the majority element (an exerciseleft for the reader).

Explanation

To see how this works, we only need to consider cases that contain a majority value. If the

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list does not contain a majority value, the second pass will trivially reject the candidate.

First, consider a list where the first element is not the majority value, for example this listwith majority value 0

[5, 5, 0, 0, 0, 5, 0, 0, 5]

When processing the first element, we assign the value of 5 to candidate and 1 to count. Since5 is not the majority value, at some point in the list our algorithm must find another value topair with every 5 we've seen so far, thus count will drop to zero at some point before the lastelement in the list. In the above example, this occurs at the 4th' element

List Values: [5, 5, 0, 0, ...

Count value: [1, 2, 1, 0, ...

At the point that count returns to zero, we have consumed exactly the same number of 5's asother elements. If all of the other elements were the majority element as in this case, we'veconsumed 2 majority elements and 2 non-majority elements. This is the largest number ofmajority elements we could have consumed, but even still the majority element must still be amajority of the remainder of the input list (in our example, the remainder is ... 0, 5, 0, 0, 5]).

If some of the other elements were not majority elements (for example, if the value was 4instead), this would be even true.

We can see similarly that if the first element was a majority element and count at some pointdrops to zero, then we can also see that the majority element is still the majority of theremainder of the input list since again we have consumed an equal number of majority andnon-majority elements.This in turn demonstrates that the range of elements from the time candidate is first assignedto when count drops to zero can be discarded from the input without affecting the final resultof the first pass of the algorithm. We can repeat this over and over again discarding rangesthat prefix our input until we find a range that is a suffix of our input where count never dropsto zero.

Given an input list suffix where count never drops to zero, we must have more values thatequal the first element than values that do not. Hence, the first element (candidate) must bethe majority of that list and is the only possible candidate for the majority of the full inputlist, though it is still possible there is no majority at all.

4.4 Performance Evaluation

The most commonly used evaluation measures in the machine learning based setting are

accuracy, Precision, Recall and F-measure

Accuracy = Total number of correctly classified Instance

Recall = Correctly classified positive instance / total no of correctly classified

Instances.

Precision = Correctly classified positive instance / the total number of positive

F-measures= The harmonic mean between Precision and recall

4.5 Summary

This chapter covers implementation part where the basic algorithms used are specified alongwith the steps of development of the implemented system. The hardware and softwarerequirements with its specification are also mentioned. The values to be calculated for resultcomparison are given with its formula in this chapter which helps in calculating result for ournext chapter.
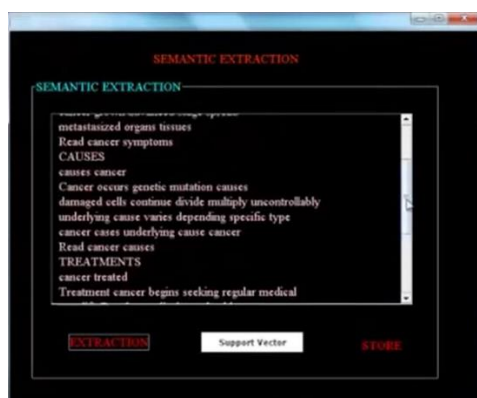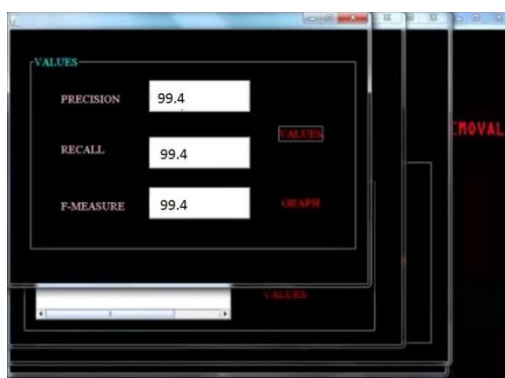

Screen Shot of Semantic extraction process on uploaded pdf using BoW& SVM Classifier
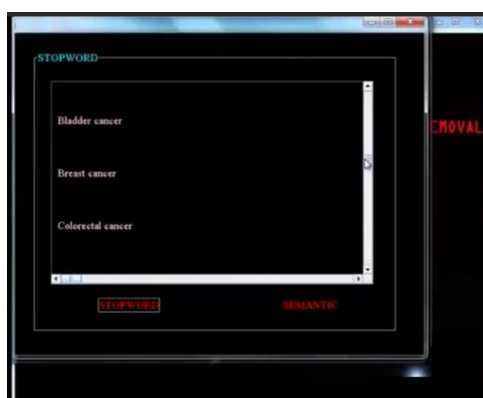
Screen Short for stop word and special character removal process
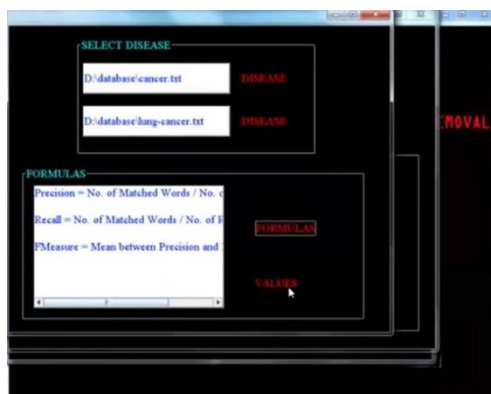
Screen Shots for system calculate Accuracy and F-measure

Screen Shots for system generated Accuracy and Recall value

Screen Short O/P of Data stored in local database after relevant data extraction

4. Results & Discussion

The results of all the above used techniques and algorithms are taken into the account andstored for further calculation. Probabilistic models are stable and reliable for tasks performedon short texts in the medical domain.Table 4 Comparison of different techniques of machine learning approach in medicalfield and there corresponding

Sr. No.	Paper	Tech. Used	Classification Algorithm	Data Representation	Comparative Result
1.	R. Bunescu[8]	Pattern-based method Statistical learning method	SVM classifier Supervised learning Lexical Features Morphosyntactic Features Semantic Features	Bag-of-words representation NLP and biomedical concepts representation Medical concepts (UMLS) representation	Result obtained Accuracy =93.73% F-measures=94.07%
2.	OanaFrunza [10]	The sentence identifies The relation identification based on NLP and ML techniques	Decision-based models (Decision trees) Probabilistic models (Naive Bayes (NB) Complement Naive Bayes (CNB) Imbalanced class distribution Adaptive learning (Ada-Boost) A linear classifier (support vector machine (SVM)with polynomial kernel) A classifier that always predicts the majority class in the training data (used as a baseline).	The bag-of-words (BOW). ConceptT-type ConText Verb phrases Concepts Semantic vectors.	F-measures= 90.4% Accuracy=90.7%
3.	Suchitra A[11]	Co-occurrences analysis Rule based approaches Statistical	Same as above	Bag-of-words representation NLP and biomedical concepts representation Medical concepts (UMLS) representation	F-measure=90% Accuracy=90.3%
		models Inductive Logic Techniques Support Vector Machine Bloom filter is used for the removal of unwanted words so as to fetch only the important words			
4.	Oana Frunza [12]	Same as above	Decision-based models (Decision trees) Probabilistic models (Naive Bayes (NB) Complement Naive Bayes (CNB) Imbalanced class distribution Adaptive learning (Ada-Boost) A linear classifier (support vector machine (SVM)with polynomial kernel) A Zero classifier that always predicts the majority class in the training data (used as a baseline	Bag-of-words representation NLP and biomedical concepts representation Medical concepts (UMLS) representation MetaMap is a tool created byNLM that maps free text to medical concepts used in the UMLS	For the relation Cure the F-measure baseline is 98.51%, for Prevent and Side Effect 88.5%
5.	Pravin Shinde	The bag-of-words (BOW). Weka Tool	NB implementation with polynomial kernel from the Weka5 tool.	The bag- of-words (BOW). ConceptType ConText Verb phrases Concepts Semantic vectors.	F-measure=82.15% Accuracy =91.5%
6.	Vijay Ingle Dr. Amit Sinhal.	Bag-of words And Support Vector Machine	Support Vector Machine with linear classifier and Voting Algorithm.	Bag-of words Tokenization Stop word removal Data Mining	F-measures=99.4% Accuracy= 99.6%

The above comparison table tells us, that using SVM Classifier a good result of Fmeasures=92.4%, SVM result of Accuracy= 93,6 % is obtained, so in the implementation

part using different data representation technique with SVM has obtain a better result. Alsothe task tackled in our research is to performed with all the above mentioned representations,plus combinations of them. The combination of BOW, NLP and biomedical concepts byputting all features together to represent an instance. The results show that probabilisticmodels based on Naive Bayes formula, obtain good results but the fact that the SVMclassifier performs well shows that the current discoveries are in line with the literature.These two classifiers have always been shown to perform well on text classification tasks.Also it has been observed, that best results are obtained when the classifier is notoverwhelmed by sentences that are not related to the task.
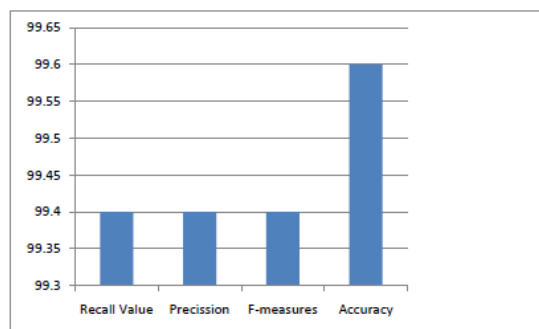
Fig7. Graphical representation of result and its Comparison

6. CONCLUSION & FUTURE WORK

6.1 Conclusion

As described there are several techniques for detection of treatment on syndrome given. Theplanned relies on ML techniques and NLP techniques i.e. a) a supervised learning methodwith an SVM classifiers and (ii). a pattern-based technique mapped together it to the methodsapplied individually. The produces results demonstrate that the useful approach considerablyoutperforms the different mentioned techniques and gives a fine other ways to increasemmachine learning performance. In this proposed work, keyword searching algorithm used toretrieve relevant healthcare information for the equivalent user symptoms and the classifierare used for classify the relative relations between disease and treatment. For finding the bestresult data mining concept is very useful.

7.2 Future Work

As future work, different formats of pdf's could be accepted by the system. Also will try tofocus more on adding features that are specific for each concept, and to reduce the contextfrom sentence level to shorter contexts, look into more verb information, and betterunderstand and incorporate additional information for each relation. Further comparativeanalysis can be done with other classification algorithms in order to provide betterperformance.

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"Employability and Career Progression in Youth: Implications for Technological Innovation, Education, and Career Promotion"
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Abstract

Youth employability in the 21st century is increasingly influenced by a complex interaction of socio-economic, educational, and technological factors. As labor markets evolve rapidly in response to digital innovation and globalization, young people are confronted with growing challenges in aligning their academic qualifications and skills with industry requirements. This review critically examines how structural inequalities, outdated educational practices, and gaps in digital access contribute to employment barriers. Drawing on global and Indian literature, the paper advocates for an integrated policy and educational framework that enhances career guidance, promotes inclusive practices, and bridges the digital divide. Emphasis is placed on the urgent need for collaborative, future-ready solutions to prepare youth for sustainable employment in a dynamic economy.

Keywords:

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Introduction

Youth represent a significant proportion of the global labor force, making their successful transition into employment critical for economic and social development. However, youth unemployment and underemployment remain persistent challenges, particularly in developing nations like India. Rapid technological advances are reshaping industries and redefining career trajectories, yet educational systems often lag behind these transformations. This misalignment leads to skill gaps, lack of digital literacy, and missed opportunities for career advancement. The review investigates how socio-economic disparities, education systems, and access to emerging technologies collectively influence youth employability. The need to adapt educational curricula, enhance policy responses, and promote inclusive practices forms the basis of this paper's inquiry.

2. Methodology

This study employs a **systematic literature review methodology**, analyzing peer-reviewed articles, policy documents, and government reports published between 2020 and 2024. The sources were selected to reflect interdisciplinary perspectives—education, labor economics, technology studies, and public policy. The review aims to synthesize common themes, identify research gaps, and provide actionable insights relevant to youth employment in India and globally.

3. Literature Review

3.1 Socio-Economic Influences on Youth Employment

Sharma (2022) and Kumar & Shobana (2024) emphasize that demographic trends, regional disparities, and gender inequalities significantly influence youth employment outcomes in India. Financial constraints and lack of exposure to industry trends often lead youth to pursue education that does not match labor market demands. Chari (2024) further links socio-economic background with access to digital infrastructure, noting that marginalized communities suffer the most from educational and employment disparities.

3.2 Educational System Gaps

Wyn (n.d.) and Pradhan & Naik (2024) highlight the limitations of traditional education models, particularly the overemphasis on academic content without integrating practical, soft, or technical skills. The need for inclusive and adaptable education systems is underscored to better serve economically disadvantaged youth, Indigenous populations, and those in rural areas. Flexible learning pathways and career-oriented curricula are identified as essential components of a holistic education system.

3.3 Impact of Technological Change

Jain & Ranjan (2020), Kolade & Owoseni (2022), and Jung et al. (2024) address the dual role of technology as a disruptor and enabler. While automation and artificial intelligence transform labor markets, they also necessitate the development of new skill sets. The mismatch between graduate skills and employer expectations creates a "technological unemployment" gap. Institutions must adapt curricula to embed digital literacy, problem-solving, and adaptability as core competencies.

3.4 Inclusive Education and Digital Equity

Inclusive education emerges as a fundamental strategy for social equity. Pradhan & Naik (2024) assert that inclusive classroom practices not only benefit individual learners but also

foster collective well-being. Digital transformation, when equitably distributed, can narrow socio-economic gaps and promote upward mobility. Kraus et al. (2021) stress the need to expand access to digital tools and training, especially in underserved regions.

4. Objectives of the Review

- To analyze how socio-economic factors shape youth career decisions and employment readiness.

- To explore the role of education in bridging skill gaps and aligning with labor market needs.

- To assess the impact of technological advancements on youth employability.

- To recommend integrated approaches for improving employment outcomes and career progression among youth.

5. Key Findings

- **Education-employment mismatch** is a core challenge due to outdated curricula and insufficient career guidance.

- **Socio-economic barriers**, such as poverty and lack of information, reduce access to quality education and technology.

- **Technological innovation** is reshaping job markets, requiring new competencies and re-skilling initiatives.

- **Inclusive education and digital equity** are critical to improving long-term employment outcomes.

- **Policy gaps** persist in effectively responding to youth unemployment with targeted and adaptive strategies.

6. Recommendations

- **Modernize curricula** to reflect current and future labor market trends, integrating soft skills and digital training.

- **Strengthen industry-academia linkages** through internships, mentorship, and collaborative training programs.

- **Implement inclusive education policies** that address the needs of marginalized communities and promote lifelong learning.

- **Expand digital access** through public-private partnerships to ensure equitable technological literacy.

- **Develop comprehensive youth employment policies** focused on career counseling, entrepreneurship support, and targeted skill development.

7. Conclusion

Youth employment is at a crossroads in an era defined by rapid technological evolution and persistent socio-economic inequality. The literature confirms that traditional education models are insufficient to meet the dynamic needs of today's job market. Technological change, though potentially disruptive, offers opportunities for innovation and self-reliance—if accompanied by responsive education and inclusive policy interventions. By bridging gaps between educational institutions, technological access, and labor market expectations, stakeholders can create a more equitable and future-ready workforce.

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Design and Implementation of Block Cipher Symmetric Key Based Encryption Algorithm Using AI

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Abstract

As our technologies are advancing day by day, there is always a requirement to modify and updates our existing algorithms accordingly. Whenever a word security comes, confidentiality of our secured data is always required. Many algorithms have been proposed to ensure this need, but there is always a competition to design an algorithm which should be better in some parameters or factors. There are two basic & important factor of algorithm designing: SPACE and TIME. For space complexity, encryption algorithm should be designed in such a way, so that it will use less than or equal size of the original file size. For Time complexity, algorithm should take minimum time to encrypt and decrypt information. Many encryption algorithms have been invented to provide better security, but some algorithm takes more time in encryption and decryption and some have the size of cipher text more than plain text. So there is a need of designing an algorithm that provides better security with minimum time and space requirement.

In this research, authors have studied many such algorithms and after deep study on that, proposed their own algorithm called "Block Cipher Symmetric Key Based Encryption Algorithm" which is better in terms of space, time and security. Author also implemented this algorithm and presented its result which shows its efficiency compared to other algorithms.

Key Words - Encryption, decryption, plain text, cipher text, symmetric key, random key and stream cipher.

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Introduction

1.1 Overview

With the **i**ncreasing use of internet, transmission of data securely over the network is a big issue. To solve this issue computer science has developed a concept of data security called Cryptography. Cryptography is a technique which deals with the privacy, integrity and confidentiality of the data. This section discusses the concept of cryptography along with its different aspects. Cryptography is effectively synonymous with encryption which is the conversion of information from a readable form to unreadable and scrambled form. Encryption is divided into two types depending upon the key used. These are the public key encryption and private key encryption. This section gives a brief account of both types of techniques used for the security of data. Also it discusses about the various aspects and goals of cryptography.

1.2 Cryptography

Cryptography means not only providing security of information, but rather it is a set of techniques. It is a mathematical technique that concern with some aspects of information security, such as privacy, integrity of data and entity authentication. Data integrity means ensuring that information has not been altered by unauthorized or unknown means. There are some uniqueness of cryptographic algorithm in terms of security, performance, and ease of implementation. Performance refers to the algorithm efficiency calculated in a specific mode of an operation. Ease of implementation refers to the difficulty of realizing the algorithm through practical implementation. People need to use the cryptography in order to keep the personal sensitive information files to prevent from foreigners in concern of the security goals. The number of operations includes several algorithms to prevent the attacks of foreigners to reach and read personal files which are sited in personal computer or the owner would like to send somewhere [23].

There are several aspects of security. These are security service, security attack and security mechanism. Security service means a service which adds to the security of the data processing system and data transfers of any organization. Security mechanisms are means that are intended to detect, prevent, or recover from a security attacks. Any act that compromises with the security of message possessed by an association is called Security attack. Encryption means the method of transforming information or data from plaintext to cipher text. A small or large section of information, typically consist of a number which is called key that enables a sender to encode the message. There is also second key which enables a receiver to decode messages sent to him or her. There are various types of encryption techniques which include classical techniques, modern techniques, and public-key encryption techniques. Classical techniques are again categorized in substitution and transposition techniques. Substitution techniques are again partitioned in Caesar cipher,

mono-alphabetic cipher and poly alphabetic cipher. Block cipher, stream cipher and DES algorithm comes under the modern techniques. In Public-key encryption the RSA algorithm is there. Digital Signatures is also a part of cryptography that looks like in functionality as of hand-written signature [8] and Digital Certificates that are related to a unique ID-card. There are various applications of cryptography which includes communication, identification, electronic commerce, key recovery identification and remote access.

1.2 Encryption and Decryption Algorithm

Encryption is the process of hiding a data so that only the authorized receiver can read it and decryption is the just opposite process of encryption in which the unscrambled message is converted to original form and only the actual recipient can read it [22]. The real procedure of cryptographic is usually a complex formulation based on mathematics, which is hard to break. A key is send to the recipient so that they can decrypt and find the actual message by deciphering. For encryption algorithms keys are defined in terms of the number of bits. The higher the number of bits more difficult is to break that cryptosystem. Figure 1.1 is showing simple encryption and decryption process [1].
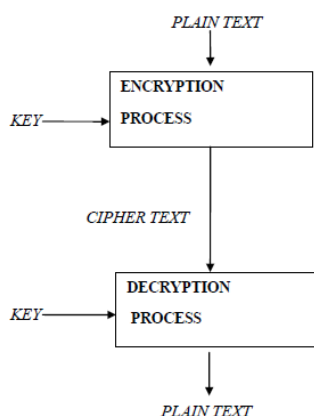
PLAIN TEXT

ENCRYPTION PROCESS

KEY

CIPHER TEXT

DECRYPTION PROCESS

KEY

PLAIN TEXT

Figure 1.1: Encryption and Decryption

2. LITERATURE REVIEW

2.1 Overview

This section of the thesis provides a brief overview of the work carried out in the field of encryption/decryption algorithm. Several algorithms have been proposed to ensure the security of the data being transmitted over the transmission channel. It presents the brief account of work done in this field. It also provides the knowledge about the several existing algorithms proposed till date to ensure the security of the data with efficient time and space requirement. Survey of different papers has been done so as to develop an algorithm that fulfills the requirement of secure data transmission along with better time and storage space.

Akhil Kaushik, Manoj Barnela and Anant Kumar [12] have developed an algorithm in their paper entitled‖ Block Encryption Standard for Transfer of Data ―. This paper named its

algorithm BEST. BEST stand for Block Encryption Standard for Transfer of data. The BEST encryption algorithm belongs to a class of private key block. It takes 10 rounds to convert 32 bit plaintext block into 32 bit cipher text block. Security of any algorithm resides in its key, BEST algorithm uses ten random keys called primary key and one secondary key to encrypt the whole text. It is easy to perform cryptanalysis on a single key, but guessing ten keys which are totally random and in a particular sequence is near to impossible. The length of the plain text and the encrypted text remains same. Total numbers of attempt required to break the key of BEST algorithm is $2^{32}*2^{10}*2^{24} = 2^{64}$.

Neeraj Khanna, Joyshree Nath, Joel James, Amlan Chakrabarti, Sayantan, chakraborty and Asoke Nath [13] have developed a new algorithm in their paper entitled —New Symmetric key Cryptographic algorithm using combined bit manipulation and MSA encryption algorithm: NJJSAA symmetric key algorithm. NJJSAA is another symmetric key data encryption algorithm used to provide confidentiality. This encryption algorithm uses a random key generator for generating the initial key and this key is used for encrypting the secret file. To generate this random key, algorithm required a bit stream of length in between

1 to 127 provided externally. For the same bit stream, the random key generated by algorithm is always same. The randomly generated key is a key divided into 8*8 matrixes, which contain all the ASCII characters having ASCII values from 0 to 255. To encrypt a message, NJJSAA uses MSA method which is basically a substitution method where it takes two characters from plaintext and then searches the corresponding characters from the random key matrix. Here three cases are possible, if the searched characters are in same row than it replaces this character by next two characters in the same row. If two characters are in same column than replace this two characters with next two characters in the same column and if the two characters are not in same row and same column than replace the first character with the character in column of second but row of first and replace second character with character which is in row of first characters but column of second character. This algorithm repeat the above step till all the characters of plaintext is encrypted.

In Research Paper [14] Dripto Chatterjee et.al presented an extension of MSA algorithm called DJSA algorithm. They overcome the weak point of MSA algorithm developed by nath et.al by applying a square key matrix of size 256 by 256. In this method basically a substitution method is used where they take four characters from any input file and then search the corresponding characters in the random key matrix file after getting the encrypted message they store the encrypted data in another file[16]. Each cell contains all possible combination of 2-lettered words (ASCII code 0-255). Author's method will also be suitable for encryption of file size 2MB or less. If the file size is very big then author suggest to choose a small encryption number so that speed of the system can be increased (2011).

In Research Paper [15], Debanjan Das, Megholova Mukherjee, Neha and Joyshree Nath introduced a key method based on an integrated symmetric key cryptographic, called DJMNA, which is a combination of two different methods (i) Modified Generalized Vernam Cipher (MGVC) and (ii) DJSA method. Generalized Vernam Cipher uses the concept of

―feedback‖ effect and it reverses the file during encryption, so it become very difficult to decrypt the data by applying any brute force method (2011).

In Research Paper [22], Aasif Hasan, Neeraj Sharma this paper is an attempt to invent a new method named Name based encryption (NBE) which provides great security level with lesser time complexity. This improved technique is combination of stream ciphering and symmetric ciphering technique. This algorithm uses a dynamic key concept in which key is decided at the time of encryption. (2014).

In Research Paper [23], Akhil Kaushik Krishan Gupta and Satvika discusses an innovative approach for encrypting small amount of data, which will be practically useful for the small scale organizations. Author used the concept of ASK cipher. It is based on the concept of bit compression, so that the less amount of data to be transferred over the unsecure channel. Author also shows that their Algorithm performs excellent for smaller organizations (2014).

In Research Paper [27], Md Asif Mushtaque and Harsh Dhiman has proposed a new encryption/ decryption algorithm called AMEA. Author shows that, their algorithm is space & time efficient as well as very secure. It is good for minimum bandwidth channel whose transmission capacity is limited. The algorithm has new added feature like random key selection with transposition for better security of data.

3. Problem Identification

3.1 Problems Identified

Several researchers have proposed encryption/decryption algorithm to offer high security with minimum time. In Research Paper [12], Akhil Kaushik, Manoj Barnela and Anant Kumar has projected a new encryption/ decryption algorithm called BEST. It is a simple Encryption/Decryption algorithm which uses multiple arbitrary keys to encrypt a single block of data. Multiple keys enhance the security as it is easy to guess a single key but it is very difficult to guess multiple keys in identical sequence. At the same time it is also important to keep those keys secret. In this algorithm, to share all keys among two parties the keys are kept in central database. If anyone succeeds to get access on this central database then the security of the algorithm is entirely failed. Also it is easy to keep one key secret but to keep multiple keys secret is quite difficult. It also has a big problem that the internal structure of BEST algorithm is not much robust.

In Research Paper [13], Neeraj Khanna, Joyshree Nath, Joel James, Amlan Chakrabarti, Sayantan, chakraborty and Asoke Nath proposed an encryption/ decryption algorithm called NJJSAA. While analysing NJJSAA algorithm, we have found a lack in NJJSAA algorithm that to produce a randomized key it generates a random number whose value is in between 0-31 and the complete randomization of the key is depended on this number, so there are only 32 different combinations are possible of randomized key. So it is easy to generate this 32 combination without knowing the exact bit stream. Therefore it is not secure. Also after

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implementing this algorithm, experimental result shows that it is not time efficien. It takes longer time to encrypt or decrypt a message.

The problem analysed in DJSA [14] is repetitions of encrypted text as the pattern of key is repeated. This problem is overcome by DJMNA [15] by integration of two methods. Author also tried to provide better security that cannot be break by any brute force method. During the analysis of AMEA [27] authors have very much tried for an algorithm that is very much secure as well as very time and space efficient but does not work well in high bandwidth channel. This thesis proved the better security and space, time efficiency by showing experimental results. This thesis implements the AMEA algorithm and to check the strength of internal structure, avalanche effect is also calculated and found that the avalanche effect of AMEA is low. Hence its internal structure is not very much secure as compared toour proposed —Block cipher symmetric key based encryption algorithm.

3.2 Problem Analysis of Research Paper

After analysis of all the research paper, the following conclusion comes.

☐ Encryption time of BEST algorithm is less than NJJSAA algorithm, but it does not have secure internal structure.

☐ NJJSAA is not time efficient. It is found that only 32 combinations are required to break the key. Throughput is less in NJJSAA.

☐ In DJSA If someone wants to give a brute force method to find their actual key then one has to give a trial for 65536 runs. But the limitation is the maximum length of the text key should be 16 characters. The problem in DJSA algorithm is that if we have same pattern repeated then the encrypted text may also repeat.

☐ In DJMNA the disadvantage of DJSA is overcome by using integration of DJSA and Generalized modified Vernam Cipher method to encrypt a large file such as one of size 2MB or more, it will take more time to encrypt as well as to decrypt some file. For large file one can choose some key in such a way that number of encryption will be less (say <=3) then encryption and decryption can be done in reasonable time.

In AMEA, size of plain text and cipher text is same. It is proved from implementation. So it is not very space efficient. And also not work well when transmission capacity is high.

4. PROPOSED WORK

4.1 Overview

In this research, researchers have introduced the architecture of a security system which provides high security over transmitted data. To provide high security, this thesis presents a new cryptographic algorithm which provides confidentiality and authentication on

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transmitted data. This thesis proposed a new Encryption/Decryption algorithm. The proposed algorithm is a block encryption algorithm that takes a single key and generates multiple random keys from that single key. The generation of these multiple keys is random but this algorithm needs to keep secret only one key that user enters. Hence it does not have a problem to keep multiple keys secret like BEST algorithm. But on the other side using multiple keys in proposed algorithm make the proposed algorithm complex for cryptanalyst. Experimental result shows that the proposed algorithm is secure and time efficient. To show the internal strength of proposed algorithm avalanche effect is calculated and experimental result shows that internal strength of proposed algorithm is high and close to ideal avalanche effect. Also experimental result shows that it is time efficient than base paper and AES algorithm.

4.2 Scope

The concept of text encryption and the word cryptography might be intimidating and complicated. The objective of the report is to develop a software tool that helps the user and the operations to achieve text security. A platform independent tool with user-friendly graphical user interface, using proposed algorithm for cryptographic operations will be the resulting product.

The following areas are within the scope of the proposed system:

☐ Encryption / Decryption Operations

☐ Authorization

4.3 Product Perspective

This new text encryption technique based on combination of block displacement and block cipher technique is a symmetric key encryption algorithm which is an improve version of existing algorithm. The proposed work overcomes the security limitations of existing algorithm by adding a new level of confusion thus resulting in a strong cryptographic algorithm. The proposed algorithm also ensures that encryption and decryption, avalanche effect and time efficiency are good as compared to existing algorithms. The architecture in the figure below shows the process of encryption and decryption. Figure 4.1 is showing the general architecture of the proposed encryption process where a text will be selected as an input then 128 bits size key value will input. After that proposed encryption process will execute number of operation and finally a cipher text will be produced as an output.

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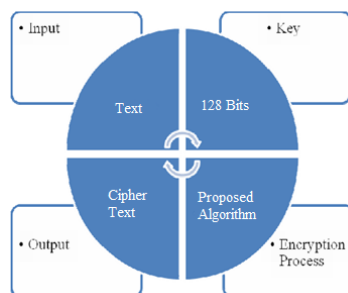Website: www.ijplsjournal.com, E-mail: ijplsjournal@gmail.com
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Figure 4.1: Architecture Diagram for Encryption

Figure 4.2 is showing the general architecture of the proposed decryption process where a cipher text will select as an input then 128 bits size key value as input. After that proposed decryption process will execute number of operation and finally original text will be produced as an output.
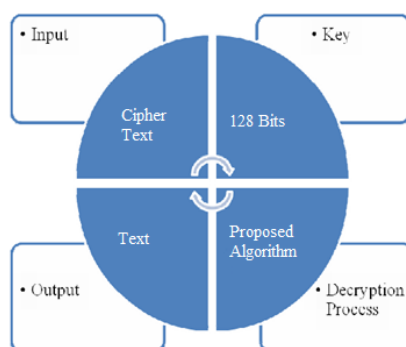

Figure 4.2: Architecture Diagram for Decryption

4.4 Proposed Algorithm Attribute

Proposed encryption/decryption algorithm has many attribute in which some of them are as follow.

- **Reliability and Fault Tolerance:** The Proposed algorithm is reliable and of enterprise quality.
- **Availability:** Secure data is always available for only authorized person.
- **Security:** The proposed algorithm is strongcryptographic algorithm because of 128 bits key length and its internal structure.
- **Correctness and Consistency:** The specification of proposed algorithm is correct and consistent.
- **Time Efficient:** Proposed algorithm is time efficient, so it can be used for real time secure data transmission.

5. EXPERIMENTAL SETUP

5.1 Overview

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This section describes the analysis, design and requirement (hardware software and functional) part of proposed algorithm. For proper designing of software it is necessary to have prior knowledge of the system requirement which can only be done by correct analysis of the requirements and the problems to be solved. If the problems are not analyzed correctly then the errors will occur which will result in poor software product development. Thus before designing any product it is necessary to have the knowledge of all aspects required for the development of the software product.

5.2 Analysis

Analysis is an important factor because "If user does not have the correct analysis, user cannot design or make the product right, and accordingly the product does not enable the users to do their work. The most common error in software development is solving the wrong problem. It comes from analysis of references. This error creates a huge number of such software products that are unprofitable or unusable and has been produced in the past, and continues to this day. The most common reason of this error is poor understanding of theproblem to be solved by the approaching software product. Tasks of formulating and prioritizing solutions are to be expected to lead to wrong conclusions without a clear analysis of the problem. Wrong conclusions result in unnecessary solutions to wrong or non-existent problems. The resulting software products are unmarketable and/or unusable [3, 5].

5.2.1 Requirement Analysis

The main purpose of system requirements analysis is to obtain a detailed understanding well defined requirement of the system need as clear in origination of project and captured in the system case, and to break it down into different needs, which are then firstly defined, clearly reviewed and agreed. At the time of system requirements analysis, simple framework of the application is developed, providing the foundation for all future design and development efforts. System requirements analysis is the challenging phase, because all of the major users and their interests are brought into the process of determining requirements. The product quality is highly dependent on the requirements identification processes that how much effectively collect these requirement. It is the most important for any developer that he present complete and accurate requirement to developed project. It is cleared that requirement analysis is the basis for all future work of the project, from design, development, testing and documentation. There are various techniques to collect accurately requirements like effective communication and collaboration among all the users, and provide the best chance of making a structure function that fulfill the needs of the users [3, 30]. The main goal of analysis phase is to make a functional specification in detail, defining the system capabilities in full set. UML models can create and ensure that the eventual solution provided by the users with the functionality then they need to meet their stated system objectives.
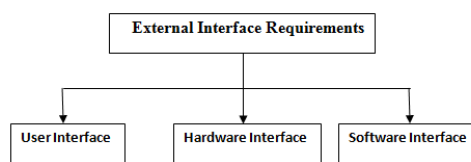
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Figure 5.1: External Interface Requirement

User Interfaces: - The proposed software will include a graphical user interface for user to interact with program. There are multiple options available in combinations of button and level with check box and radio button options and/or arguments.

Hardware Interfaces: - The Proposed work will be efficiently implementable in custom hardware and used for general purpose small, large as well as, medium sized processors (for e.g. Smart cards microprocessors and microcontrollers respectively).

Software Interfaces: - The proposed software is in C# programming language. The portability of other software implementations will depend on portability of chosen programming language.

5.3 Design

5.3.1 Data Flow Design

Data flow diagram shows the flow of the data. Data flow diagram has many types in which zero level data flow diagram is the initially diagram in which whole process is shown in the circle indicating the input flow and arrow indicates out flow. Figure 5.2 is showing zero level data flow diagram for the encryption process where plain text are passing in the encryption process as an input and after executing encryption process produces cipher text as an output. Similarly in the figure 5.3 is shown zero level data flow diagram the decryption process where cipher text passing in the decryption process as an input and after executing decryption process produces plain text as an output.

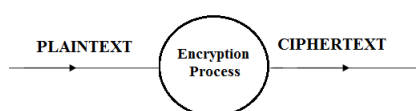Zero Level Data Flow Diagram for Proposed Encryption System:

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Figure 5.2: 0 Levels DFD for Encryption

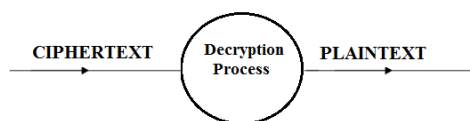Zero Level Data Flow Diagram for Proposed Decryption System:

Figure 5.3: 0 Levels DFD for Decryption

5.3.2 Use Case Diagram

A use case diagram depicts the conduct of the system or part of a system and also it describes a set of sequence of action together with variants that a system performs to give way a noticeable result of value to an actor. Figure 5.3 to 5.5 are the use case diagram for the proposed system.
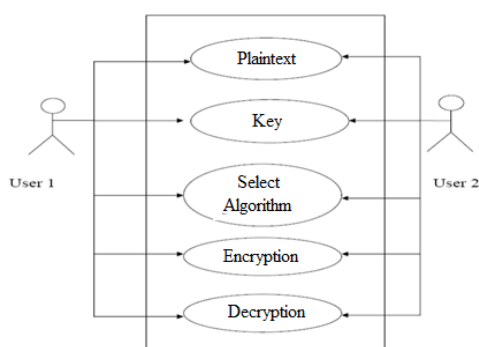
Use Case – 1: For Proposed Algorithm

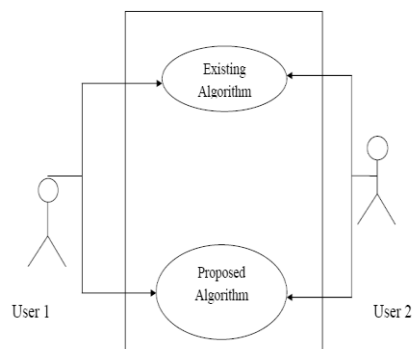Figure 5.4: Use Case -1

Use Case – 2 For Selection of Algorithms

Figure 5.5: Use Case Diagram 2
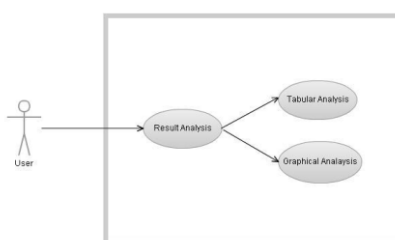
Use Case – 3 For Results Analysis

Figure 5.6: Use Case Diagram 3

6. RESULTS ANALYSIS

6.1 Overview

In this part the analysis of the result is mentioned in terms of performance. Several sample files of various sizes are analyzed. Several rounds are performed to calculate the result with both the algorithms. The experimental result calculated shows the efficiency of the proposed algorithm over the existing algorithm. This section also compares the result of both the algorithms to show the efficiency of the proposed algorithm. The performance of the algorithm is estimated on the basis of speed, time and security. The security is measured in terms of avalanche effect. The greater the value of avalanche effect more secure is the algorithm.

6.2 Performance Analysis

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This section of the thesis shows the results of the calculated efficiency of the proposed algorithm which is based on selected parameters. The main aim of this research is to provide security to the data being transmitted over the network by proposed technique. To accomplish this, displacement technique and block cipher technique are combined to increase the efficiency of the proposed system. The experimental results mentioned below show the supremacy of the proposed encryption algorithm over existing algorithms in terms of processing avalanche effect and timing. In the experiments, the system encrypts/decrypt text. There are two parameters that are being calculated by the proposed system which include timing and avalanche effect which is shown in table 6.1, 6.2 and table 6.3. The proposed system has been run hundred times approximately for the three selected text displayed below. Every time, same text is respectively encrypted by existing algorithm and proposed algorithm. Size of the selected key was kept same for every time for the proposed algorithm. At last, the output obtained is the encrypted text (CipherText) (produced by existing algorithm and proposed algorithm). The timing and avalanche effect are noted in numeric form and are displayed below.

6.2.1 Tabular Analysis

All the results are presented below in the form of tables.

6.2.1.1 Timing

The basic benefit of any cryptographic algorithm is the speed of encoding and decoding of message. Proposed algorithm is particularly designed for the mentioned feature. Table 6.2 is showing encryption time of the proposed encryption/decryption algorithm on different files

size with same key value with base paper AMEA [25].

Table 6.1: Comparison of Encryption Time of Proposed Algorithm on Various File Size In Seconds

Files In KB	Algorithm			
	Execution Time In Second			
	AMEA Algorithm		Proposed Algorithm	
	Execution Time In Second	Throughput (Bytes/Sec)	Execution Time In Second	Throughput (Bytes/Sec)
5 KB	0.156	32576.9	0.110	46200.0
10 KB	0.483	20447.2	0.170	58094.8
15 KB	0.937	16008.5	0.35	42857.1
20 KB	1.747	11306	0.480	41150.0
25 KB	2.074	12054	0.65	38461.5

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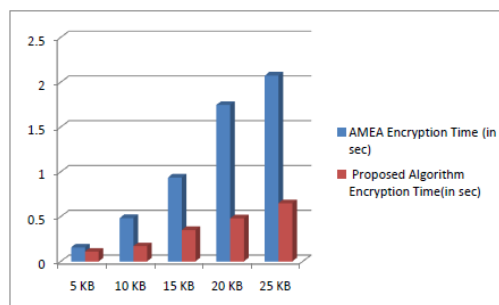Website: www.ijplsjournal.com, E-mail: ijplsjournal@gmail.com
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Figure 6.1: Encryption time of the AMEA and Proposed algorithms in seconds

A graphical representation for the table 6.1 is shown in figure 6.1. As per the graph, there is a leaning for encryption/decryption algorithm; execution time ascends with the file size. But required time for the execution of proposed encryption/decryption algorithm is much smaller than execution time of compared algorithms.
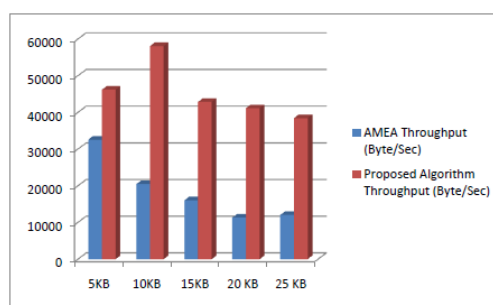

Figure 6.2: Throughput of AMEA algorithm and Proposed Algorithm

After detail analysis of comparison table it is clearly seen that proposed algorithm is more time efficient than other.

6.2.1.2 Security (Avalanche Effect)

Evaluation of security of cryptographic algorithm is a complex problem, because security usually means ability to withstand an attack, which is difficult to evaluate [19]. Encryption security considers the strength of encryption algorithm. In cryptography, the avalanche effect is considered as an enviable property of any cryptographic algorithm. In the case of block ciphers, a small change in either the key or the plaintext should produce a drastic change in the cipher text [28]. Avalanche Effect is used to calculate the strength of any cryptographic algorithm. According to the avalanche effect, on changing the single bit in key 50% bits of

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cipher text must change. The algorithm close to avalanche effect is more secure against cryptanalysis. Table 6.2 shows the avalanche effect of proposed algorithm.

Algorithm		
Avalanche Effect		
Sample	AMEA Algorithm	Proposed Algorithm
5 KB	34.72	47.97
10 KB	32.71	48.33
15 KB	36.23	48.92
20 KB	34.18	49.37
25 KB	39.87	50.12

On processing different 50 files, it is found that average avalanche effect comes out between 49 to 50%. This shows the strength of proposed encryption algorithm on comparing it with AMEA and Proposed algorithm; it is found that avalanche effect of proposed algorithm is better than the AMEA algorithm.

7. CONCLUSION & FUTURE WORK

7.1 Conclusion

The proposed algorithm has been intended in an adept approach but off- course not compromising the security issues of the data. It has been effectively implemented on the text data. The proposed work also tried to measure the performance of presented algorithm against some famous Symmetric Key Algorithms like AES algorithm. The proposed algorithm uses less time to transfer data as compared to the existing algorithms and it provide the better security aspects than the other symmetric key algorithms. Avalanche effect of nproposed algorithm exhibits the internal firmness of proposed encryption and decryption algorithm. So for this reason this algorithm proves to be a very efficient technique for transmitting data from sender to the receiver, accomplishing both confidentiality and message authentication. The proposed algorithm avail extreme protection throughout the transmission of data, thus accomplishing data to be least fragile to different network attacks.

7.2 Application

Proposed algorithm can be used for secure data transmission over the network. It can be used by technologies providing mass encryption of constant data, such as e-mail messages and document files.

7.3 Future Enhancement

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☐☐Make it more efficient in terms of security, time and space.

☐☐It can also be integrated with other algorithm like integrity, authentication algorithm

to get more benefits.

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The Changing Role of HRM in the Age of Artificial Intelligence

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Abstract

The integration of Artificial Intelligence (AI) in Human Resource Management (HRM) is fundamentally evolvingtheworkplace.AI technologiesareincreasingly being utilizedin performance management, talent acquisition, employee engagement and training. These tools not only automate tedious repetitive administrative tasks, but also offer predictive analytics, real-time feedback and personalized employee experiences. This study explores the changing role of HRM through a thorough analysis of recent literature and theoretical frameworks. It suggests a three-phase model of AI integration in HRM, i.e, Technocratic (task automation), Integrated (AI-human collaboration), and Fully Embedded (strategic partnership).Drawing fromempiricalresearchandtheoreticalmodels,thestudyexaminesboththeopportunities and challenges presented byAI in human-centric workplace management.

The key discoveries suggests that whileAI enhances productivity,accuracyandpersonalization,it also raises concerns around bias, transparency, and job displacement. The paper culminates that HR professionals must adopt an ethical, multidisciplinary, and human-centered approach to manage the evolving dynamics of AI in HRM efficiently.

Keywords: Human Resource Management, Artificial Intelligence, Recruitment,Performance Management, Human-Centric AI, Employee Engagement, Ethical AI, Digital Transformation, HR Tech.

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Introduction

A new ear in organizational administration has been brought about by the development of Artificial Intelligence (AI), which has had a big impact on Human Resource Management (HRM).HRM has always been linked to administrative duties like payroll compliance and hiring, but it is currently developing into a strategic role central to digital transformation and organizationalperformance(Fenwicketal.,2024).AItechnologiesimproveproductivityand strategicdecision-makingbyenablingreal-timeanalytics,tailoredemployeeinvolvementand the automatic of repetitive process (Nishar, 2023).
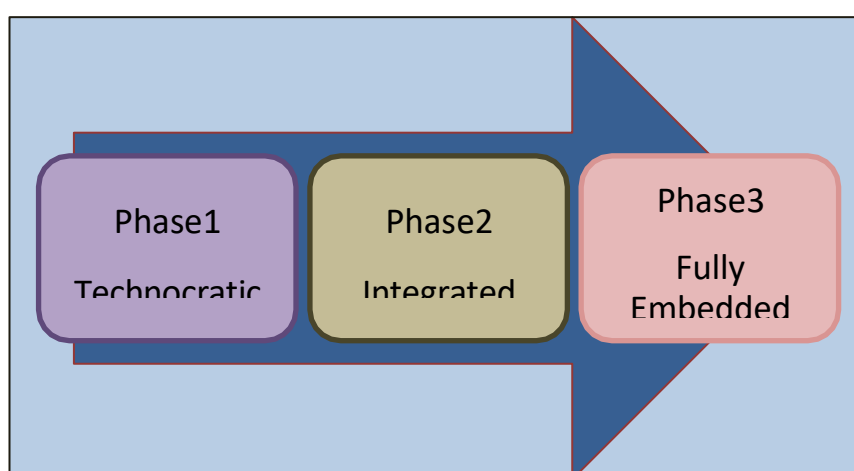
The transformation of HRM throughAI can be viewed through three progressive phases, i.e, theTechnocratic(taskautomation), Integrated(AI-humancollaboration)andFully-embedded

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(strategic human-AI symbiosis.As organizations transition through these phases, HR professionals confronts both unprecedented opportunities and challenges, such as algorithmicbias,ethicalimplicationsandtheneedfornewskillsets.This paperdelves deeply into these changes and provides a roadmap for HRM's changing function in the AIera.

LiteratureReview

The revolutionary potential of AI in HRM services has been highlighted in recent research. According to Nishar (2023), AI improves fit prediction, lower bias and automates applicant screening to maximize hiring.Platforms powered byAI simplify performance management by providing real-time feedback and predictive analytics.AI has also changed training and development by providing individualized virtual coaching and adaptive learning pathways.

The integration of AI and HRM is divided into three stages by Fenwick et al. (2024).AI facilitates task automation during the Technocratic phase, including onboarding and resume filtering.AI works alongside human decision makers in the Integrated phase to complete activities like succession planning and performance appraisal.Lastly, AI systems are envisioned as strategic partners in forming organizational culture and policy during the Fully Embedded phase.

Phase1
Technocratic

Phase2
Integrated

Phase3
Fully Embedded

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Despite these advancements, the literature raises critical concerns.De Stefano and Wouters (2022) warn against invasions of data privacy whereas Budhwar et al. (2023) draw attention to the dangers of dehumanization and loss of employee trust.These studies highlight how HRM must strike a balance between efficiency and moral accountability, supporting transparent and human-centered AI systems.

ResearchMethodology

Using a qualitative review methodology, this work synthesizes findings from conceptual papers, case studies and recent peer-reviewed journals.Amongthe chosen sources are policy studiesbyregulatoryliterature,theoreticalframeworksbyFenwicketal.(2024) and empirical research by Nishar (2023).The three stages of the AI-HRM framework: Technocratic, Integrated and Fully Embedded forms the basis of the analysis.

The five main HRM functions of recruitment, training, performance management, employee engagement and retention were the subject of a thematic coding approach used to extractdata.Challenges like data privacy, ethical AI use and organizational preparedness were also taken into account.This approach offers a comprehensive understanding of the evolving HRM landscape in the age of AI.

OpportunitiesEnabledby AIin HRM

Artificial Intelligence (AI) offers a plethora of options to improve human-centric workplace management by transforming conventional HRM functions into more effective, data-driven and personalized process.By automating the sourcing and screening of candidates and using algorithms that evaluate vast datasets to find qualified applicants based on fit and skills, Artificial Intelligence (AI) improves workforce quality and lowers human error in hiring (Nishar, 2022).Additionally, AI-powered platforms facilitate customized learning and development initiatives allowing staff member to participate in self-paced training that is in line with their job descriptions and professional objectives.These chatbots and virtual teacherspromote lifelonglearning, enhanceskill acquisitionandofferpromptadvice(Nishar, 2022).Furthermore, AI-driven performance management systems evaluate employee behaviour, output and teamwork using real-time analytics enabling HR to provide more immediatefeedback and personalized support.Byseeingearlyindicatorofdisengagement or turnover risk, AI's predictive capabilities significantly boost talent retention tactics by enabling prompt interventions that raise employee loyalty and job satisfaction.More widely, with real-time data insights and more intelligent decision making processes, AI integration enable HR to transition from transactional roles to strategic partners, allowing people management to match with company's goals (Fenwick et al., 2024).

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Findings

Thefindingsreveal thatAIhas significantlyenhanced HRM operations:

1. **Recruitment:** AI-powered tools like resume parsers, chatbots, and predictive analytics enhance candidate experience and reduce time-to-hire (Nishar, 2023).

2. **Training and Development:** Adaptive learning systems provide personalized training programs, increasing employee engagement and retention (Fenwick et al., 2024).

3. **Performance Management:** AI enables continuous feedback and objective appraisal mechanics, fostering a culture or real-time performance improvement.

4. **Retention:** Predictive models identify at-risk employees and suggest tailored retention strategies, increasing job satisfaction and organizational loyalty.

5. **Engagement:** Sentiment analysis and AI-driven surveys offer insights into employee morale and workplace culture.

The incorporation of AI is not without limitations, though.Problems like algorithmic bias and lack of explainability revealed issues during the Technocratic phase.User resistance and HR professional's lack of AI literacy are two issues in the Integrated phase.The Fully Integrated phase necessitates strong ethical frameworks and adherence to regulations to guarantee accountability and equity.

Discussion

The transition from HRM through AI reflects a shift from operational support to strategic influence.Efficiency and cost minimization are the main priorities during the Technocratic phase.The Integrated phase necessitates new competencies in ethical oversight and data interpretation between AI systems and human professionals.

As organizations move into the fully embedded phase, embark on HRM's responsibilities grow to encompass employee welfare, AI governance and digital culture management.A human-centricstrategythatprioritizecontinuouslearning,transparencyandinclusivityis necessary for

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this transition.HR professionals need to act as intermediaries between developers and employees, ensuring that AI tools align with organizational principles and employee expectations (Fenwick et al., 2024).

Conclusion

AI is redefining HRM's function , shifting it from administrative effectiveness to strategic leadership in digital transformation.Although AI has many advantages such as personalization, automation and predictive capabilities, it also presents organizational, societal and ethical challenges.HRM's future resides in its capacityto balance both machine and human intellect, creating a workplace that is both highly technologically sophisticatedand deeply human.

HR executives need to takeamultidisciplinarystrategy that combines technologyproficiency with emotional intelligence, moral judgment and strategic vision in order to successfully manage this shift.Through this approach, HRM can guarantee that AI enhances rather than diminishes the human experience at work.

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Mobile Payment Systems and the Unorganized Retail Landscape: Catalysing Innovation and Startup Development

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Abstract

Focussing on their ability to inspire innovation and startup creation, this study looks at how mobile payment systems might alter the unorganised retail sector. Characterised by its scattered structure and low technological adoption, the unorganised retail sector finds great difficulty adjusting to the changing digital economy. This study looks at how the operating environment of these stores is changing as mobile payment technologies—digital wallets and QR code-based transactions—are embraced. By use of a mixed-methods approach comprising customer and store surveys as well as case studies of nascent fintech businesses, this study examines the adoption trends, advantages, and difficulties related to mobile payment systems. Results show that for disorganised stores, mobile payments increase transaction efficiency, customer reach, and financial inclusion. Moreover, the research notes the rise of creative businesses using mobile payment systems to offer value-added services, so promoting industry entrepreneurship. The study ends with stressing the strategic consequences for stakeholders and legislators in advancing digital literacy and infrastructure development to completely realise the potential of mobile payment systems in fostering innovation and sustainable development inside the unorganised retail environment.

Keywords: Mobile Payment Systems, Unorganized Retail, Innovation, Startup Development, Digital Economy, Fintech, Financial Inclusion.

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Introduction

Small, unofficial companies running outside the established retail model make up the unorganised retail sector. In many emerging countries, these companies—which range from street sellers to kiosks to neighbourhood stores—form a sizable share of the retail sector. They frequently struggle, nevertheless, with problems including financial exclusion, transaction inefficiencies, and limited access to digital tools. The arrival of digital technologies—especially mobile payment systems—has fundamentally changed the way these stores run. The contribution of mobile payment technology to innovation,

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entrepreneurship, and startup creation inside the unorganised retail market is investigated in this work.

Problem Statement

Even if digital technologies are becoming more and more popular, a lot of unorganised stores are still reluctant to use mobile payment systems for reasons including lack of digital literacy, infrastructure flaws, and opposition to change. Furthermore, even if mobile payment systems have many advantages, further research is needed on the difficulties integrating them into current corporate models cause. This study intends to fill in these voids by evaluating the effects of mobile payment systems on the unorganised retail sector and determining the main determinant of their acceptance.

Objectives

- To investigate unorganised retail sector mobile payment system usage trends.
- To investigate for small stores the advantages and drawbacks of using mobile payments.
- To investigate how fintech companies may propel digital revolution in unstructured retail.
- To evaluate how mobile payments affect financial inclusion and entrepreneurial development.
- To provide strategic guidance to legislators and interested parties' soto enhance digital adoption.

Review of Literature

Several studies have examined the impact of digital technologies on the unorganized retail sector. This section reviews existing research to provide insights into key trends, challenges, and opportunities in mobile payment adoption and digital transformation.

Adoption of Digital Payments in Retail

- **Agarwal and Chua (2021)** looked into how digital payments affect financial inclusion in developing nations. According to their research, mobile payment systems greatly lower transaction fees and improve small store accessibility to financial services.
- **Gupta and Sharma (2022)** examined how, especially in cash-driven countries, mobile payment solutions support consumer retention and corporate efficiency.

Challenges in Digital Payment Adoption

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- **Kumar and Mehta (2019)**found obstacles to digital payment acceptance including digital illiteracy, mistrust of digital transactions, and cybersecurity issues. Their research underlined the need of financial literacy campaigns in order to close the disparity in digital adoption among small stores.
- **Bansal (2020)**underlined even further how infrastructural constraints—such as inadequate internet access—limit the general deployment of mobile payments in rural and semi-urban areas.

Role of Fintech Startups in Digital Transformation

- **Jain and Verma (2021)**Small companies have greatly embraced mobile payments thanks in large part to fintech startups as Paytm, Google Pay, and PhonePe. Their research showed that loyalty programs and rebate offer inspire digital transactions, hence raising acceptance rates among unorganised stores.

- **World Bank (2021)**validated these conclusions, showing that by providing easily available financial services to micro-entrepreneurs, fintech-driven digital solutions help to empower individuals economically.

Impact of Mobile Payments on Entrepreneurship and Business Growth

- **Sharma and Patel (2022)**looked at how better cash flow management and increased market reach of digital payment systems help to support corporate expansion. According to their studies, small stores using mobile payments have more customer happiness and more profit-ability.
- **Das and Roy (2023)**investigated how unorganised stores may increase their operations by integrating mobile payments with e-commerce systems, therefore offering them fresh chances for expansion.

This review of literature highlights the significant role of digital payment solutions in transforming the unorganized retail sector. While mobile payments offer numerous advantages, challenges such as digital illiteracy and infrastructure limitations must be addressed to maximize their benefits.

Research Methodology

This study adopts a secondary research approach, relying exclusively on existing literature, reports, and case studies to analyse the impact of digital technologies on the unorganized retail sector.

- **Secondary Data Collection:** The research draws from journal articles, industry reports, government publications, and existing case studies to provide a comprehensive understanding of digital transformation in unorganized retail.

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- **Case Study Approach:** Specific cases of small retailers who have successfully integrated digital payments will be analysed to extract best practices and key takeaways.

Case Studies

Case Study 1: Adoption of Mobile Payments in Small Retail Businesses

Adoption of mobile payments greatly improves transaction efficiency and customer retention, according a case study of neighbourhood convenience stores in urban and semi-urban settings. According to studies already in publication, digital payments have lowered cash handling problems and raised sales.

Case Study 2: Role of Fintech Startups in Promoting Mobile Payments

Digital adoption among small stores has been greatly driven by fintech businesses as Paytm, PhonePe, and Google Pay. To inspire use, many sites include rewards, rebates, and easy-to-use layouts. Business model analysis of these businesses reveals their efficiency in closing the distance between conventional retail methods and digital financing.

Findings and Discussion

- **Increased Transaction Efficiency:** Adoption of mobile payments speeds up transactions and improves customer convenience, hence increasing sales volumes.

- **Financial Inclusion:** Small stores can use digital payments to access credit and banking services, therefore supporting economic stability.

- **Challenges in Adoption:** Major obstacles include lack of infrastructure, digital illiteracy, and worries about cybersecurity.

- **Role of Startups:** By providing bespoke financial products, incentives, and customised solutions fit for small stores, fintech companies help to enable digital transformation.

- **Strategic Implications:** Policymakers should concentrate on raising digital literacy, strengthening cybersecurity, and offering rewards for digital usage.

Conclusion

A major first towards digital transformation, the inclusion of mobile payment solutions in the unorganised retail sector promotes entrepreneurship and innovation. Although mobile payments have many advantages, their impact may be maximised only by solving adoption challenges. This study emphasises how cooperatively legislators, fintech startups, and stores should build an inclusive and sustainable digital economy. Future research should investigate how long-term digital adoption affects unorganised retailers' financial development.

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SIMULATION OF HEAT TRANSFER ENHANCEMENT IN CORRUGATED CHANNEL BY NUMERICAL INVESTIGATION

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Abstract

In the current work, a numerical exploration is made on the flow characteristics and improvement of heat transfer in 2D channel with wavy wall covering a broad range of Reynolds numbers. For enhanced understanding, the numerical analysis is carried out by considering three different wall-geometry (triangular, sinusoidal, and trapezoidal corrugated wall). The outcomes are examined by drawing graph of the wall-Nusselt number along the channel length by varying the operating parameters like Reynolds number, amplitude of geometry, heat flux. The flow characteristics (such as pressure, temperature, velocity) deviation down the channel are also being examined to encapsulate the hydrodynamics. The two modes of boundary conditions employed are constant heat flux and constant wall temperature at the channel-wall, at the inlet velocity is completely stated, and atmospheric pressure is specified at outlet. The fluid used for the simulation is water.

In this analysis, it is perceived that with the increase in the geometry amplitude and Reynolds number there is significant enhancement in heat transfer. It is obtained from the analysis that the heat transfer rate is maximum with triangular channel and the pressure drop is minimum with triangular channel.

Keywords:

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1.Introduction

Heat transfer augmentation with nominal pressure drop by any heat exchanging devices is extremely important phenomena within the thermal engineering [5]. It has a bunch of application in Heat exchangers, method industries, Evaporators, Condenser, Thermal power plants, Air-conditioning systems etc. Overheating is the major problem associated with any power plants that triggers the failure of the system and the efficiency of the system is also reduced due to loss of heat in various forms. To overcome this problem effective cooling is required for which a heat exchanger is employed [2]. A heat exchanger is a device that transfer heat from hot fluid to the cold fluid with maximum rate and minimum investment. Employing heat exchanger also improve the efficiency of the system for super-heater, feed hot-water heater, condenser, air pre-heater used in power plant is used to increase the efficiency of the system [1]. The two major parameters associated with heat exchanger are heat transfer rate and the pressure drop across it (if it is high then additional power would need to pump the fluid). In a heat exchanger device heat transfer takes place mainly due to

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convection and from newton's law of cooling for convection heat transfer depend on surface area exposed and difference of wall temperature and fluid temperature [3]. Since temperature difference can be varied only to certain limit, other ways to improve the heat transfer rate is by either varying heat transfer coefficient or to vary the area exposed in such a way that it has minimum pressure drop across it. A number of the ways to improve the warmth transfer rate are given below.

1.1 Methods to improve the Heat Transfer:

Transfer of heat in a heat exchangers takes place primarily due to convection and from newton's law of cooling for convection we all know that the heat transfer is proportional to convective heat transfer coefficient, the surface area exposed, and difference between the surface and fluid temperature [4]. The convective heat transfer coefficient is the function of fluid properties like its density, velocity, viscosity, specific heat, velocity etc.

a) ActiveMethod: This method is based on the forced convection that is an external devices like blowers, pumps, fan etc. are used to agitate the fluid. Due to which convective heat transfer coefficient increases [10]. The Figure 1.1 shows a compact machine that is cooled by axial flow fan is an example of active method.
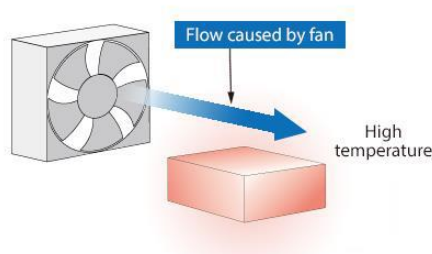
Figure 1.1: Active Method of enhancing heat transfer rate

b) Passive Method: This technique based on the surface treatment method without aid of any external power device. Various surface treatment like: imposing surface roughness on the wall, use of baffles or fins, changing the shape of the wall of pipe/channel (corrugated wall), etc. are used.
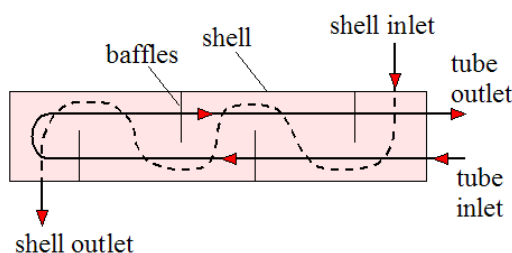

Figure 1.2: Passive Method of enhancing heat transfer rate

Figure 1.2 shows shell and tube heat exchanger using baffles. This method is very simple and does not require any further power. Therefore the cost of operation is less as compared to

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active method. The baffles creates barrier to the flow so that thorough mixing of the fluid takes place, which in turns increases the heat transfer rate. But the major disadvantage associated with it is that the pressure drop across it is increased and eventually more power for pumping of working fluid is required.

c) Compound Method: This method is the amalgamation of the two methods discussed above. It is clear from the Figure 1.3 that the fins are incorporated to the wall of the channel and the external device (Fan) forced the fluid in the channel.

This thesis is solely based on the passive method of heat transfer enhancement.
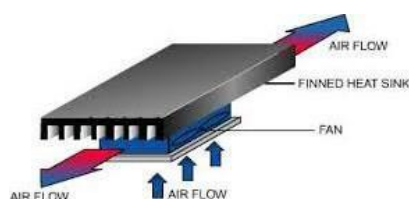
Figure 1.3: Compound Method of enhancing heat transfer rate

1.2 Corrugated Channel and Its Application: The term corrugated means that wavy or uneven that's, it consists series of repetitive and parallel formed wall such as: curving, triangular grooves, square, trapezoidal etc [10]. As a result of this uneven geometry, it creates the disruption within the flow and causes the reversal or recirculation of the flow. Recirculation regions at the wall boosts the blending of the fluid and diminish thermal boundary layer, which results in rise of the heat transfer rate. However the corrugated channel has major disadvantage of accumulated overall pressure loss, which ends in additional power demand to pump the fluid.
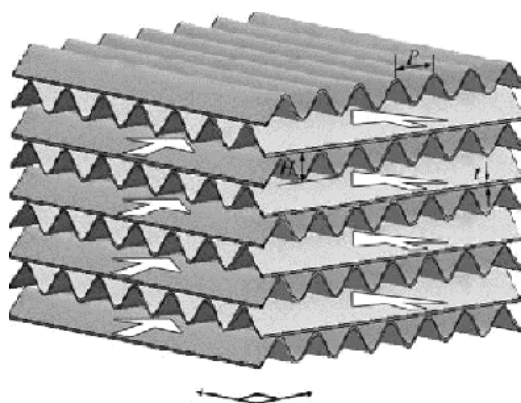
Figure 1.4: Sinusoidal Corrugated channel

2. LITERATURE SURVEY

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Corrugated channel are being well utilized in small heat exchangers, micro heat exchangers, and lots of different heat exchangers such as: thermal power plants, condenser, air-con system, evaporators, cooling of turbine blades, radiators of vehicles and vehicles etc.

Enhancement of heat transfer rate using furrowed channels (passive method) is associate rising space of analysis currently a days. Several scientist are operating completely in this area. They indeed done numerous experimental, numerical, and analytical study with numerous forms of furrowed channels. Several of them have given their contribution in this area. For instance,

Hamza et al. [1] has done associate experimental study on the results of operational parameters on stratified forced convection. He thought of V-corrugated channel with air as an operating fluid for this experiment. For this experiment associate constant heat flux condition is applied to the upper wall of the V- furrowed channel and the lower one was insulated. The assorted variable parameter taken are Reynolds number, temperature of air, painter variety the angle of tilt of the V-corrugated channel. And therefore the result of those parameters on the Nusselt numbers were evaluated by varying these parameters in respective ranges.

Islamoglu et al. [2] performed associate experiment to judge the friction factor and convective heat transfer coefficients of furrowed channel in a plate heat exchanger during which operating fluid used are air. He performed the experiment for 2 totally different heights of furrowed channel and single tilt angle of V- furrowed channel for different value of Reynolds number. The results displays that there's a vast increment in each the Nusselt variety and the pressure drop with the heights of the wave.

Paisarn [3] did associate experiment to review the heat transfer characteristics and pressure drop of the streamline flow through the triangular formed furrowed channel. He performed the experiment for various angle of 20°, 40°, and 60° whereas the peak being constant at 12.5 mm. He maintains a continuing heat flux through the channel and varied the Reynolds numbers within the range of 500 to 1400. And created associate observation that for higher worth of Reynolds numbers and the tilt angle, the rate of heat transfer is higher on the expense of pressure drop.

Mohammed et al. [4] studied numerically the fluid flow and therefore the stratified forced convective heat transfer characteristics. He performed the simulation on V- furrowed channel having the worth of Prandtl number as 0.71. For his studies he varied the Reynolds numbers from 500 to 2500 and the angle of V-corrugated channel from 00 (straight pipe) to 600.

Pethkool et al. [5] performed associate experiment on helical furrowed tube and examined the convective heat transfer with flow. He collected the result for various pitch to diameter ratio and Reynolds numbers and observed a rise within the convective heat transfer of 1.23 to 2.32 times than that of sleek pipe, reckoning on the rib height of the helical tube. Friction factor conjointly will increase within the range of 1.46 to 1.93 times of the sleek tube.

Yin et al. [6] investigated numerically the flow and also the convective heat transfer characteristics of curving furrowed channel by varying the phase angle between the higher and lower furrowed wall. He meted out the simulation for constant wall temperature condition at the wall and periodic condition at recess of the channel for different Reynolds numbers. The results shows that by increasing the phase angle, The shear stress, friction

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factor and the average Nusselt number decreases linearly. It absolutely was concluded within the paper that higher overall performance is extracted by the channel having part shift angle of 0o and 90o. The best result was obtained by the channel having part shift angle of 0o.

Ozbolat, V. et al. [8] coherently describes the heat transfer improvement and flow characteristics in two-dimensional furrowed (sinusoidal and square) channel. During this work the comparison has been created between completely different shapes of furrowed geometries with different Reynolds numbers and different wall temperatures boundary conditions. This work additionally provides completely different rate and temperature contours for various conditions. This work also compare the Nusselt number variation among the straight, curving and square furrowed channel and eventually they reported that curving furrowed channel provides higher results than different two shapes.

Pehlivan et al. [9] performed experiment by taking three differing kinds triangular furrowed surfaces. Two completely different channel height was taken and angle of tilt was varied. The experiment was performed for the various Reynolds numbers keeping the heat flux constant. This paper conclude that converging-diverging furrowed channel has comparatively higher result than that of furrowed channel having same phase angle and straight channel.

3. PROBLEM FORMULATION

3.1 ASSUMPTION FOR THE SIMULATION

The 2D incompressible steady flow of water (Newtonian fluid) is taken into account here. The fluid taken into account is assumed to be in single phase once it's flowing through the channel. The radiation heat transfer compare to the convection heat transfer is neglected here. The thermo-physical properties of the fluid are taken as constant.

3.2 CASES PERFORMED UNDER PRESENT PROBLEM

The problem is solved by considering different boundary conditions and different geometrical shapes that are described below.

3.2.1 Fully developed streamline flow with constant wall heat flux boundary condition:

The fully developed streamline flow is taken at the water of the channel. Inlet temperature of the water is taken as 300 K. The constant heat flux with no slip and no penetration boundary condition is applied at the wall of the channel. Different values of heat flux taken are 50 kW/m2, 100 kW/m2, and 150 kW/m2 and200 kW/m2. Three different furrowed channel with varying amplitude are taken into account that are represented below.

3.2.1.1 Sinusoidal geometry: The amplitude of this channel is varied as 1.75 mm, 3.50 mm and 7.00 mm. The specifications of the channel are shown in Table 3.1.

Amplitude (a) in mm	Wavelength (L_w) in mm	Minimum space (H_{min}) in mm	Maximum space (H_{max}) in mm
1.75	28	6	13
3.50	28	6	20
7.00	28	6	34

Table 3.1: Overall specifications of the channel with totally different amplitudes

With these amplitudes and constant heat flux BC, the problem are being solved for four different Reynolds number: 500, 1000, 1500 and 1900. The geometry for sinusoidal channel is shown in Figure 3.1. The profile equation for curving wall profile is taken as:
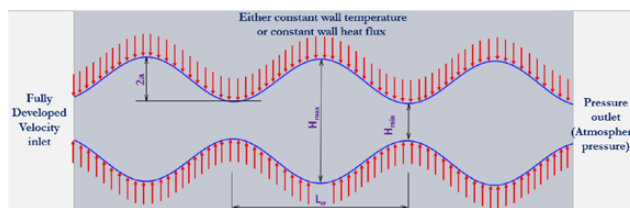

Figure 3.1: Schematic representation of the sinusoidal corrugated channel.

3.2.1.2 Trapezoidal geometry: The schematic diagram of trapezoidal profile is shown Figure 3.2. This case studied by considering amplitudes as 1.75 mm, 3.50 mm and 7.00 millimeter (See Table 3.1). With these amplitudes and constant heat flux BC, the problem are solves for four totally different Reynolds number: 500, 1000, 1500 and 1900.
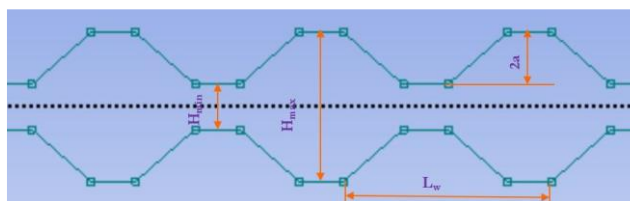
Figure 3.2: Computational domain of the Trapezoidal corrugated channel

3.2.1.3 Triangular geometry: The schematic diagram of triangular profile is shown in the Figure 3.3. Additional the amplitude of this channel is varied as 1.75 mm, 3.50 mm and 7.00 millimeter (See Table 3.1). With these amplitudes and constant heat flux BC, the problem are solved for four totally different Reynolds number: 500, 1000, 1500 and 1900.
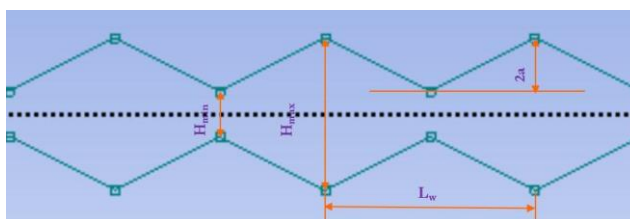
Figure 3.3 Computational domain of the triangular corrugated channel

3.2.2 Fully developed streamline flow with constant wall temperature BC: The totally develop streamline flow (given by using User outlined function) is taken at the inlet of the channel. Inlet temperature of the water is taken as 363 K. The constant wall temperature with no slip and no penetration condition is applied at the wall of the channel. Three totally different values of the wall temperature (365 K, 367 K, and 369.25 K) are considered. Three totally different furrowed channel and their amplitude considered are represented below.

4. NUMERICAL CALCULATIONS

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The governing equations are discretized by using the Finite Volume Method (FVM). For solving the problems of turbulent flow k-ε turbulent model is used. A commercial CFD software Ansys-Fluent 16 is used for the simulation. The details about the simulation scheme are described below.

4.1 GRID PATTERN EMPLOYED

After an extensive verification quadrilateral grids are employed for the present study. To capture the wall effect as well as to save the computation time, finer grid are selected near wall and coarser at the middle portion of the channel. The mesh employed for the sinusoidal geometry is shown in the Figure 4.1. For trapezoidal and triangular geometries, the mesh are shown in the Figure 4.2 and Figure 4.3 respectively.
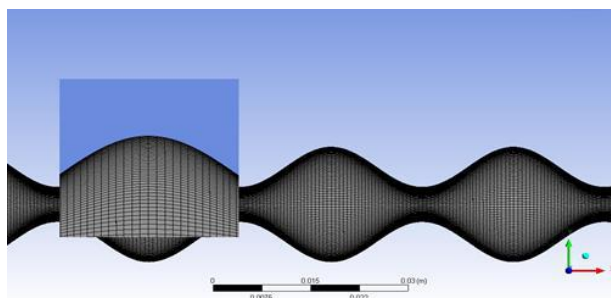
Figure 4.1 Pattern of grid for sinusoidal corrugated channel
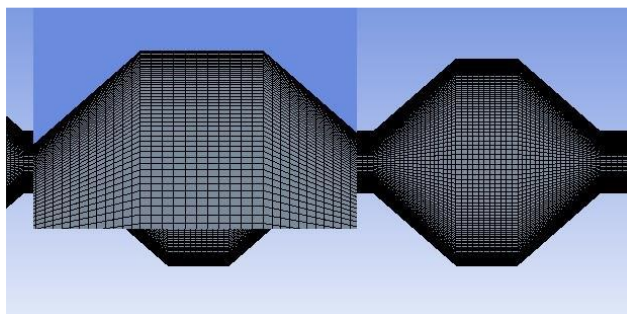
Figure 4.2 Pattern of grid for trapezoidal corrugated channel
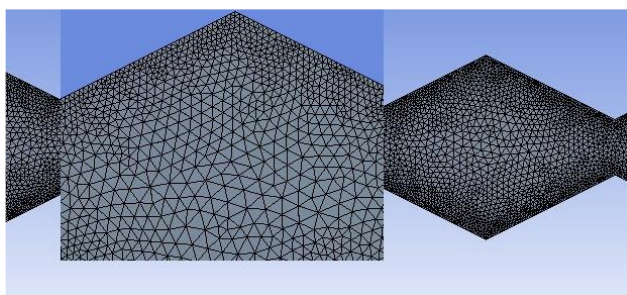
Figure 4.3 Pattern of grid for triangular corrugated channel

5. RESULTS AND DISCUSSION

5.1 GRID INDEPENDENCE TEST

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The mesh size and its quality affects accuracy and the computation time strongly. So the Grid independence test is carried out to choose the optimum grid size. The Grid independence test is performed by plotting surface Nusselt number along channel wall considering grid distribution as, 20×300, 50×300, 50×600, 100×300, 100×600, 150×600, 200×600 and 200×700 on the sinusoidal corrugated channel.
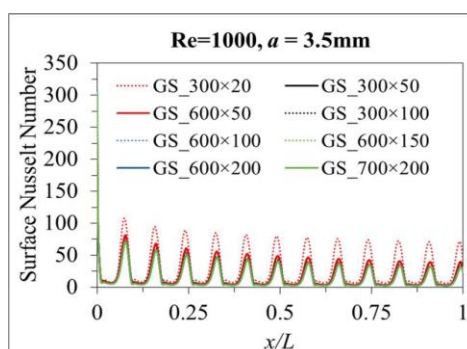

Figure 5.1 Grid independence test for surface Nusselt number, on corrugated sinusoidal channel of amplitude

For this test, the boundary condition at wall is taken as constant wall temperature (369 K) and at inlet, is taken as 'velocity inlet' with inlet water temperature of 367 K. At inlet fully developed velocity profile is used. Figure 5.1 shows the variation of surface Nusselt number along the corrugated wall of the channel with different grid sizes. It is found that when the number of element is more than 100×600, the variation in the surface Nusselt number with grid is very negligible. It is also confirmed from the Figure 5.2. Figure 5.2 shows a plot of average Nusselt number along the length of corrugated sinusoidal channel with different grid sizes. After an exhaustive verification of the results for different grid sizes and grid element, the mapped quadrilateral grid with 100 division along width and 600 division along length is considered for the present problem.
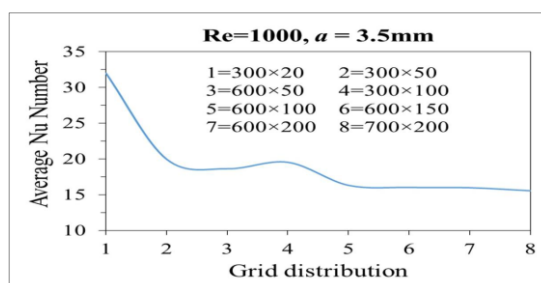

Figure 5.2 Grid independence test: Variation of average surface Nusselt number (on corrugated sinusoidal channel) along the length for different grid size.

5.2 VALIDATION

The validation of the present methodology is performed with Ozbolat et al. Validation performed with this work with the help of plot of surface Nusselt number along the wall of channel. The validation is shown on Figure 5.3. The result obtained are almost matching with the paper results.
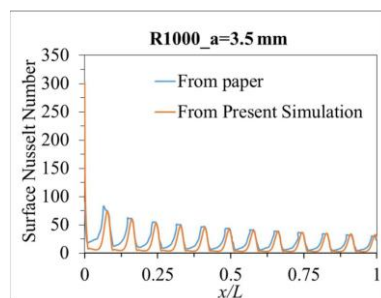
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Figure 5.3: Validation of surface Nusselt number along the sinusoidal corrugated channel with "Ozbolat, V. et al" research work

5.3 LAMINAR FLOW WITH CONSTANT WALL HEAT FLUX BOUNDARY CONDITION

Results for the present case are shown below categorically. Effect of *Re*, heat flux, geometry profile and the value of amplitude considering present case are shown.

5.3.1 Effects of the Reynolds Numbers: In this particular case, effects of Reynolds number on the surface Nusselt number for different heat flux are shown in Figure 5.4 to 5.7. The sinusoidal corrugated channel with amplitude (*a* =1.75 mm) is taken. The result shows that surface Nusselt number increases as the Reynolds number increasing. This may due to the reason that more recirculation is created consequently more mixing occurred as the Reynolds number increases.
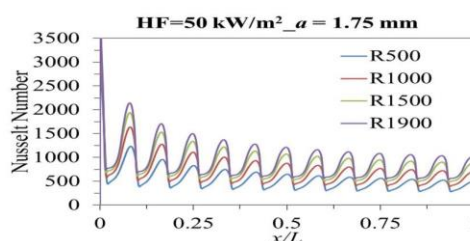

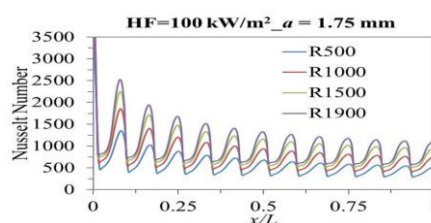Figure 5.4. Effect of Reynolds number on Surface Nu no. HF=50 kW/m2

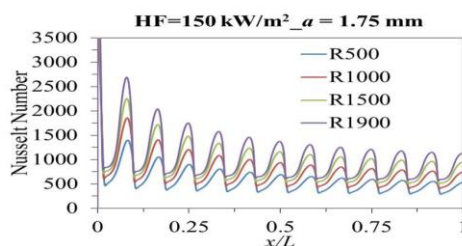Figure 5.5. Effect of Reynolds number on surface Nu no. HF=100 kW/m2

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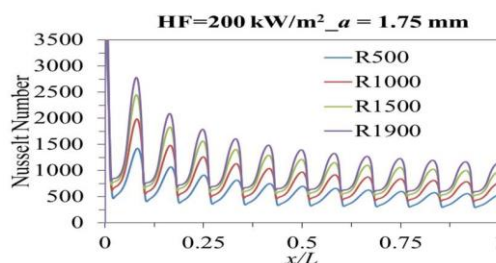Figure 5.6: Effect of Reynolds number on surface Nu no. HF=150 kW/m2

Figure 5.7: Effect of Reynolds number on surface Nu no. HF=200 kW/m2

5.3.2 Effects of the Heat Flux (HF): The variation of surface Nusselt number with length are plotted for different heat flux. This study is repeated for each of the geometry profiles. Figure 5.8 to 5.10 shows the results of these study. For all the cases in these Figures, the amplitude is fixed as $a = 1.75$ mm and Reynolds number is fixed as 500.
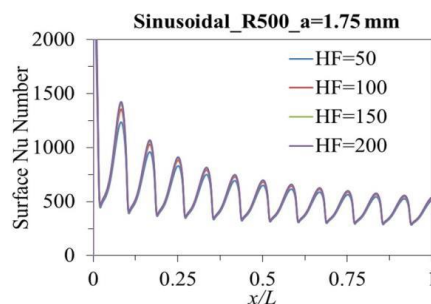

Figure 5.8: Effect of HF on surface Nu no.

(Sinusoidal profile)

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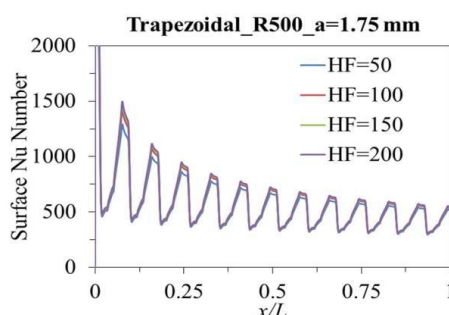**Website: www.ijplsjournal.com, E-mail: ijplsjournal@gmail.com**
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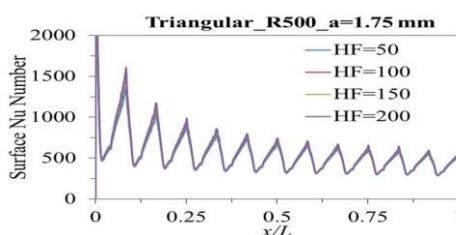Figure 5.9: Effect of HF on surface Nu no.

(Trapezoidal profile)

Figure 5.10: Effect of HF on surface Nu no.

(Triangular profile)

It is observed that there is a tendency to get a higher Nusselt number the heat flux is increasing. This tendency is maximum in trapezoidal profile.

5.3.3 Effects of the Geometry Profile: The Figure 5.11 shows the effects of the geometry profile on the velocity along center line. Effect of geometry of the surface Nusselt number are shown on Figure 5.12. Effect of geometry on the outlet fluid temperature is shown on Figure 5.13. From the Figure 5.12 it is observed that Nusselt number variation along the length is not much affected by the shape of the geometry. It is also observed that fluid flowing in the trapezoidal corrugated channel have the highest outlet temperature. It is lowest in the triangular corrugated channel.

6. CONCLUSIONS AND FUTURE SCOPE
6.1 CONCLUSIONS

The Numerical simulation is performed on the sinusoidal, trapezoidal and the triangular corrugated channel with water as working fluid. At the wall, boundary condition are taken as constant wall heat flux or constant wall temperature with no slip and no penetration boundary condition. The simulations cover a wide range of the Reynolds numbers, heat fluxes and wall temperatures. At the inlet, velocity is specified by using the user defined function. For each of the geometry profiles, its amplitude has been varied as 1.75 mm, 3.50 mm and 7.00 mm. From the present study some important findings have been observed which are given below.

☐ Heat transfer enhancement is maximum for triangular corrugated channel followed by trapezoidal and triangular channel for laminar flow.

☐ In case of turbulent flow, the triangular corrugated channel shows the better heat transfer rate than others two corrugated channel.

☐ Pressure loss is maximum in case of trapezoidal corrugated channel followed by sinusoidal and triangular channel for laminar flow.

☐ For higher Reynolds number the surface-Nusselt number is higher.

☐ On increasing the amplitude of wavy wall, the Nusselt number increases.

6.2 Future scope

The 3-D simulation of the present work can be made in the future. It is required to continue this study extensively by considering other possible geometries. A hybrid scheme can be

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develop in future for automatic optimization of the geometry profile in order to get maximum heat transfer rate with minimum pressure loss.

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A STUDY ON MODERN INVESTMENT OPTIONS FOR SALARIED EMPLOYEES

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ABSTRACT

Currently, individuals are more preoccupied with their future than their present. All individuals want financial autonomy and economic stability. Consequently, it is essential for them to make investment selections. Understanding and familiarity with various investment options are crucial for making informed investment decisions. Investment is the most effective means to achieve financial security. The objective of investment is to optimize the earning potential of investors. This research offers a comprehensive review of contemporary investment alternatives and succinctly describes investment pathways associated with short, medium, and long durations. The aim of the research is to elucidate the investing options and their associated advantages. The research will be executed in a descriptive manner using secondary data. A research is conducted to examine the various investment options accessible in the Indian market. Investment may occur in both financial and non-financial instruments.

Keywords: Investment, Income, Investment options in India, Tax benefits

INTRODUCTION

An investment is a financial commitment made to one or more assets that will be retained for a future length of time. Future gains and present sacrifice are the two key components of investing. One of the numerous ways individuals may save money is by reining in their unnecessary spending. Everyone wants to feel more secure, have more freedom, and be able to afford what they want in life. Investments are crucial because they promote financial interdependence, income development, the achievement of individual objectives, and the mitigation of future dangers. Savings and investing are essential for meeting future demands and dangers, just as blood is essential for living. There will always be unforeseen and unknown occurrences in the future, thus it is important to save and invest appropriately. Due to the great number of businesspeople, government agencies, private organizations, and industries, as well as the high rate of money circulation, India offers a wide range of opportunities for saving and investing. Investors are concerned about the security of their capital. They need their investment to be dependable. The government and other organizations devise creative plans to mobilize people's savings, which may then be effectively used to the growth of the economy. To make logical choices about how to invest their funds, investors must be sufficiently informed of and knowledgeable about the many investment options.

Investment is the commitment of finances for future periods in exchange for a sufficient return to persuade one to part with monies. In general, it means to pay off by allocating the funds to worthwhile endeavors. A trade-off between now and future consumption informs every investment choice. The practice of using resources to boost future revenue and industrial output is known as investment. Everyone is drawn to investment, regardless of their age, sex, career, or level of education. Investment might result in increased revenue or valve growth. Care must be made while choosing an investment choice to ensure that it doesn't raise taxable income. Every investment has some level of risk. The manner,

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instrument, and duration of investing all affect the level of risk. Individuals, the economy, and society all benefit from investment.

Investment Option for the Salaried Person in the Modern Era

Salaried people nowadays have several investing opportunities to develop money, reach financial objectives, and secure their future. Systematic mutual fund investments using SIPs (Systematic Investment Plans) are popular because they enable modest sums to be invested frequently and benefit from rupee cost averaging and compounding. With good research and long-term holding techniques, direct equity investing may provide large returns for people with a somewhat greater risk appetite. In addition, fintech platforms have made stock market investment easier. Fixed and recurring deposits are secure, low-risk investments for conservative investors, albeit their returns may barely surpass inflation. The Public Provident Fund (PPF), National Pension System (NPS), and Equity Linked Saving Schemes (ELSS) provide returns and tax advantages under Section 80C of the Income Tax Act, making them appealing tax-saving devices. Real estate investing is conventional and tangible, but it demands a lot of cash and is illiquid. Despite their volatility and speculative nature, crypto currencies have attracted younger paid workers. Digital gold investments like Sovereign Gold Bonds or Gold ETFs hedge inflation. EPF and voluntary pension programs are also important for long-term planning. Salaried people should diversify their investment portfolio depending on their risk appetite, financial objectives, and investment horizon. Modern financial security may be achieved with a balanced mix of high-growth and stable-income alternatives and frequent financial evaluations.

Main Reasons for Investment

A. Security of family: Security and safety of the family is essential objective of the investment. Investment fulfills the main objectives of the family file provision for children education and marriage.

B. High Returns: Investors always invest their saving to earn regular and high returns. The return on investments is the reward to the investors. To earn capital appreciation investment can be made in both financial and non-financial assets.

C. Tax benefits: while selecting an investment option, care has to be taken that investment should not result in increase in taxable income. Most of the investors make investments for getting the tax benefit in the form of exemptions under the Income Tax Act, 1961.Tax benefits is important consideration for an investor as proper tax will help to improve the efficiency of investor's investments

D. Liquidity: Investors generally prefer those investments which offer higher liquidity. It is considered as one of the important factor which is to be considered before making an investment. Liquidity means an ability of an investment to be converted into cash as and when required.

E. Retirement plans: Investors, while investing their hard earned money consider those investment plans which help them after retirement to meets their future needs like provision for old age and sickness, provision for house construction and provision for dependents.
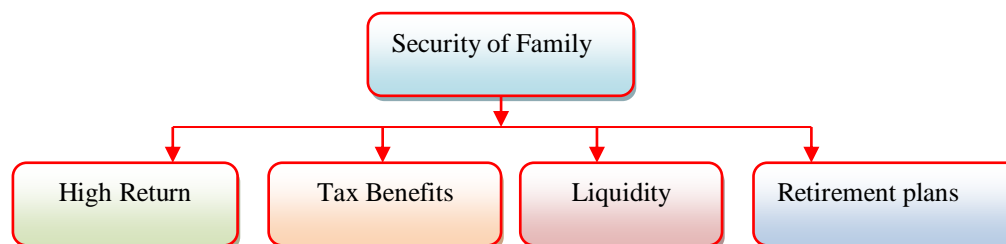
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                    ┌─────────────────┐
                    │ Security of Family │
                    └─────────────────┘
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│ High Return │ │ Tax Benefits│ │  Liquidity  │ │Retirement plans│
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Fig.1 Main Reasons for Investment

Factors affecting investments
(1) Safety of money
(2) Children marriage and education
(3) Security of life after retirement
(4) Tax saving
(5) Regular and best returns
(6) Educational level

LITERATURE SURVEY

Tenzina Sharma et.al (2025) financial literacy is the ability to understand, evaluate, and make educated choices to achieve financial goals. This article investigates how financial literacy affects investment choices made by salaried persons in Kathmandu. It The study evaluated how financial education, attitude, and awareness impact investing choices. The study examined potential biases in investing choices based on gender, monthly income, work sector, employment level, and marital status. A well-structured, closed-ended questionnaire was administered to 200 paid Kathmandu workers from various sectors. Hierarchical multiple regression was used. Positive and substantial findings indicate that financial attitude and awareness positively affect investing choices. Financial information, albeit being strongly associated, does not significantly impact investing choices. None of the controlled factors affected investment choices much. Financial mindset and knowledge significantly impact salaried individuals' investing choices [01].

Nur Ratna Komalasari et.al (2024) Urban millennials' personal financial management is impacted by a number of elements, including cultural norms, financial knowledge, and risk-taking confidence. In order to ensure the welfare of urban millennials—primarily urban workers from different parts of Indonesia—the author of this research aims to identify patterns in pay management. The study examined how they save money, what kinds of investments they comprehend, and how brave they are to invest, all of which are tied to their ethnic and cultural customs. Using a qualitative ethnographic approach, this research interviewed six (six) millennial respondents from the Javanese and Minangkabau tribes who were between the ages of 25 and 40. They are professionals with a fixed income from their salaries who reside in the DKI Jakarta region. According to the study's findings, most respondents already exhibit adequate financial behavior and financial literacy by regularly allocating a part of their monthly income for investments and savings. It is also evident that the kinds of investments people choose are influenced by their ethnic background [02].

R.E. Walunj et.al (2024) India is developing. Improving Per Capita Income requires effective money circulation in many areas, such as manufacturing, services, exports, and

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technology. A large amount of money is necessary for development. Fund availability relies on functioning intermediaries such as banks, non-banking financing firms, post offices, and share exchanges. These organizations provide valuable investment opportunities for people to save and invest. People invest in many routes with hopes of a favorable return in the future. It is acknowledged that idle money does not increase in value but rather diminishes it. People are now staying informed about market and financial situations for investing objectives. Public sector employees are capable of making informed investment choices. People are diversifying their investments into several possibilities, based on their happiness with the characteristics or aims of each investment. Tax responsibility is difficult to dodge for salary earners owing to visible and traceable finances. Thus, people hesitate before spending money. Employees are aware of the pros and cons of numerous investing options in the market. Considering factors such as safety, liquidity, security, marketability, tax advantages, and risk, investors choose the best option for their investment. The research examines the investing patterns of public sector personnel, namely in the banking industry of Pune [03].

Joseph R. Giomboni et.al (2023) This study adds to intern labor topics, specifically educating young workers for cultural industry professions and exploitative situations that may limit their success. This research seeks to improve our knowledge of young practitioners' skillsets and how creative autonomy might change the internship debate from useful to (self-)exploitative, paid and unpaid professional experiences. Analysis of semi-structured in-depth interviews with current students and recent college graduates suggests that knowing implicit and explicit cultural industry role and responsibility expectations gives participants creative license. Interviewees who grasp institutional processes and their significance in corporate governance frameworks provide significant work at the internship site and shed the intern label. However, site managers often overlook and abuse young workers who are unaware of these industrial dynamics. The findings show that structured internship programs with site supervisors can help these individuals develop their skillset and learn industry norms through shadowing and observation to pursue better career paths or professionally rewarding experiential learning [05].

Sonali Patil et.al (2014) India is still a developing nation. Proper money circulation in a number of industries, including manufacturing, services, exports, technology, etc., is necessary to increase per capita income. The availability of a significant amount of money is necessary for development. The operational circumstances of intermediaries such as banks, non-banking financing businesses, the post office, and share markets affect the availability of cash. By providing a range of investment options, these organizations are essential in assisting individuals in saving and making investments. People are putting their money into various investment channels in the hopes of earning a favorable rate of return in the future. They are aware that idle money devalues money rather than increasing its worth. These days, individuals keep themselves informed about financial and market situations in order to make investments. Workers in public sector organizations are intelligent enough to make their own investment choices. They are spreading their funds among many investment alternatives where they are satisfied with the features or goals of each one rather than putting their money into just one. Because their money is public and accountable, salary earners have very little opportunity to dodge their tax obligations. Therefore, before spending their hard-earned money, they carefully reconsider. Workers are aware of the several investing options on the market, including both their advantages and disadvantages. From their perspective, they are

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choosing the best option and allocating the funds to a certain direction based on factors including marketability, safety, liquidity, security, tax advantages, and risk. With particular reference to Pune's banking industry, this research concentrated on the investing habits of public sector workers [04].

OBJECTIVES OF THE STUDY
- To identify the various investment options available for investment in India.
- To find out the main reasons for Investment.

RESEARCH METHODOLOGY
The current research relies on secondary data, so it is descriptive in nature. Data has been obtained from published records, magazines, and publications. Furthermore, the data gathered from several newspapers, periodicals, books, websites, and journals, among others.

INVESTMENT OPTIONS AVAILABLE IN INDIA
There are large numbers of investment avenues are available in the market of India.

- Post office savings plans: All post office schemes are entirely secure and provide a risk-free investing opportunity. Recurring deposits, Kisan Vikas Patra, and senior citizen saving plans represent some of the most advantageous post office savings options.
- Insurance policies include life insurance with an investment component, pension plans, and tax-saving schemes. It offers a balanced risk and return profile.
- Public Provident Fund and Provident Fund: An individual may establish a PPF account at any nationalized bank. The set term for a PPF is 15 years, and one may withdraw half of the sum after seven years. The interest income is exempt from taxation, and there is a tax advantage under section 80C of the Income Tax Act.
- Bank deposits: They represent one of the safest and most secure investing options. The interest rate is contingent upon the duration of the deposit. The main forms of bank deposits include current accounts, savings accounts, recurring deposit accounts, and fixed deposit accounts.
- Share capital: Investment in shares is a highly speculative endeavor, although it offers the potential for substantial returns. Understanding the stock market is a fundamental need for investors.
- Bonds and debentures are forms of financial securities issued by enterprises. Investment in bonds or debentures yields returns at regular intervals.
- Real estate: Investment in real estate yields advantages in the short term over an extended duration. It is a long-term investment choice that involves a substantial sum of money. The risk and return in real estate are contingent upon market-related factors. It is also liable to capital gains tax.
- Mutual funds are exposed to market risk. It is a system that aggregates capital from several participants and allocates it across various financial products. Types of mutual funds include equity funds, debt funds, balanced funds, index funds, and fixed income funds.
- Pension funds are a recent and significant investing option in India. This plan allows the investor to allocate funds to both stock and debt instruments. The investor must decide the proportion of capital to allocate between debt and equity. Until the age of

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35, the allocation to stock and debt is 50% each. The contribution is determined based on the investor's age.

- Gold, silver, and valuable items: Investment in metallic commodities Gold, silver, and valuable items such as paintings, sculptures, coins, and stamps are prevalent forms of investment. It confers social stature and money. Investment in precious commodities and metals is less hazardous and suitable for the long term. It offers liquidity at all times, since it can be converted into cash on demand.

Certain investment alternatives and schemes provide tax benefits to investors. The Government must promote such schemes to incentivize investors to participate, since they provide substantial tax savings. In some programs, the whole investment is executed tax-free as well.

Numerous risks are involved with various kinds of investments. Risk may be categorized as minimal, medium, or high. Investment avenues are classed according to the related risk.

Table 1: Investment avenues according to risk

Low Risk Investment avenues	Medium Risk Investment avenues	High Risk Investment avenues
Public Provident funds	Mutual Funds	Real estate
Fixed bank deposit	Gold/Silver & Precious articles	Chit funds
Post office saving schemes	Bonds & Debentures	Share market
Life insurances		

Table 2: Investment benefits to different sectors

Benefits of investment to individual	Benefits of Investment to corporate sector	Benefits of Investment to the Government
More income Tax benefits Safety and security Liquidity	Permanent capital Credit worthiness No fixed burden	Leads capital formation More employment More revenue for development of the economy as a whole

CONCLUSION

The research on contemporary investing alternatives for paid individuals underscores the changing paradigm of financial planning in the current dynamic environment. Due to the rising accessibility of digital platforms, customized financial products, and heightened awareness, salaried individuals now possess a diverse array of investment options, spanning from conventional instruments like PPF and fixed deposits to modern alternatives such as mutual funds, equities, and digital assets. Successful investing hinges on comprehending one's financial objectives, risk appetite, and investment timeframe. A well-diversified portfolio, along with disciplined investment and regular evaluations, may assist salaried people in both protecting their income and accumulating long-term wealth. As financial markets progress, being educated and getting expert counsel when necessary will enable salaried persons to make astute investment choices and attain financial independence.

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Experimental Investigation on Incremental Forming Behavior of Inconel 625 and Its Surface Characteristics

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Abstract

This research examines the formability and surface roughness characteristics of Inconel 625 alloy during the Single Point Incremental Forming (SPIF) process, an advantageous technique for versatile and low-volume sheet metal production. Inconel 625, a nickel-based superalloy recognized for its exceptional strength, corrosion resistance, and thermal stability, presents considerable difficulties in traditional forming processes owing to its restricted ductility and work hardening characteristics. The study examines the impact of critical SPIF parameters—such as tool diameter, step depth, feed rate, and spindle speed—on the material's formability and the resultant surface polish. Experimental trials used a CNC milling machine modified for incremental forming, and the produced components were assessed to ascertain maximum formable angles, thickness distribution, and surface roughness (Ra values). The findings indicate that reduced step depths and increased tool diameters often improve formability and decrease surface roughness. Nonetheless, there are trade-offs between formability and geometric precision. The research emphasizes the significance of toolpath technique and lubrication in reducing surface imperfections. The results indicate that SPIF is an effective technique for shaping Inconel 625, providing satisfactory formability and surface quality with adjusted parameters. This study enhances the use of SPIF for high-performance alloys in aerospace, energy, and biomedical sectors.

Keywords: Inconel 625, Single Point Incremental Forming (SPIF), Formability, Surface Roughness, Step Depth, Tool Diameter etc.

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INTRODUCTION

The deep drawing and stamping processes have historically shaped the sheet metal industry for large-scale production runs. A large quantity of components can be produced rapidly with significant investment resources [1]. In the beginning stages of any mass production, prototypes must be developed. A flexible process must exist that can be accomplished with minimal investment [2].

The incremental sheet forming process (ISF) is characterized as a flexible manufacturing technique in which the sheet undergoes localized deformation at the tool-sheet interfaces, independent of a die. Incremental sheet forming is categorized according to various criteria as illustrated in Fig 1.
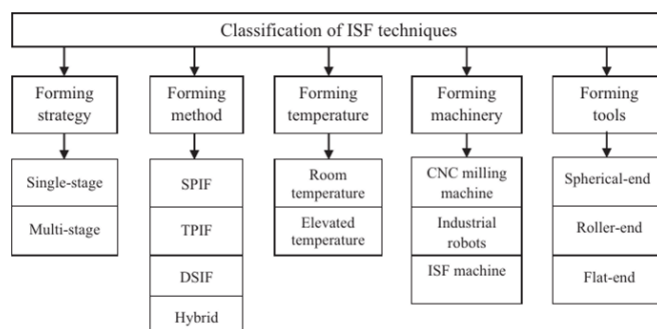
Figure 1Classification of ISF process

In 1967, two patents were issued concerning the ISF process, which are variations of the spinning process. One was issued to Berghahn from General Electric, and another was issued to Leszak. The Leszak manufacturing method involves preparing the final shape of a product by locally bending a rotating clamped sheet through linear displacement using a roller tool. In contrast, the Berghahn method deforms the sheet through movements in all three directions with the roller tool [3]. Kitzawa and his colleagues have led the way in transforming this process for various industries, initiating a significant change in the sheet metal sector [4].

Single point incremental forming
SPIF stands for single point incremental forming process, which, as the name implies, involves deformation that occurs progressively at a single point of contact, akin to a layered engineering approach. This is a derived form of the ISF process. The fundamental elements of the process include a sheet, a work-holding fixture, a computer numeric control machine, and a cylindrical-rod shaped tool, as illustrated in Fig 2. Therefore, the approach employed utilized versatile tooling and clamping systems for the tasks at hand, making it ideal for the swift prototyping of intricate forms and small-scale production systems. The benefit of the process lies in the increased formability of sheet components prior to experiencing fracture. The magnitude of strains is significantly greater than that observed in conventional processes or dome tests.
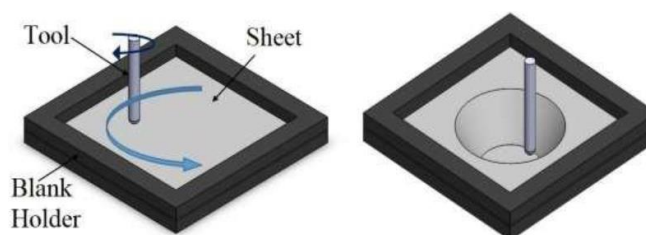
Figure .2 SPIF process

Process parameters
Process parameters are the independent input factors influences product quality. The process based parameter for SPIF process are initial sheet thickness, step size/ step depth, tool diameter size, tool rotational speed, tool feed rate motion, and wall angle of the final component.
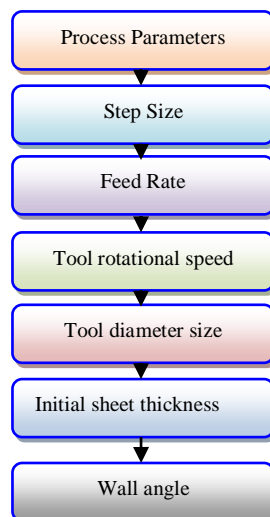
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Fig. 2 Flow Diagram

LITERATURE SURVEY

Govind Panwar et.al (2025) Aluminum alloys have been used for the Single Point Incremental Forming (SPIF) process due to their formability, corrosion resistance, less weight and its isotropic mechanical properties. The proposed research work aims to experimentally investigate the optimisation of the process inputs affecting the quality of the SPIF incrementally formed surface. The experimentation was performed to optimise parameters under varying conditions, focusing on various process factors. The surface roughness (SR) has been found most significantly affected by the tool diameter, followed by vertical step size, side wall angle, feed rate, and rotational spindle speed. Experimentation result shows the outstanding values of the experimental set-up for surface finish found on the base of the ANOVA at 70° cone angle under the test setting of a TD of 13.0 mm, a VSS of 0.50 mm, RSS of 1000 rpm, and a FR of 2500 mm/min. The parametric optimisation for SR with Desirability approach, TLBO (Teacher learner-based optimisation), and ACO (ant colony optimisation) methods has been attempted, out of which the best optimum value (with ACO) for SR was achieved as 0.162 µm at the optimal parametric settings of TD = 14.75 mm, VSS = 0.660 mm, RSS = 521.70 rpm, FR = 2760 mm/min, and WA = 76.56° [01].

Diptanshu Rai et.al (2024) Single point incremental forming (SPIF), which can form sheets without any prior setup is an ideal option for prototype and batch production. Geometrical accuracy is a major challenge in the formation of Inconel 625 super alloys. Parameters such as spindle speed, feed rate, step size and wall angle were considered to assess the influence of the forming factors on the geometric accuracy of the Inconel 625 super alloys. The investigation was performed on 100×100 mm flat sheets with a thickness of 1 mm. Sheet metal with the desired shape was designed and developed using computer aided design (CAD) software. A circular shape was manufactured via incremental forming using a hemispherical tool with a 5.8 mm radius. A tool path was generated using Fusion 360

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software to perform SPIF on Inconel 625 super alloys by varying the parameters. When experimental and simulation data were examined, significant agreements were found [02].

Zibo Tang et.al (2023) In this study, an investigation into whether or not SPIF processing is compatible with Al-Li alloy was carried out. In this study, both numerical modeling and experimental testing were used to evaluate the impact that the forming angle has on the geometry correctness and strength of the truncated pyramid component. Based on the findings, it can be shown that the maximum thinning rate and wall thickness deviation steadily decrease as the forming angle rises. The component that is created at a greater angle of 57 degrees achieves the highest level of geometric precision compared to other components. The results of the SPIF experiment demonstrate that the surface quality, geometry correctness, and wall thickness uniformity of the created truncated pyramid component have been significantly improved as a result of increasing the forming angle. All of the stress and strain modeling as well as the microstructural measurements provide an explanation for the cause. The stress is lower and the strain distribution is more uniform when the forming angle is increased [03].

Weining Li et.al (2023) Single-point incremental forming (SPIF) is a sheet forming technique that deforms sheet materials incrementally to a designated shape. The process has shown high ability to deform low-strength materials for good geometrical accuracy and formability at room temperature. Deforming high-temperature alloys, such as high-strength steels and Ti-6AI-4 V, requires integrated heat sources to increase the ductility of the metal sheets for deformation. However, the integration of heating results in unpredictable thermal behaviours and impacts the formability, geometric accuracy, thickness distribution and surface quality. Considerable research eforts have invented diferent heating methods and designed novel tools and analytical modelling to resolve the limitations. This study aims to review the heating-assisted SPIF systems for high-strength alloy sheets to solve the current limitations. The method includes analysis of heating systems, tool, tool path design, lubricants and macro- and micro-numerical analyses. Additionally, the study aims to correlate the microstructural properties to the mechanical behaviours and subsequent efects on forming force, strain, springback, geometrical accuracy and surface quality [04].

Rupesh Kumar et.al (2023) Because it does not use dies to create complicated forms, incremental sheet forming (ISF) is becoming more acknowledged as the realistic answer to the problem of producing complex shapes. In batch production, ISF is a feasible option for meeting essential needs such as customisation, reducing the amount of time needed to set up the die, lowering the cost of equipment, and lowering overall costs. The story of the International Social Fund (ISF) from its beginnings to the present day is explained in chapters that are redundant. This chapter is an effort to fill up this vacuum in the literature. The readers will get acquainted with all of the essential components of ISF as a result of reading this. There is a brief introduction to the ISF technology presented in the first section. Following that, a comprehensive analysis of the different classifications of ISF is carried out. This chapter discusses classification based on a variety of forming processes, including hot-forming, tools, pathways, and machines, among others. There is a description of the advantages, limitations, and applications of each item [05].

PROPOSED METHOD

Material selection In the early 2000s, various alloys with different chemical compositions were created to address engineering challenges and fulfill the needs of key sectors like petrochemicals, automotive, and aerospace. Significant focus is placed on nickel-based alloys because of their excellent mechanical properties in extreme environments; they are typically classified as superalloys [47]. Inconel 625 (UNSN06625/W.Nr. 2.4856) is an alloy composed of nickel, chromium, and iron, which is enhanced through solid solution strengthening at its intermetallic phase. The composition of Inconel differs from that of Haste alloy; Inconel primarily consists of nickel-chromium, whereas Haste alloy is mainly composed of nickel-molybdenum. The current investigation utilizes Inconel 625 sheets measuring 130 mm x 130 mm x 0.5 mm, as illustrated in Fig 3.
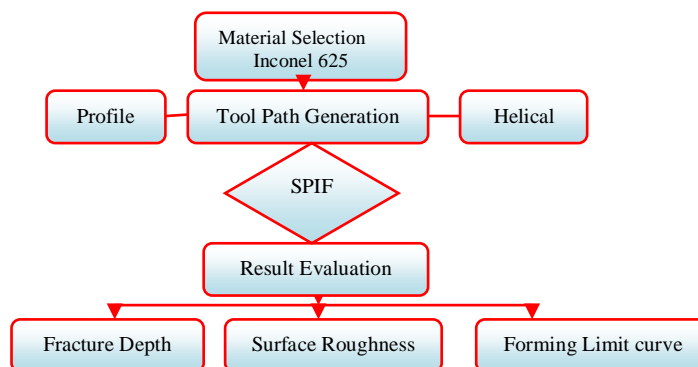
Figure 3 Flow diagram of Experiment

Inconel 625 constituents shown in Table 3.1. This superalloy also contains carbides like M6C (M is plentiful in niobium and molybdenum), MC (M is plentiful in niobium and molybdenum), and M23C6 (M is plentiful in chromium). The role of constituents in this alloys are as follows. Niobium acts as a strengthener in the Ni-Cr matrix, both chromium and molybdenum act as a hindrance to corrosion; and iron minimizes the cost of the alloy.

Table .1 Inconel 625 compositions

Ni	Cr	Mo	Fe	Nb	Co	Mn	Al
58-71%	21-23%	8-10%	5%	3.2-3.8%	1%	0.5%	0.4%

The properties outlined for this superalloy render it highly suitable for essential structural engineering applications, including those in the nuclear, aerospace, marine, and petrochemical sectors.

Tool path

Single point incremental forming may be done on an SPIF machine or any numeric control machine. For main spindle or work table movements, this machine needs coordinates. See Fig. 3.4 for toolpath categorization. At the pre-experimental stage, the tool path controls working time and output factors such formability, axial force, and surface quality [53]. Tool paths for geometry are developed using CAD/CAM systems or programming languages like MATLAB, C/C++, Java, Python, etc.

Programming language is used to develop tool routes logic for Profile/Z-level and Helical strategies in this research because it allows data analysis and design adjustment. Java is used to extract truncated cone geometry coordinates because it permits modular programming and is compiler-independent. Java code written as Java byte code and according to the JVM is

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changed to system-specific compiler. The 60° wall angle tool path dimensions are as follows. Rmajor = 30 mm, Rminor 15.56 mm, H 25 mm.

Algorithm

For loop (i = 0; i □≤ --n; i++)

{

For (α = 0; α □≤ 360; α++)

{

$R = R_{major} - \{(1/n+1) \times (R_{major} - R_{minor})\}$

X coordinates = R x cos (α)

Y coordinates = R x sin (α)

Table 2 ISF Machine specification

Make company	Interface Design Associates Private Limited
Work Table	700 mm x 700 mm x 525 mm
Maximum Sheet Thickness Holding Capacity	5 mm
Maximum Spindle Feed Rate	1000 mm/min
Work Envelope	500 mm x 500 mm x 525 mm

RESULTS AND DISCUSSION

All experiments were done on 0.5-mm Inconel 625 sheet with an 8-mm tool diameter. Truncated cone geometry is created using helical tool paths.
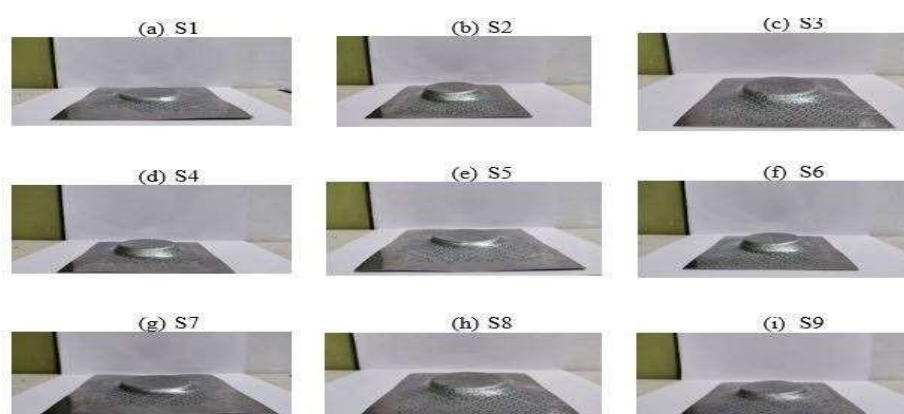
Figure 4 Taguchi table test specimens

Table 3 Response table for SN ratio (Formability)

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Level	Step size	Feed rate	Spindle speed
1	22.91	21.85	22.24
2	21.91	22.07	21.90
3	22.28	22.18	21.96
Delta	0.37	0.33	0.34
Rank	1	3	2
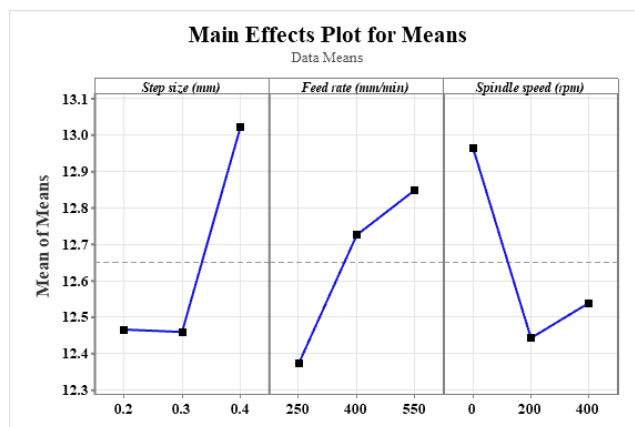
Figure 5 main effects plot for means (Formability)
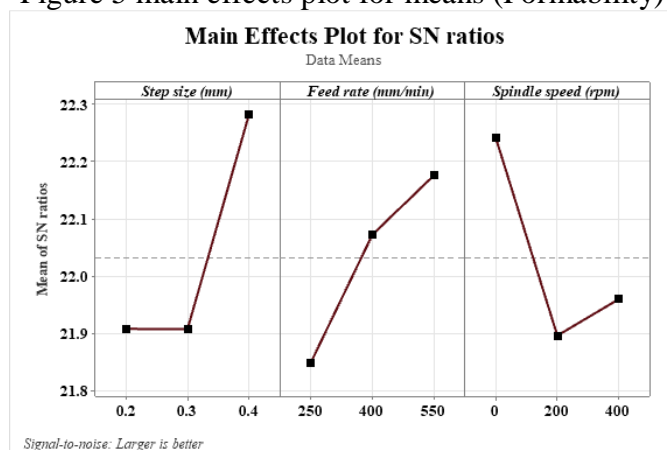
Figure 6. Main affects plots for SN ratio (Formability)

From the response Table 4.2, based on the delta value the rank of input parameters is decided. It can be seen clearly that the formability of sheet in the process is dependent on step size, spindle speed and feed rate in decreasing trend respectively.

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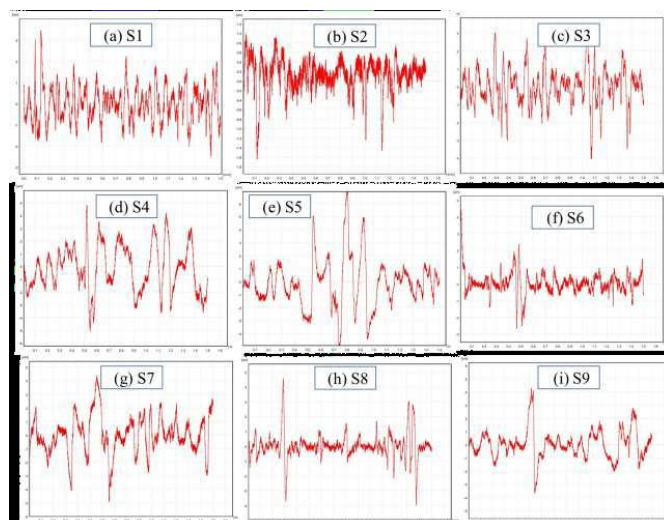
Figure. 7 Surface roughness graph
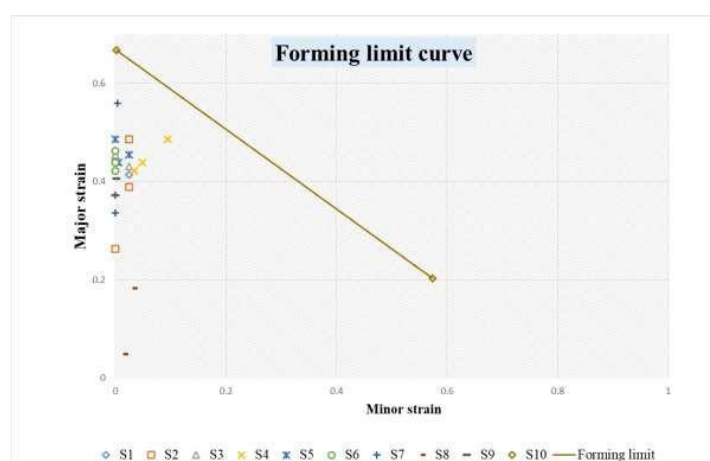
Figure 8 Forming limit curve for 0.5 mm thick Inconel 625 sheet

CONCLUSION

In the present thesis work, the single point incremental forming process is carried out on Inconel 625 sheets of thickness 0.5 mm to investigate the effect of process parameters such as step size (0.2, 0.3, & 0.4 mm), feed rate (250, 400, & 550 mm/min), and spindle rotational speed (0, 200, & 400 rpm) on the formability in terms of maximum fracture depth and surface roughness. The experiments were conducted according to Taguchi L9 design and spiral tool path strategy is used for the different geometries. The following conclusions can be drawn as follows:

- Both formability and surface roughness is highly influenced by the parameter step size.
- For the step size range 0.2 mm to 0.3 mm there is no appreciable change in formability but in the later region fracture depth increases with an increase in step size due to the increase in the forming temperature caused by the resistance to dislocation between the intermolecular particles.
- Formability increases with the increase in the feed value due to less chance of heat dissipation between the tool-sheet interfaces.
- Spindle speed shows negative effect on the formability for the region 0 rpm to 200 rpm because for the lower rotational speed, the frictional effect is dominant over the heating effects.

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Integrating Sustainability into CSR Strategies: The Role of Microfinance in Community Development

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Abstract

Over the years, Corporate Social responsibility has evolved from benefiting the immediate society to community development and allocating organizational resources for social, environmental and economic development. Corporate social responsibility strategies have been vitally used to tackle global challenges and creating long term value for the organization and its stakeholders. In this research paper we have analyze, the pivotal role of microfinance institutions in implementing Corporate social responsibility(CSR) strategies for developing communities, creating self-reliant societies, alleviating poverty empowering Indian economy. We have explored how organizations are leveraging services of microfinance in their CSR strategies to maximize its benefits and increase shareholder's value. The study also uncovers various areas like inclusion of fintech in microfinance, gender diversity and corporate governance for fostering sustainability, social innovations as future areas of research.

Keywords: Corporate Social Responsibility, Sustainability, microfinance, empowering, economic development, fintech, CSR

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Introduction

Corporate Social Responsibility has now become core business activity from a complimentary function. Once seen as a voluntary practice, CSR is today an integral framework that oversees ethical business practices, environmental stewardship, and social responsibility (Carroll, 1991). Carroll's (1991) CSR pyramid defined four dimensions—economic, legal, ethical, and philanthropic responsibilities—which together structured contemporary CSR practice. The new millennium witnessed a proliferation of CSR reporting, catalyzed by the emergence of sustainability rankings, global environmental pacts, and stakeholder pressures (Kotler & Lee, 2005). In the wake of increasing concerns over climate

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change, natural resource depletion, and income disparities, corporations are under mounting pressure from stakeholders to align their operational models with sustainable development tenets (Bansal & Roth, 2000). The coverage of CSR has grown enormously since its start, fuelled by the changing governance policies at the global level, increasing consumer consciousness, and changing investor and regulator expectations (Porter & Kramer, 2011). Today, businesses use CSR as a strategic means to promote long-term business sustainability along with tackling important society issues like reducing poverty, education, gender equity, and environmental conservation.

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Today, businesses use CSR as a strategic means to promote long-term business sustainability along with tackling important society issues like reducing poverty, education, gender equity, and environmental conservation. Sustainable CSR practices emphasize value creation over the long term and take into consideration ecological preservation, ethical supply chain management, and inclusive business models (Brammer, Jackson, & Matten, 2012).Corporations are adopting shared value strategies, which prioritize the concurrent achievement of business profitability and societal gains (Porter & Kramer, 2011). These include investments in renewable energy, microfinance, circular economies, and sustainable production that aligns with sustainable development goals (UN Global Compact, 2015).

Literature review

Bundling sustainability within Corporate Social Responsibility (CSR) planning has come on strong as an essential method of long-term community building, especially in developing economies (Carroll & Shabana, 2010). Microfinance institutions (MFIs), previously conceived as financial middlemen, are now becoming identified as crucial vehicles for weaving sustainability into CSR platforms (Hermes, Lensink & Meesters, 2011). By providing financial services to poor communities, MFIs play a role in poverty reduction, financial inclusion, and socio-economic empowerment—pillars of sustainable development (Armendáriz & Morduch, 2010). Microfinance initiatives integrated in CSR strategies are more effective at enhancing community resilience and self-reliance. Microfinance has the potential to transform when applied in conjunction with corporate initiatives aimed at education, health, and environmental conservation (Yunus, 2007). Microfinance programs through CSR are mostly aimed at women, promoting gender equality and enhancing household well-being (Kabeer, 2005; Swain & Wallentin, 2009). Additionally, embedding sustainability into CSR via microfinance allows firms to align with the United Nations Sustainable Development Goals (UN SDGs) and, in this case, goals focused on poverty (SDG 1), gender equality (SDG 5), and decent work (SDG 8) (United Nations, 2015).

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Academicians assert that such embedding not only supports the social license to operate but also promotes stakeholder engagement as well as corporate reputation (Porter & Kramer, 2011; Jamali, 2008). But the literature also emphasizes challenges such as over-indebtedness, mission drift, and regulatory needs (Morduch, 1999; Rhyne, 1998). Hence, sustainable CSR practices need to include impact analyses and inclusive governance frameworks to promote long-term benefits (Epstein & Buhovac, 2014). Microfinance, as argued by Yunus (2007), empowers poor people, particularly women, by offering them the necessary capital to initiate or grow small enterprises. These enterprises benefit the local economy, improve employment opportunities, and foster social stability. Through financial inclusion, microfinance supports sustainability objectives, yielding long-term social and economic impacts (Karlan & Valdivia, 2011). Otero (1999) points out that MFIs have shifted roles from being single-purpose financial services providers to changemakers facilitating health, education, and environmentally sustainable lifestyles. Their joint undertakings with companies in CSR activities have fostered activities including clean energy services, health provision, and training programs, all of which contribute to attaining sustainable development (González, 2013).Additionally, linking sustainability to CSR strategies through microfinance can help combat gender inequality. Mayoux (2001) contends that microfinance empowers women because it allows them to create and develop businesses that are socially and environmentally oriented, resulting in sustainable community benefits over time. MFIs targeting women not only contribute to gender equality but also enable community resilience, as women invest more in family and community upgrading (Schreiner, 2002). Still, the success of microfinance to enhance sustainability requires striking a balance between financial and social objectives. Morduch (1999) points out that MFIs need to become financially viable and at the same time achieve social objectives. Financial and social considerations are essential for maintaining long-run community development gains.

Objectives

- To analyze how microfinance institutions apply principles of sustainability to their Corporate Social Responsibility strategies.
- For assessing the effect of eco-friendly CSR-based microfinance programs on community development results.
- To determine challenges and best practices in applying sustainable CSR initiatives through microfinance in disadvantaged communities.

Research Methodology

This research employs a descriptive research design with secondary data to investigate the incorporation of sustainability by microfinance institutions in CSR planning for community development. The data will be obtained from literature on academia, MFIs' CSR and sustainability reports, government documents, and NGOs' publications. Content and thematic analysis will be employed to search for patterns within CSR practice consonant with the triple bottom line—economic, social, and environmental sustainability. The study will systematically record models in place, evaluate their efficiency, and outline best practices and challenges. Outcomes will guide future CSR practices that utilize microfinance for inclusive, sustainable community development.

Results and Discussions

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MFIs, includes sustainability in three important dimensions which are economic viability, social equity, and environmental responsibility . These dimensions are very important for the long-term success of CSR activities and are strongly related to the triple bottom line approach—people, planet, and profit. Economic sustainability in MFI-driven CSR activities is mainly concerned with increasing the income-generating ability of marginalized communities. MFIs implement this principle by framing CSR programs aimed at financial literacy, entrepreneurship promotion, and access to livelihood. By enabling clients to earn money in a sustainable manner, MFIs facilitate economic self-reliance in the long term. Companies like Bandhan Bank have adopted CSR activities that involve training in skill development, incubation of micro-enterprises, and financial literacy for women and rural youth. These programs are often designed for local needs and are supported by government and civil society partnerships to ensure scalability and context. Social sustainability in the CSR approach of MFIs targets promoting social inclusion, equity, and empowerment. MFIs are important in advocating for gender equality, community engagement, and social cohesion through their CSR programs. Most MFIs operate CSR programs that empower women in leadership, health education, and awareness of rights. For instance, the "Dignity and Empowerment" initiative of Ujjivan Small Finance Bank incorporates social messaging on hygiene, education, and domestic violence into group sessions, thus enhancing the social fabric of communities. Additionally, MFIs employ participatory models to conceptualize and execute CSR initiatives, which is done to ensure that the beneficiaries are consulted in determining the outcomes.

This increases ownership, sustainability, and cultural appropriateness of the programs. These efforts help social sustainability by enhancing social capital and minimizing structural disparities. Social sustainability in MFI CSR strategies focuses on fostering social inclusion, equity, and empowerment. MFIs play a crucial role in promoting gender equality, community participation, and social cohesion through their CSR activities. Many MFIs run CSR initiatives that support women in leadership, health education, and rights awareness. For example, Ujjivan Small Finance Bank's "Dignity and Empowerment" program integrates social messaging on hygiene, education, and domestic violence into group meetings, thereby strengthening the social fabric of communities. Moreover, MFIs use participatory models to design and implement CSR projects, ensuring that beneficiaries have a voice in shaping the outcomes. This enhances ownership, sustainability, and cultural appropriateness of the initiatives. Such efforts contribute to social sustainability by building social capital and reducing structural inequalities.

MFIs are increasingly incorporating environmental objectives into CSR by means of awareness drives, green loan products, and collaborations with environmental groups. Microfinance institutions such as ESAF Small Finance Bank, for instance, have introduced green CSR initiatives involving clean energy solutions, rainwater harvesting, and waste management in the rural sector.

Certain MFIs also encourage environmentally friendly behavior by way of "green loans" that finance the acquisition of solar lanterns, biogas plants, and efficient cookstoves. These activities not only minimize the carbon footprint of rural households but also enhance health benefits and energy access, and they facilitate SDG objectives 7 (Affordable and Clean Energy) and 13 (Climate Action). MFIs bring sustainability to the heart of business operations and decision-making structures and this encompasses adopting Environmental, Social, and Governance (ESG) parameters in risk evaluation, performance appraisal, and

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stakeholder interactions for CSR approaches to be truly sustainable. MFIs increasingly use social performance management (SPM) models that integrate financial objectives with social and environmental impacts. Instruments such as the Universal Standards for Social Performance Management, prepared by the Social Performance Task Force (SPTF), enable MFIs to institutionalize sustainability in their operations (SPTF, 2021).

Economically, these initiatives offer microloans to environment-friendly initiatives like organic agriculture, renewable energy facilities (such as solar panels and biogas units), rainwater harvesting, and green artisan crafts. Financial access for such green businesses allows low-income earners to earn steady income while maintaining local ecosystems. Consequently, communities benefit from increased economic resilience and decreased reliance on destructive or non-renewable resources. Socially, these initiatives empower marginalized communities and women, who are usually the foremost beneficiaries of microfinance services. Through strategic CSR efforts, the beneficiaries are imparted training in sustainable living, entrepreneurship, and environmental awareness. This not only increases their confidence and competence but also encourages inclusive engagement in local economic processes. Community solidarity is also enhanced as joint initiatives towards sustainability create a sense of shared purpose and responsibility. Environmentally, the use of clean energy, organic inputs, and conservation methods results in less pollution, enhanced biodiversity, and enhanced natural resource management. These transformations result in healthier living conditions, lower health risks, and enhanced community awareness of environmental concerns.

One of the main challenges is poor financial literacy among the beneficiaries, which can be a constraint to efficient use of microfinance loans and knowledge of sustainable practices. Infrastructure shortages—like poor market access, electricity, or internet connectivity—can also constrain the success of environmentally friendly projects. Cultural resistance and change aversion can occur, particularly when introducing new technologies or practices. Inadequate monitoring and evaluation systems also make it hard to track impact and provide accountability. Insufficient coordination among CSR programs, microfinance institutions (MFIs), and local stakeholders can result in poorly coordinated efforts lacking scalability.

To address these issues, a number of best practices have been developed. Involvement of the community and participation from the beginning ensures that activities are meaningful and culturally relevant. Offering financial and environmental literacy training enables beneficiaries to make sound choices and utilize resources in a sustainable manner. Capacity-building activities, such as technical training and mentoring, equip participants to run eco-friendly businesses effectively. Integration of digital technologies and mobile platforms can improve outreach, simplify loan disbursals, and enhance transparency. Synergies created by partnerships involving corporates, MFIs, NGOs, and government agencies make programs more robust. Finally, ongoing impact assessment with qualitative and quantitative measures enables real-time feedback and program improvement.

Conclusion

Microfinance Institutions (MFIs) have a transformative role to promote sustainable development by involving CSR initiatives based on the triple bottom line of society—people, planet, and profit. By involving economic viability, social equity, and environmental responsibility, MFIs empower marginalized segments with sustainable livelihood opportunities, enhance inclusion and gender equality, and reinforce environmental stewardship. Institutional programs such as those of Bandhan Bank and Ujjivan Small

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Finance Bank are good examples of how financial literacy, skill building, and community outreach lead to long-term impact. Green CSR activities by players like ESAF Small Finance Bank promote renewable energy and green conservation, helping in achieving universal aspirations like SDG 7 and 13. Even under hindrances like lack of proper financial literacy and limited infrastructure facilities, MFIs reduce these challenges with participative means, capability development, electronic methods, and smart alliances. By institutionalizing sustainability via models such as ESG and Social Performance Management, MFIs make their CSR interventions effective, scalable, and in alignment with the integrated development of disadvantaged communities.

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Effect of technical analysis tool in price predication - A bird eye View

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Abstract
Technical analysis (TA) has long been used by traders and investors as a framework to forecast future stock price movements based on historical data. This paper explores the application and effectiveness of technical analysis tools in the context of stock market price prediction. It offers a concise overview of key indicators such as Moving Averages (MA), Relative Strength Index (RSI), Moving Average Convergence Divergence (MACD), Bollinger Bands, and Fibonacci Retracement. The paper also examines empirical evidence from literature, the integration of technical indicators in modern machine learning systems, and discusses the limitations and challenges inherent in technical-based forecasting. Findings suggest that while TA offers valuable signals, its accuracy in isolation remains inconsistent, especially in highly efficient markets, emphasizing the need for hybrid models that combine TA with fundamental or AI-driven approaches.
Keywords: Technical Analysis, Stock Market Prediction, Moving Averages, Relative Strength Index (RSI), MACD etc.

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Introduction
The stock market represents a complex and dynamic system influenced by a variety of economic, psychological, and geopolitical factors. Investors and traders continuously seek reliable methods to forecast future price movements and make informed decisions. Among the tools available for this purpose, technical analysis (TA) has gained widespread popularity for its data-driven approach, relying on historical price and volume patterns to predict future trends. Unlike fundamental analysis, which assesses a company's intrinsic value based on financial statements, economic indicators, and industry conditions, technical analysis focuses solely on market-generated data, operating under the assumption that all relevant information is already reflected in the stock price.

The foundational principle of technical analysis is that "history tends to repeat itself" and that price movements follow identifiable patterns. Over time, a variety of technical indicators and charting tools have been developed to capture these patterns, including Moving Averages (MA), Relative Strength Index (RSI), Moving Average Convergence Divergence (MACD),

Bollinger Bands, and Fibonacci Retracement. These tools are designed to help traders identify trends, measure momentum, determine overbought or oversold conditions, and detect potential reversal or continuation signals.

Fig.1 Share Market Technical Analysis

While technical analysis remains a favored method among retail and institutional traders alike, its predictive accuracy and reliability have been the subject of extensive debate. Proponents argue that TA provides actionable insights into market behavior, especially in short-term trading. Critics, however, question its scientific validity, particularly in highly efficient markets where new information is quickly absorbed and reflected in prices.In recent years, the fusion of technical analysis with machine learning and artificial intelligence techniques has reignited interest in its application, offering enhanced capabilities for pattern recognition and predictive modeling. These hybrid models utilize technical indicators as features to train algorithms capable of adapting to non-linear and dynamic market conditions.

Fig.2 Flow of the Article

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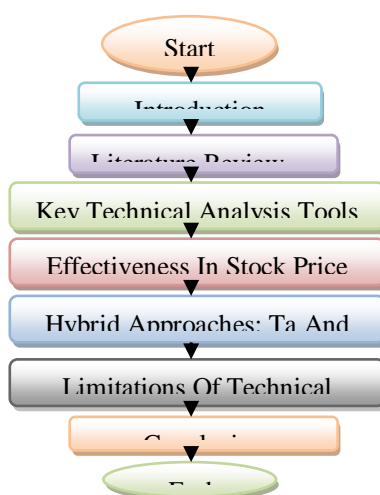
II. LITERATURE REVIEW

Chinthakunta Manjunath, et.al. (2024) Stock market forecasting may maximize profits and reduce risk. However, market volatility makes these predictions questionable. Thus, stock market data analysis is important for study. Stock price prediction tools from analysts and experts assist investors make decisions. Extensive research shows that machine learning can predict markets using stock data. This article tested max voting, bagging, boosting, and stacking ensemble learning methods to anticipate the Nifty50 index. To improve performance, each base regressor is hyperparameter tuned using grid search, and embedded feature selection is used to identify the best fundamental indicators for the model. Our results show bagging and stacking ensemble models using random forest (RF) feature selection have reduced error rates. The bagging and stacking regressor model 2 fit ensemble regressors better than all other models with the lowest root mean square error (RMSE) of 0.0084 and 0.0085. Final results suggest that machine learning algorithms may aid fundamental stock trading choices [1].

Htet Htet Htun, et.al. (2023) Accurate stock price forecasts require identifying essential factors that impact machine learning (ML) models. Stock market forecasting using ML, statistical, and deep learning approaches has been reviewed in many studies. No stock market forecasting survey has examined feature selection and extraction methods. The following survey analyzes 32 research studies that combine feature study with ML methods in stock market applications. We systematically search Scopus and Web of Science for 2011–2022 papers. We discuss some effective feature selection and extraction methods used in the articles' stock market assessments. We report and assess the performance of feature analysis and ML approaches. Other survey papers, stock market input and output data, and factor analysis are also available. For stock market applications, correlation criteria, random forest, principal component analysis, and autoencoder are the most popular feature selection and extraction methods with the greatest prediction accuracy [2].

Hardik Modi, et.al. (2023) Algorithmic trading in financial markets lets traders automate their strategies and benefit from market inefficiencies. This article describes a Python-based algorithmic trading model that uses technical indicators and compares it to the common buy-and-hold strategy. These indicators reveal market patterns and trading entry and exit points by examining historical price data. We extensively compare our algorithmic trading model against the buy-and-hold approach to assess its performance. A GUI that interfaces perfectly with our algorithmic trading model allows users to readily modify parameters, creating an easy and engaging trading experience. This work advances algorithmic trading by supporting technical indicators and interactive interfaces for trade execution and decision-making [3].

Sayan Gupta, et.al (2023) Investment decision-making is complicated by competing goals. Investors aim to enhance wealth while minimizing risk in the stock market. Common investors want to reduce risk. This paper presents a distant framework for stock selection for

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portfolio construction using Bayesian classifier and a popular Multi-Criteria Decision Making (MCDM) technique like TOPSIS and Entropy. Study period: 2013–2020. We use risk-adjusted ratios like Sharpe, Treynor, Information, Jensen, and Calmar to compare NSE 100 companies in our study strategy. The non-normal distribution sample of enterprises was obtained using DP omnibus test. Using financial beta, we choose the result based on return and risk. The Entropy-TOPSIS framework was used to rank equities by profitability each year, and the Bayes portfolio model selected the overall profitability associated with low risk for the portfolio. Stock performance is inconsistent year-to-year [4].

Bhagyashree Pathak, et.al. (2023) This study uses technical analysis-based data mining strategies to observe and predict stock market trends by analyzing and interpreting market behavior using historical trading data, technical indicators like moving averages, RSI, and MACD, and providing investors and traders with actionable insights for making informed decisions in the volatile stock trading environment. The strategy uses quantitative analysis and predictive modeling to improve trend predictions and find successful trading opportunities. These methods are carefully tested against market movements using cross-validation and back testing, providing a comprehensive framework for risk management and portfolio optimization. This multidisciplinary approach simplifies the stock market and creates new paths for financial technology research and development, promising to advance economic forecasting and investment strategy [5].

III. KEY TECHNICAL ANALYSIS TOOLS USED IN STOCK MARKETS

Moving Averages (MA)

Moving averages are used to smooth price data and help traders identify trends. The Simple Moving Average (SMA) and Exponential Moving Average (EMA) are the most commonly applied types. Crossover strategies, such as the Golden Cross (50-day MA crosses above the 200-day MA) or Death Cross, are widely used to signal bullish or bearish trends.

Relative Strength Index (RSI)

RSI is a momentum oscillator that measures the speed and change of price movements over a period, typically 14 days. A stock is considered overbought when RSI > 70 and oversold when RSI < 30. RSI helps in identifying potential reversals in overextended markets.

MACD (Moving Average Convergence Divergence)

MACD is calculated by subtracting the 26-day EMA from the 12-day EMA. The resulting line, along with a 9-day EMA signal line, is used to identify bullish or bearish momentum. Signal line crossovers and divergences from price trends are key signals.

Bollinger Bands

Developed by John Bollinger, these bands consist of a 20-day SMA and two standard deviation lines above and below the average. Bands widen with volatility and contract during stable periods. Price touching the upper or lower band may suggest continuation or reversal depending on market conditions.

Fibonacci Retracement

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Fibonacci retracement levels (23.6%, 38.2%, 50%, 61.8%, and 78.6%) are used to predict potential support and resistance zones. These levels are widely used to identify areas where the stock price is likely to retrace before continuing in the original direction.
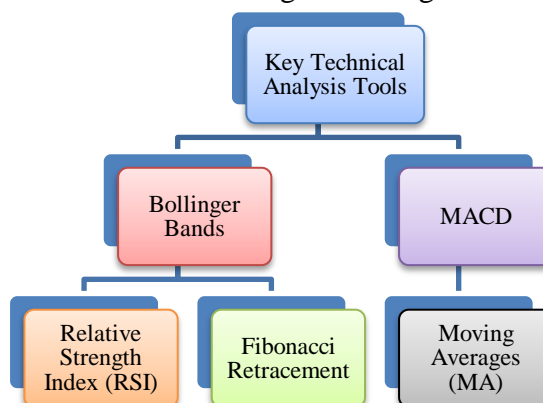

Fig.3Key Technical Analysis Tools

IV.EFFECTIVENESS IN STOCK PRICE PREDICTION

Empirical Evidence

Numerous studies have assessed the efficacy of technical indicators in predicting stock returns. Brock et al. (1992) provided early support for TA, showing that simple moving average rules had predictive power in the U.S. market. However, later research indicated that TA often underperforms in highly efficient markets due to quick dissemination of information.

The adaptive market hypothesis, proposed by Lo (2004), suggests that market efficiency is not static, and during times of volatility or irrational investor behavior, TA tools may outperform.

Application in Different Market Conditions

TA tends to perform better in trending markets where momentum indicators such as MACD and RSI can capture price continuations. In sideways markets, however, many indicators give false signals. Moreover, TA may work better in retail-driven or less efficient markets, such as emerging economies or penny stocks.

Integration in Trading Systems

Technical indicators are frequently embedded in algorithmic trading systems. High-frequency traders use short-term signals from indicators to execute large volumes of trades. Furthermore, retail investors often use them in combination with chart patterns (head-and-shoulders, flags, triangles) for decision-making.

V. HYBRID APPROACHES: TA AND MACHINE LEARNING

Recent advancements have led to the incorporation of technical indicators as features in machine learning (ML) and deep learning (DL) models. Algorithms like Support Vector

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Machines (SVM), Random Forests, and Long Short-Term Memory (LSTM) networks have shown promising results in stock price prediction when technical indicators are used as inputs. For instance, combining RSI, MACD, Bollinger Band width, and volume changes with LSTM networks can improve short-term trend prediction. This hybrid approach addresses some of the traditional limitations of standalone technical indicators by learning from large datasets and adapting to non-linear market patterns. Nevertheless, the black-box nature of AI models and overfitting risks remain challenges that need to be managed carefully.

VI. LIMITATIONS OF TECHNICAL ANALYSIS

Despite widespread adoption, TA is subject to significant limitations:

- Lagging Indicators: Most technical tools are reactive, not predictive. They reflect past market behavior and can generate signals too late.
- Subjectivity: Different analysts may interpret the same chart differently, especially in pattern recognition.
- Overfitting and Noise: When backtesting strategies, indicators can be overly optimized on historical data, making them unreliable in real-time conditions.
- Ineffectiveness in Efficient Markets: In highly liquid and efficient stock markets, price movements often reflect new information instantaneously, rendering TA signals obsolete.

VII. CONCLUSION

Technical analysis tools continue to be a central part of stock market forecasting strategies, particularly among retail investors and algorithmic traders. While these tools can offer valuable insights into price trends, momentum, and volatility, they are not foolproof predictors. Their effectiveness largely depends on the market condition, asset type, and time horizon. The integration of TA with machine learning models has significantly enhanced prediction accuracy, although caution must be exercised to avoid overfitting and misinterpretation. Ultimately, technical analysis should be employed as part of a broader, multi-dimensional investment strategy, incorporating risk management and possibly fundamental insights for optimal decision-making.

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"The Impact of Artificial Intelligence on Banking, Education, Healthcare, Automobile, E-commerce & Digital Marketing Sectors- A critical review"
Afreen Baksh, Ankita Gour, Harshita Saxena

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Abstract

In today's digital age, technology plays a pivotal role in helping businesses maintain their competitive edge in an ever-evolving market. One of the most transformative technological advancements in recent years is Artificial Intelligence (AI), which has significantly reshaped global industries. Recognizing the importance of AI, this study aims to explore its impact across six key sectors: Education, Healthcare, Banking, E-commerce, Digital Marketing, and the Automobile industry. The adoption of AI in these domains has led to substantial shifts in operations and service delivery. For this study desktop research has been used, primarily sourced from academic journals and relevant literature. Findings indicate that AI is making a profound and positive impact across all six sectors, enhancing efficiency, innovation, and user experience. However, the study also identifies several challenges that need to be addressed for AI to reach its full potential. Overall, AI represents a forward-looking technological advancement with immense future prospects, provided that existing limitations are effectively managed.

Keywords: Artificial Intelligence, Education, Healthcare, Banking, E-commerce, Digital Marketing, Automobile, Technology

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Introduction

Changing technology always open doors for new possibilities, innovations and new experiences for everyone. Artificial intelligence is one of the new technologies that is knocking around the door of every sector worldwide. Global markets are changing rapidly after the origin of artificial intelligence. Artificial Intelligence is a technology where set of tasks are done by machines with human intelligence such as ability to see, speak, learn, calculate and many other tasks. Basically, AI is used in robotics development where this technology is used like brain in robots. AI has become a necessity of this modern world.

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Father of Artificial Intelligence, John McCarthy has defined AI as "The science and engineering of making intelligent machines, especially intelligent computer programs". It is used in various fields such as e-commerce, healthcare and finance. This new innovation can be use in any industry from the origin of the product to provide the end services. AI is now revolutionizing the globe and helping every sector grow massively. AI is more efficient than any human being as it can perform multiple tasks at once as it can work tirelessly for hours. From this we can say that AI has transformed and will continue to transform our world for the better. We can say that AI challenges human power. AI helps machines to improve their performance day by day without any reprogramming. It has a vast future depending on humans, how they treat this precious gift.

Banking Sector:

The banking sector plays a vital role in driving the economy of any country. Banking sector acts as a backbone for the economy. Artificial intelligence is re-shaping the banking sector and guiding the sector towards the age of digitalization. AI is helping banking sector in the enormous ways and making the day-to-day task more secure, easy and personalized. AI has the capacity to make human-like decisions and neglect human-like errors. AI is making banking more accessible and convenient for the general public by providing 24/7 customer care support through chat bots, fraud detection, personalized services etc. In near future AI will going to handle more banking operations and will support human workforce in the more efficient manner.

E-commerce:

E-commerce can be defined as the transaction where the sale and purchase of a goods is done via internet or on any online platform. E-commerce industry is adopting the new technological changes more rapidly and using artificial intelligence in the wider way such as: inventory management, providing costumer support, fraud detection, product personalization etc. AI's main goal is to increase the in-built intelligence of software and work more effectively with humans and help them to make the task easier. Artificial Intelligence is playing a pivotal role in revolutionizing the e-commerce industry and making marketing and shopping easier and more accessible to the general public.

Digital Marketing:

AI is rapidly becoming a key force in the global economy and marketing landscape. As AI tools continue to evolve, they're transforming how businesses operate. From converting prospects into loyal customers to keeping them engaged through smart chatbots, targeted email campaigns, and interactive websites, AI is reshaping the customer journey. It gathers data from sources like social media and customer reviews, then uses that information to craft content tailored to individual interests. By tracking customer behaviour, delivering personalized experiences, and identifying at-risk customers, AI helps businesses boost marketing effectiveness, save time, and cut costs by focusing on what truly matters to their audience.

Automobile industry:

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AI is ushering in a new era for the automotive industry, transforming everything from design and manufacturing to logistics, sales, and customer service. Its influence extends well beyond autonomous vehicles, fuelling a comprehensive shift across all facets of the industry's operations and customer experiences. Artificial Intelligence is helping the automobile industry by converting complex supply-chain management into more convenient process by reducing process cycle, higher speed in maintaining inventory etc. With AI, the world of automobile sector is going to touch new sky, in a massive big way.

Healthcare Sector:

The use of Artificial Intelligence in the healthcare sector is increasing rapidly day-by-day. From patient-care, primary diagnoses to drug-development and robotic surgery, AI is spreading its wings massively in the healthcare sector. Healthcare professionals are using AI algorithms in order to ease their work and provide best possible facilities to the patients. Frost and Sullivan have estimated that AI will improve patient outcome by 30% to 40% with a reduction of 50% in the treatment cost. AI algorithms are helping healthcare professionals in making diagnoses more precisely and also suggest the best available treatment to the patient.

Education Sector:

Recently artificial intelligence (AI) based tools for education are in more demand and used by both students and teachers extensively. AI is converting education by making learning more personalised, efficient and accessible. Many applications of AI are widely practiced by academicians in designing the content of books, learning materials and AI algorithms are used to scan huge data. AI makes study easier for students and it also save time of teachers as it can also spot where students are struggling so teachers can help them accordingly, over all AI is making education more accessible, fun and easier for everyone.

Literature Review:

AI & Healthcare sector:

Ragavi V et al (2020), the researchers focus to find out how the algorithms in healthcare sector works and it also examines the effect of AI in the healthcare sector. Secondary data has been used to conduct this research. From the study of this research, it is found that now a day's health care professionals using deep learning and machine learning. In this article different department of health sector was studied which includes cardiology, radiology, oncology, automated image diagnosis etc. It was also discussed that how useful artificial intelligence is in the above-mentioned healthcare departments. It is predicted that AI is going to be very useful in the health care sector in the coming years, it is important that all medical professionals know the essential of AI, which helps them giving improve services to their patients.

Mohammed Yousef Shaheen (2021), This study discussed and examine the up-to-date applications of AI in the medical sector. Three main areas had been highlighted in this study i.e. clinical trials, AI led drug discoveries and patient care. This research has been completed

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by using secondary data.He concluded in the study that pharmaceutical sector is taking advantage from AI and is helping in drug discovery and target identification. He also reveals that AI is working better than humans and after some time humans can be supplanted by AI in the health sector at the preliminary stage. Many challenges in the critical health care sector can be eased by AI.

Thomas Davenport and Ravi Kalakota (2019), their main purpose was to investigate the possible future of Artificial Intelligence in the healthcare sector. The research was conducted by gathering secondary data. The main key areas that were focused in the study were treatment and diagnosis suggestions, administrative related activities and patient engagement. They concluded that it is really challenging at the early age for AI to provide accurate diagnosis and treatment recommendations but it is proven to be useful for scanning radiology images and text & speech recognition were widely adopt by the health sector for patient communication. They forecast that AI will not replace humans on a large scale but it is the responsibility of the healthcare professionals to must work alongside with AI.

David B Olawade et al (2024), they had studied about the inclusive examination of the artificial intelligence in the healthcare sector, focusing on its variations accomplishment and challenges. They conducted the research by using secondary data. The researchers concluded that AI has the positive impact in the healthcare sector, it helps healthcare sector by giving more precise diagnosis, by treatment personalisation, driving robotics. They also reveal that AI algorithms are helping more accurately in analysing medical images for diagnosis. The researchers also found that AI driven robots automate various tasks specially in surgery. They recommend that there is a need for strong ethical and legal structure, human collaboration and safety authentication, education in order to established the effective integration of AI in healthcare.

AI & Banking Sector:

Krutika Sawant et al (2023), the research aims to study current usage of artificial intelligence in the banking and financial sector. Data was gathered from the secondary sources such as books, research journals, websites etc. It is concluded from this study that currently many banks are experimenting with AI in order to become familiar with the growing technology. It also reveals that AI is really beneficial for the costumers as they can access to banking services whenever required and it is also helpful for banks in reducing frauds and credit risk could also be easily analysed.

A Geetha (2021), the main purpose to carry out this particular study was to discover the impact of AI in the banking and financial services. This study was set up in the banking industry of Chennai. Secondary as well as primary data was collected for this study. A well-structured questionnaire was prepared in order to collect the primary data from the customers and the secondary data was gathered with the help of e-books, research papers, magazines etc. It is concluded from this research that many private financial institutions and private banks are using different types of AI services in order to benefit customers. Banking industry are adopting chatbots, KYC/AML and security compliance so that the costumers can be fulfil easily.

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Ashwini T G, Khan M A, Hussain A (2023), this study aims to examine the effect of artificial intelligence on the banking industry. Secondary data was taken into account by the authors for this research and it is gathered through journals, different publications and research papers. Positive and negative impacts of AI had been broadly discussed in this article. This research article had concluded that the banking industry has positively impacted by AI by improving fraud detection, risk management, by offering personalized services etc but there are also negative aspects of AI such as job displacement, data privacy and security risk, dependency on technology etc. It is suggested to keep the balance between positive and negative impact of AI in order to adopt sustainable AI in banking sector.

Radhika K G and Shriraksha R (2024), they focus on to examine the concept of artificial intelligence and the opportunities of AI in the Indian banking sector. For this particular study the researchers had used secondary data and previous research articles was reviewed for that. It is found in this study that Indian banking industry has quickly adopt AI technology and implementing the same gradually. AI applications include: chatbots, personalizing servicing, fraud detection etc. Researchers hadpredicted that AI will be sole determinant of the competition in the near future.

AI & Education:

Elyjoy Micheni, Jackson Machi and Julius Murumba (2024), The primary objective of the research was to examined the use of AI in education, the potential of AI in learning and the pedagogical consequences of AI. The researchers explained how artificial intelligence may change learning environments and materials, paving the door for scalable services both within and outside of the classroom. The researchers came to the conclusion that although incorporating artificial intelligence (AI) into the classroom has many advantages, there are also serious concerns. Ethical considerations must be taken into account in order to take full advantage of AI's technological breakthrough for educational purposes.

Muhammad Tahir et al (2024), researchers aim to discover the use of AI in the education industry, future opportunities and challenges. Key topics covered by the authors in this research report included challenges like lack of personal contact, lack of inclusion and equity for students from all backgrounds, and ethical concerns including data privacy. Based on these themes, researchers came to the conclusion that while AI is going to play a greater part in education coming into the future, there are still issues that must be resolved if the full potential of AI in education is to be realized.

Aniella Miharla Vieriu and Gabriel Petrea (2025),They investigated the role of AI in learning process and academic performance at the National University of science and technology Polytechnic Bucharest. They gathered data from 85 students who used AI tools in their education. A well-structured questionnaire was circulated via google form in order to collect data. Data was analysed by frequency and percentage calculation while thematic analysis were used to analyse qualitative data.The outcome shows that AI helps customised learning, improve grades and enhance students' engagement, however they also highlighted issues like

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over dependence on AI reduced problem-solving, privacy issues and cheating the study advise that for AI to be used well in education, there should be clear instructions and a balance approach to handle both its benefits and risks.

Ahmet Gocen and Fatiha Aydemir (2020), they investigated the role of AI and its impact on teachers, schools and leaders in education based on interviews from education, law and engineering sectors.The research shows that AI offers both benefits and challenges while most participants seen AI positively. The result shows that teachers and academics worry about its impact on future of teaching, lawyers highlight legal concerns of AI in education while engineers focus on its potential to upgrade education. The study also suggests ways to use AI effectively and prevent possible problems.

AI & E-commerce:

Dr. S Shanmugapriya and S. Pavithra (2024), they examine the nature of e-commerce & AI and the benefits of artificial intelligence on e-commerce. They also aim to access the importance of AI and it's uses in the sector of E-commerce. Benefits and uses of AI in the E-commerce industry was briefly discussed in this article. The researchers concluded that AI is playing crucial role in the different customer experience and innovative solution. It is reveals that the AI is helping in product recommendations, inventory management and personized shopping in the E-commerce sector.

Prof Mohd Hanif et al (2023), the purpose to carry on this study was to access the effect of artificial intelligence in the sector of E-commerce. The data was gathered from the secondary sources for this study and in order to gather that journals, research papers and magazines were used. They conclude that artificial intelligence is a demand of today in the sector of E-commerce. Product recommendations, personalized shopping and inventory management are some of the widely-accepted applications of AI. They also found that E-commerce is continuously growing and becoming user friendly with the help of AI.

Faiza Kanwal et al (2024), the main goal of the study was to examine the role of AI in the sector of E-commerce and also its impact on the management and customers. The study was conducted by gathering primary as well as secondary data. Primary data was collected with the help of surveys & interviews and secondary data was gathered from industrial report, published journals, case studies etc. The data was tested by using regression analysis and it was analysed with the help of SPSS. The authors concluded that the operational efficiency in the e-commerce has been improved after the introduction of AI. They also highlighted two main challenges of AI i.e. high cost and privacy issue. It is also found out that Artificial intelligence helps the business by reducing daily routine activities, inventory management, provide real time information etc.

AI and Digital Marketing:

Nadia Meddah (2024),she examines the effect of artificial intelligence on the behaviour of customers. The research based on secondary data and the factors influencing consumer

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behaviour has been discussed in the study. Sheconcluded that AI is one of the important tools to understand the purchasing behaviour of customers and upgrading strategies, the study also concludes that AI helps businesses make better decisions, enhances customer experience, boosts retention, and creates lasting competitive advantages. It is recommended that accepting AI is essential for all sectors aiming to grow and stay ahead in today's market.

Koushiki Biswas and Dr Gourango Patra (2023)they aim to study the impact of artificial intelligence on analysing the changing customer behaviour. The data for this study was collected from secondary data mainly from published research articles. For this particular study six different sectors had been studied. This research concludes that AI makes marketing process easier as compared to traditional shopping methods. They also find that AI can be use by the marketing team in order to decode huge data which helps them to target customers and make marketing strategies. It also plays a big role in healthcare and banking, from detecting diseases to spotting frauds.

Dr.L Bhuvaneswariet al (2024), They aim to examine the growing impact of AI on digital marketing. The research based on the secondary data. The studyconcluded that AI has transformed digital marketing by enhancing personalization, improving efficiency, and enabling data-driven decisions. With tools like chatbots, automation, and predictive analytics, businesses can better connect with audiences and adapt to changing demands. AI will remain key in advancing marketing strategies and achieving business goals.

Mona H Mussa (2020), the main purpose behind carry on the research was to investigate the how artificial intelligence influence consumer behaviour in the retail sector. The study was set-up in Egypt. The data was collected by circulating online questionnaire through convenience sampling method. Sample size for the study was 384. Reliability and Regression test were used as statistical test and the data were analysed by SPSS version 22. She concluded that the relationship between artificial intelligence and consumer behaviour found to be significant. The study recommends that retailers must adopt AI as it enhances purchase decision, need recognition and also predict post purchase behaviour.

AI and Automobile Sector:

Igor Koricanac (2021),the objective of his research was to examine the role of AI in the U.S. automobile industry. He used secondary data to conduct the study. He finds that algorithms of AI are essentialin the U.S. automotive industry as it can predict market forecast and heavy algorithms can even be used in manufacturing and supply chain process. It is expected to have a major impact on automotive companies and the global supply chain. He also predicted that automotive firms that adopt AI early can gain a major competitive advantage.

Tai Yoon Chai and Ismail Nizam (2021), they aim to examine the impact of Artificial Intelligence in the automotive industry. The research based on primary data and the data was collected from 160 responded. A well-structured questionnaire was designedand circulated online in order to collect data. Regression and reliability were used as the statistical test and SPSS were used to analyse the data. Dependent variables taken for the study were leadership change, smart factory, autonomous vehicle and sales & marketing while the independent

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variable was AI. The researchers concluded that there is significant and positive impact of AI on all the dependent variable.

ES Soegoto et al. (2019) investigated the benefits and impact of artificial intelligence in the automotive industry, focusing specifically on driverless car technology. Their study, which utilized secondary data, concluded that autonomous vehicles represent the future of the automotive sector. The researchers emphasized that the integration of AI is helping automobile companies meet modern demands by automating various aspects of transportation. Additionally, the study highlighted that driverless cars provide users with increased free time and improved travel experiences.
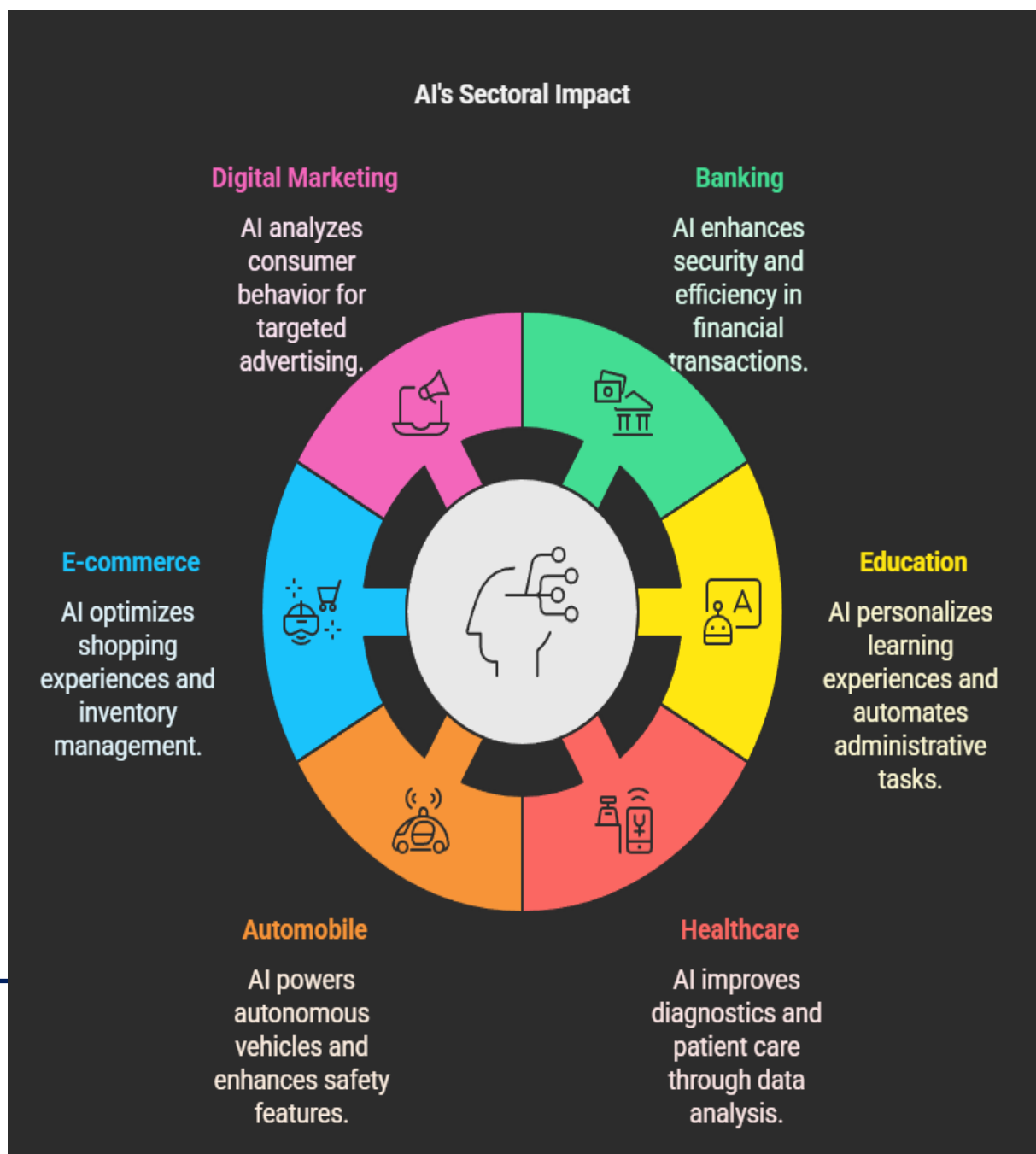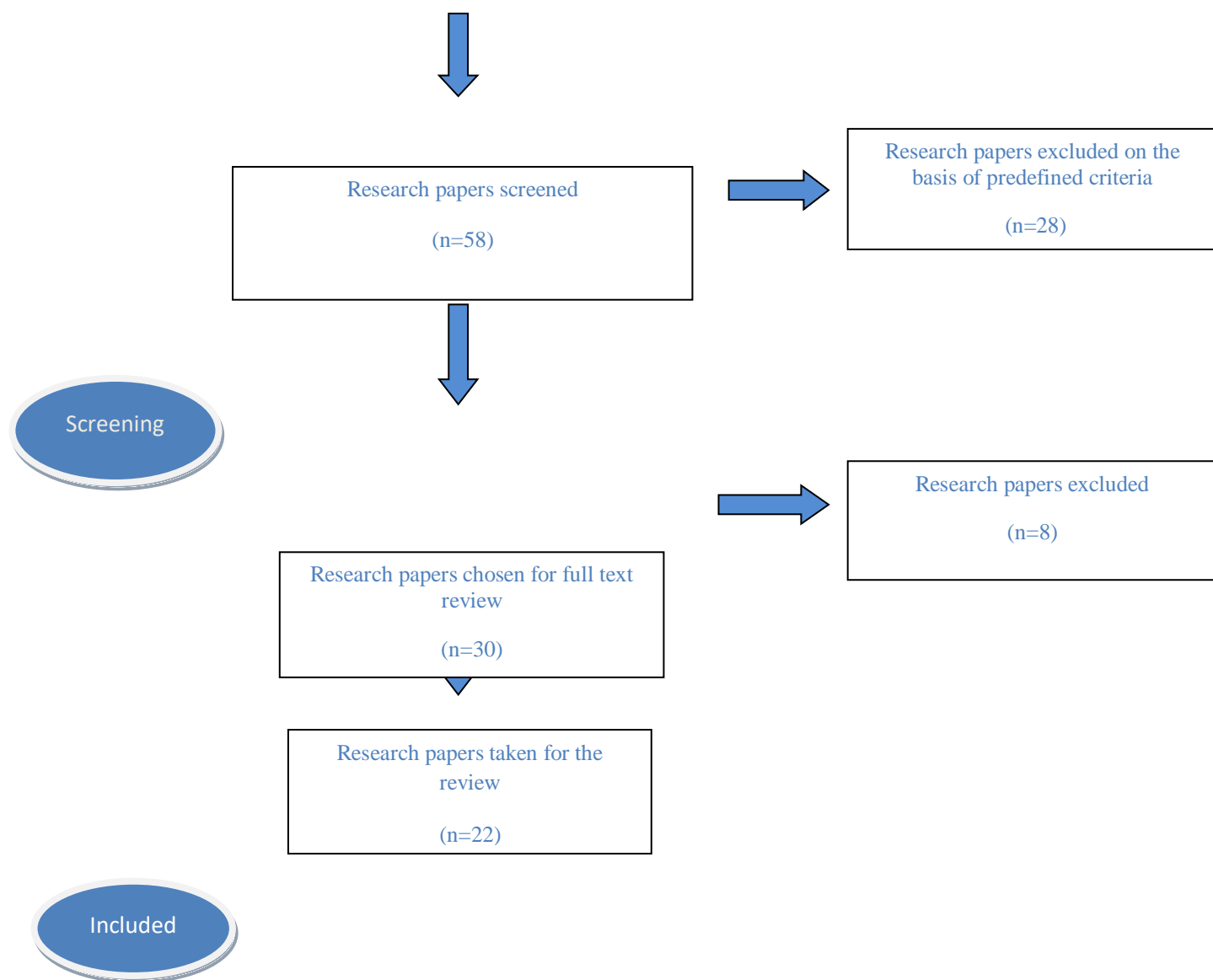
Figure: 2Data Extraction Model

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Research Methodology:

This article is the conceptual overview in order to determine the impact of artificial intelligence on different sectors. This particular research uses the desktop research. We have adopted systematic approach for this study and therefore, articles of various scholars and authors is reviewed. Research article from google scholar, research gate and various peer-reviewed journal has been taken into consideration. Articles those are unrelated to AI and all six sectors are excluded from this study.

This study retrieved total 68 research articles of various scholars as follows:

Google Scholar: 26

Research Gate: 22

Other peer-reviewed Journal: 20

These articles underwent for initial screening on the basis of Title and Abstract. Left-over articles were sub-divided and underwent for full text review. Total 58 articles were screened in the initial stage which results in the elimination of total 28 articles on the basis of predefined criteria. Total 30 articles were selected for full text review and by thorough analysis we eliminated 8 articles and total 22 high quality articles were selected for the research.

Future Challenges of Artificial Intelligence:

1. **Biasness in AI**: Artificial intelligence relies heavily on algorithms and data, and if the data fed into these systems is biased, it can result in a lack of transparency. Such bias can lead to discrimination and unfair outcomes. Sectors like law, human resources, and banking are particularly vulnerable to the negative impacts of these biases.

2. **Job Displacement**: Job displacement is expected to be one of the greatest challenges brought on by AI. Nearly every sector faces uncertainty as automation threatens to replace human labour. To navigate this shift effectively, organizations must implement AI thoughtfully and invest in educating their workforce to ensure a smooth and adaptive transition.

3. **Data Privacy & Security**: Data security is one of the biggest concerns after the introduction of artificial intelligence. AI basically has to deal with lots of data and it could lead to breach confidential information. Privacy preservation outlook must be adopted by the organizations in order to minimize security risk.

4. **Deepfakes & Misinformation**: This is also one of the challenges facing by the world. Fake information is roaming around almost all the corners because of misuse of AI.

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The world seems to be in dilemma and not able to differentiate between reality and fake content. Deepfakes are widely use in spreading potential frauds, political propagandas etc.

5. **Loss of Human Skills**: Human forces are losing skills after the introduction of artificial intelligence. As AI is able to automate the work and can make the task easier humans are becoming more dependent on this technique. Higher dependency may result in loss of critical thinking, problem-solving skills, lack of face-to-face interaction.

Conclusion:

The role that is portrayal by the technology in today's digital era cannot be ignored by the business organizations as it helps them to remain competitive and stand strong against the competitive market. Recently, it has been noticed that global markets are experiencing the drastic technological changes after the introduction of Artificial Intelligence (AI). This study concludes that artificial intelligence (AI) has a positive impact across all six sectors examined. In the banking sector, AI is enhancing fraud detection, enabling personalized services, and supporting 24/7 customer access through AI-powered chatbots. In e-commerce, AI is transforming operations by recommending products, managing inventory, and offering personalized shopping experiences. In healthcare, AI is assisting professionals in making more accurate diagnoses and reducing the time required for various tasks. AI will be going to compliment human force in near future rather than replacing it in healthcare sector, although it has the ability to supplant humans only at the preliminary stage. AI algorithms are helping professionals in analysing medical images accurately.

In the education sector, both academicians and students are benefitted by various AI applications and it is helping them in customised learning, enhancing learning process according to the ability of the student but also there are many challenges like lack of personal interaction, data privacy, declined problem solving capacity etc. The algorithms of AI in the sector of digital marketing are helping in upgrading the marketing strategies, recognising customer need and buying behaviour. Massive data can be easily decoded with the help of AI which help in targeting the customers. In the Automobile sector, complex supply chain management and manufacturing processcould be easily manageable due to AI algorithms and it is rapidly changing automobile industry by launching many new features in cars such as: voice assistant, improved safety, autonomous cars etc.

Although AI is still in its early stages of adoption across sectors, it faces challenges such as job displacement, data security, Biases, loss of human skills, misinformation etc. Overcoming these hurdles is essential in order to realize AI's full potential as a transformative innovation. The study also recommends that businesses embrace AI and equip their workforce with the necessary skills to adapt to this emerging technology, ensuring they remain competitive in a rapidly evolving market.

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This article proven to be beneficial for the researchers who wants to conduct the study in the same field by taking primary data.

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Retrieval of Semantic Video Actions with Genetic Algorithm and Optimize Support Vector Machine Based Categorization
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Abstract

In existing years, there has been an increasing require for computerized visual surveillance systems added and further surveillance cameras are use in public Domain this is an determined intend which has concerned an growing amount of researchers to determine recurrently encounter surveillance problems of object detection, object tracking, object classification, and abnormality detection over in the video attracting widespread concentration due to public security. Verdict preferred information in a video clip or in a video record is a complicated and difficult task owing to its semantic gap between the lowlevel characteristic and sophisticated video semantic perception. Video information encloses collection of semantic information. The semantic information illustrates what is incidence in the video and furthermore what is evident by human users. Method for quick video browses, video repossession be converted into crucial as video essence become supplementary and extra obtainable and delicate. In this research, we proposed attempt to mine semantic context information together with object-specific circumstance information and scene-specific context information. On the other hand, video retrieval allow the customer to search for meticulous video segment based on some description commercial increase and SVM(Support vector machine) are included for feature selection and ensemble classification Video is quickly attractive single of the largest part accepted Multimedia due to its elevated information and amusement capability.

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1.INTRODUCTION

In recent years, there has been an growing require for automatic illustration observation systems [1] additional and more surveillance cameras are use in public area such as airport,

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banks, malls, and passageway station. though, they are not optimally utilize due to the guide inspection of the output, which is exclusive and defective. Automatic observation systems intend to put together real-time and efficient computer vision algorithms in order to assist human operators. This is an determined objective which has attracted an growing amount of researchers to resolve frequently encounter surveillance problems of object detection, object organization, object pathway and aberration detection over the years. In this research, main challenge to resolve these problems by mining semantic circumstance information.

With the proceed of storage potential, compute power and multimedia knowledge, the investigate on semantic event motion detection happen to further and added active in recent years, such as video observation, sports emphasize detection, Movie concept and house video retrieval etc. during event motion detection, customers can recover precise video segments hurriedly from the long videos and save a great deal time in browsing. Though [2], semantic event detection is still a demanding problem due to the huge semantic gap and the complicatedness of modeling temporal and multimodality kind of video.
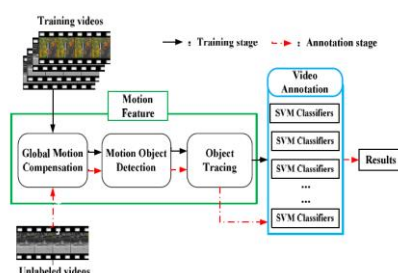
Figure 1.1: event motion detection based on SVM Classifiers

The Segments Classification technique treats event Detection as a categorization problem. The technique primary select probable event motion video segments, a sliding data window[3], and after that adopts classification algorithms to envisage the semantic label of every segment. use game-specific rules to categorize events. even though the rule system is instinctive to yield sufficient consequence.

Figure 1.2: example of video event classification based on motion

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Figure 1.3: Highway Object Tracking and Classification

2. LITERATURE REVIEW

These Research give a brief survey of associated works for this investigates. Remaining to its extensive range of function, video event detection has increase a significant attention of practitioners and academic from dissimilar area. Subsequently, a variety of techniques have been anticipated in current years. owing to space limitation, it is impracticable to provide a complete survey in this paper. as an alternative, drill downwards our focus and give a quantity of investigate results straight associated to this study. huge quantity In real life application, the dimensionof video data is enormous (still every item is a great deal big than a tuple in a conservative (relational) data repository). Dealing with such data items necessitates

huge amounts of computational resources such as storage and data dispensation power. A characteristic example is that video data might go beyond gigabytes on special computers.

Wei Fu et.al [1] In this research, it has been proposed a novel unsupervised approach is learn semantic motion patterns for a dynamic scene. By representing a video as a topic model, an enhanced sparse contemporary coding framework is use to find out the semantic topical bases, with which each video clip can be sparsely reconstructed. This work indicates that the sparse representations for videos are promising for scene analysis applications.

Jianchao Yang et al[5] develop an extension of the SPM method, by generalizing vector quantization to sparse coding go after by multi-scale spatial max pooling, and suggest a linear SPM kernel base on SIFT sparse codes. This novel proceed remarkably decrease the difficulty of SVMs to O(n) in training and a stable in testing. In a quantity of image classification experiment, they discover that, in terms of categorization accuracy, the optional linear SPM based on sparse coding of SIFT descriptors always considerably outperforms the linear SPM kernel on histograms, and is even improved than the nonlinear SPM kernels, leading to state-of-the-art performance on several benchmarks by using a single type of descriptors.

Bangpeng Yao et al[7] In this work, utilized characteristics and parts for activity acknowledgment. The qualities are verbs related depiction of human activities, while the parts are made out of articles and poselets. It has been educated an arrangement of scanty bases of the qualities and parts based picture representation, permitting an activity picture to be recreated by an arrangement of inadequate coefficients concerning the bases.

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Yang Cong et al[8] proposed a new criterion for abnormal event detection, namely the sparse reconstruction cost (SRC). Whether a testing sample is abnormal or not is determined by its sparse reconstruction cost, through a weighted linear reconstruction of the over-complete normal basis set. Thanks to the flexibility of their proposed dictionary selection model, method cannot only support an efficient and robust estimation of SRC, but also easily handle both local abnormalevents (LAE) and global abnormal events (GAE). By incrementally updating the dictionary, our method also supports online event detection.

Dong et al. [9] propose a novel case based calculation which maps a worldwide shape highlight by Fourier descriptors to different setups of people straightforwardly and utilize privately weighted normal to add for the most ideal applicant arrangement. Likewise, they utilize dynamic programming to alleviate the natural equivocalness.

Zhao and Nevatia [10] use human shape to decipher closer view in a Bayesian structure. Be that as it may, these techniques are not proper for dividing a gathering of articles into person. Since bearings of movement of items are distinctive, their stances will change, which might bring about these elements not to be achievable. Likewise, protests in a gathering might have comparable shading, composition and shape highlights.

Timothy Hospedales et al[11]they was address these issues by introducing a new dynamic topic model, termed a Markov Clustering Topic Model (MCTM). The MCTM builds on existing dynamic Bayesian network models and Bayesian topic models, and overcomes their drawbacks on sensitivity, robustness and efficiency. Specifically, our model profiles complex dynamic scenes by robustly clustering visual events into activities and these activities into global behaviors with temporal dynamics. A Gibbs sampler is derived for offline learning with unlabeled training data and a new approximation to online Bayesian inference is formulated to enable dynamic scene understanding and behavior mining in new video data online in real-time. The strength of this model is demonstrated by unsupervised learning of dynamic scene models for four complex and crowded public scenes, and successful mining of behaviors and detection of salient events in each. Most recent works for video-based human motion recognition have introduced 3- dimensional scale invariant feature transform (SIFT).

Jianjiang Lu et. al[12]In this work, they was study the problem of visual event recognition in unconstrained broadcast news videos. The diverse content and large variations in news video make it difficult to apply popular approaches using object tracking or spatiotemporal appearances. In contrast, adopt simple global feature, local feature and motion feature to represent video clip. Using these features, video clip can be encoded as a set of feature vectors. Then according to different feature, they train SVM classifiers, and a bi-coded chromosome based genetic algorithm is performed to obtain optimal classifiers and relevant optimal weights based on training stage. This is a research to investigate effective genetic algorithm to fuse the information from different features.

Bazi et. al [13] proposed a system to detect the best discriminative features (without requiring their number to be set a priori by the user) and to estimate the best SVM parameters in a fully

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automatic way by means of a genetic optimization framework. Melgani et. al [4] presented a PSO-based SVM approach to detect the best subset of available features and solving the tricky model selection issue. Although the two methods provide pretty good performance, they still might be trapped in the local optimism problem and their convergence speeds are not very high.

Hengzhen Gao et. al[14] This research presents a novel method combining SVM with two heuristic algorithms GA and PSO for hyperspectral image classification. They integrate the GA operators into PSO algorithm to improve the feature selection and parameter estimation performance. The hybrid PSOGA method can search for the optimal parameter values and obtain a optimal subset of features. The optimal subset of features is then used in both training and testing for optimal outcomes in the classification. Comparison of the obtained results with those of other approaches demonstrates that the developed PSOGA-SVM approach has a better performance than others approaches.

Theodoros et. al[15] presented a method for user-driven audio event detection in news videos. They has focused on detecting five particular audio events, which were more often in the CASAM dataset, which consists of almost 100 real news videos. The audio detection algorithm is based on the classification scheme, while support vector machines have been adopted, as binary classifiers. The decisions of the automatic scheme can be adapted to the user's knowledge (regarding particular audio classes), by using a probability weighting technique .

Chitra H et. al[16]method to fuse the low level features and apply them to object tracking. In this algorithm, the graph grammar rules are used to detect the object in the beginning of the video sequence and then dynamically examine and adjust the tracking procedure to make it robust. The effectiveness of the algorithm was demonstrated by experiments.

3. Problem Definition and Methodology

3.1 PROBLEM IDENTIFICATION

☐☐Amid the variety of category of video information, events pose the most challenge in provisions of the accurateness that can be attain in their automatic modeling and categorization.

☐☐Automatic recognition of video highlights has been the center of attention of a quantity of research efforts in current years. However to replica and extract events for semantic classification using low-level video features remains a most important challenge. It is though a topical issue mostly due to:

1) A growing need for automatic classification of precise events in the networked society, at extremely least for surveillance and perceptual user interfaces.

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2) The lack of robust feature narrative and classification schemes for video events. For semantic event classification techniques, the events are generally symbolize as vectors of feature values.

☐☐The typical approach is to construct a computational replica for alteration of video frames in the used event features.

☐☐As is evident in many supervised learning problems, feature selection is important. SVM have been revealed to perform poorly when there are many irrelevant features.

3.2 METHODOLOGY

3.2.1 VIDEO EVENTS ANALYSIS

Dynamic activity detection is an important cue for video content analysis, including action-based video indexing, browsing, clustering,…, etc. Semantic understanding of multimodal content is the final frontier in video analysis and retrieval. The difficulty lies in bridging the gap between low-level features and representations that can be automatically computed from the content and its associated high-level semantics as perceived by humans. Acknowledging the need for providing video analysis at semantic level, research efforts set focus on the automatic extraction of video descriptions matching human perception. Therefore, the ultimate goal characterizing such efforts is to bridge the so called semantic gap between lowlevel multimodal features that can be automatically extracted, from the aural, visual, textual and spatio-temporal content, and the high-level concepts capturing the conveyed meaning. Analysis of events has primarily focused on the recognition of sets of predefined events or actions. However, real-world applications are unlikely to be restricted only to recognition of pre-studied carefully modeled events.

Moreover, when dealing with general video data, often there is no prior knowledge about the types of events in the video sequence, their temporal and spatial extent, or their nature (periodic/non-periodic). Here, training vector xi is set in correspondence in a space of higher dimension (sometimes innite) through the function. Support vector machines then determine a separating linear hyperplane in this space. is the projection kernel and C the penalty parameter of the error term. Among the possible kernels (linear, polynomial, radial basis function, sigmoid), & choose the radial basis function: kernel parameter.

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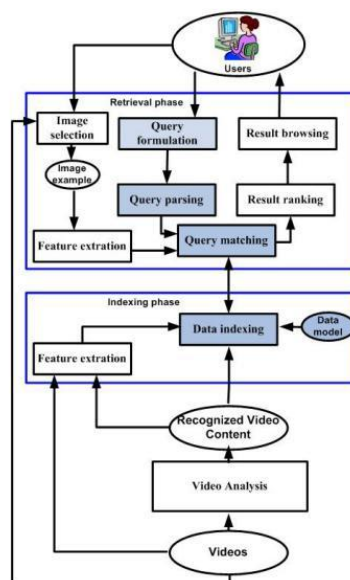
Figure 3.2.3: A Query Language for observation Video Retrieval

4. PROPOSED METHODOLOGY

Genetic algorithm based optimization of support vector machine is an incremental method prospect with an instigation population of randomly produce genotypes. Our

research introduced support vector machine model whose feature assortment, instance assortment, and kernel parameter settings are globally optimized in order to improve prediction accuracy. Genetic operation uses this superiority information for construction a new population of features, occurrence and parameters for the support vector machine.

The entire learning technique can be seen as divided into a microscopic cycle for learning of a SVM and a macroscopic evolutionary cycle. Instigation In this step, the system produce the preliminary population that will be used to find global optimum factors such as feature and instance selection variables, and kernel parameters. The preliminary values of the chromosomes for the inhabitants are randomized before the search process. To enable our GA to find the optimal factors, intend the structure of a chromosome as a binary string. Every chromosome in our technique has all the information for feature selection.

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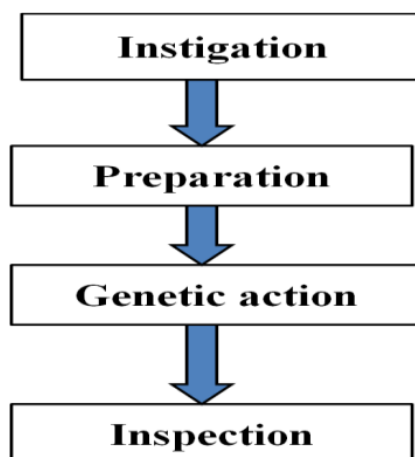
Figure 4.1: Training phase

Training After generate the establishment population, the system execute a characteristic SVM process using the assigned value of the factors in the chromosomes, and assesses the recital of each chromosome. The performance of each chromosome is intended through the fitness function for the GA. the major objective is to discover the most favorable or near optimal parameters that construct the the majority precise classification solution.

Thus, first set the fitness function to the classification accuracy of the test dataset. The fitness function is an important issue for assessment and progress of SVMs providing suitable and stable consequences in real time applications. Consequently, it should communicate the user's aim and should favor SVM with acceptable simplification capability in order to select precious classier analytically. Genetic action a novel generation of the population is produced by applying genetic operators such as selection, crossover, and mutation.
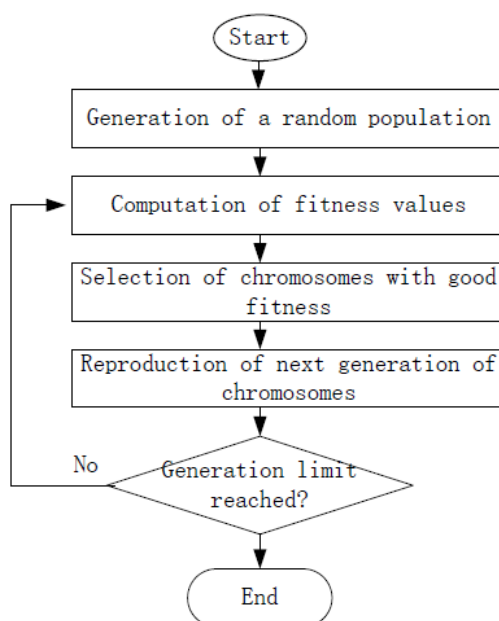
Figure 4. 2: Training phase

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To train the classifiers, labeling a large training set by hand can be timeconsuming and tedious. The difficulty is the high cost of acquiring a large set of labeled examples to train the two classifiers. Usually, collection of a large number o unlabeled examples in most applications has much lower cost, as it requires no human intervention. Therefore, adopt a semi-supervised method to learn two classifiers, inspire by the idea of co-training learning.
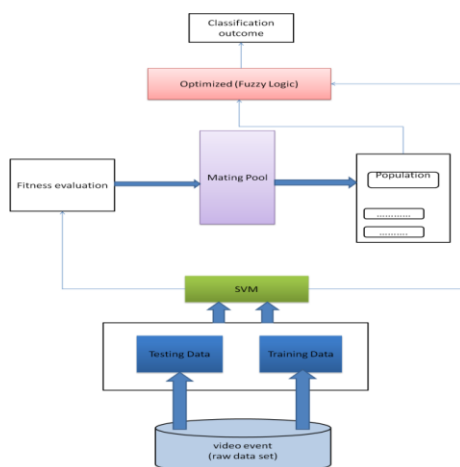
Figure 4.3: Proposed Architecture

Object classification improves by fusing different feature and enlarging unlabeled samples under a co-training framework. Scene-specific perspective information will efficiently and effectively learnt by use of Gaussian Mixture Model (GMM) .observe events of interest in a hybrid camera network consisting of uncelebrated cameras. Our approach accomplishes this task with minimal knowledge about the environment by accumulating and processing observation data over time. Research validate the effectiveness and the performance of the camera parameter prediction algorithm using both simulated and real-life experiments. Our propose results obtain are encouraging and consistent with the algorithm's expects behavior.

5. IMPLEMENTATION

Implementation required for this software and hardware on the development side system.

5.1 VISUAL STUDIO.NET 2010

The .Net is a technology which for developing windows, web based and web based related application and service. It has four components:

1. .NET framework [BCL and CLR]

2. .NET Languages [C#.NET, VB.NET and 40 plus languages]

3. .NET Tools [Visual Studio.NET 2008/2010/2012]

4. .NET Servers [Biz talk server, IIS Server]

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Through these components can develop any type of application. In this application mention the above tools and languages. It is necessary to go through the features of the technology and tools. Client Side

• Web Browser (Chrome, Opera, Mozilla)

Project will be done in ASP.NET with VB.NET as front end and SQL Server 2005 as back end. Microsoft .NET is software that connects information, people, systems and devices. It spans clients, servers and developer tools and

consists of:

☐ The .NET Framework programming model that enables developers to build Web-based applications which expose their functionality programmatically over a network using standard protocols such as SOAP and HTTP.

☐ Developer tools such as Microsoft Visual Studio .NET, which provide a rapid application integrated development environment for programming with the .NET Framework.

☐ A set of servers including Microsoft Windows 2000, Microsoft SQL, Server and Microsoft BizTalk Server that integrates, runs, operates and manages XML Web services and applications.

☐ Client software such as Windows XP, Windows CE and Microsoft Office XP that helps developers deliver a deep and compelling user experience across a family of devices and existing products.
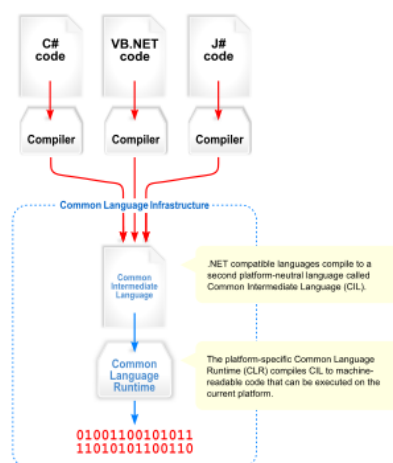
Figure 5.1 .Net Architecture

The .NET Framework is the programming model of the .NET environment for building, deploying and running Web- based applications, smart client applications and XML Web services. It manages much of the plumbing, enabling developers to focus on writing the business logic code for their applications. The .NET Framework includes the common language runtime and class libraries.

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5.2 SQL SERVER 2008

SQL Server is a relational database management system (RDBMS) from Microsoft that's intended for the enterprise environment. SQL Server runs on T-SQL (Transact -SQL), a set of indoctrination extensions from Sybase and Microsoft that add a number of features to standard SQL, counting transaction control, exception and error handling, row dispensation, and affirmed variables.

6. RESULT ANALYSIS

To take out dependable motion in sequence, dense motion vectors (MVs) are first figured out from raw video data by with customary block-matching method, but subsequently validated for use in following camera motion estimation. Normally, MVs from compressed MPEC data are not dense enough (one MY for each 16*16 macro block) and may be erroneous since the goal of block-matching is to purchase an MV that minimizes least misrepresentation in encoding process, somewhat than an MV that reproduce the true motion performance. To achieve the above purpose, block-matching is performed each four pixels in both measurement. not still non-overlapping 16x16 ME, as in MPEG standard. The reference template is centered at each considered pixel for MY estimation.

Figure 6.1: video frame for object detection

In this way, the MV field will be denser than in MPEG. Then we to reduce the number of candidate positions to be evaluated in the search region, as shown in Fig 6.1 as the dark points. It is reasonable that the sampling of candidate positions is higher for earlier regions, while inferior for distant region. This property was adopted in the development of fast algorithms for motion estimation. Processing flow of the proposed semantic classification for highway traffic videos. When computing the similarity among the position pattern and the applicant block, Wei Fu method [I] was adopted. Their algorithm speeds up the working out by early on rejecting unfeasible applicant by iteratively checking the partial sum of differences. Via a proper organize of scan lines according to image incline, the partial sum of errors can be quickly accumulated for wrong applicant, hence growing the probability of early on rejection. This was often adopted in fast full search algorithms for motion estimation. This fast procedure to a saving of 75% computation.

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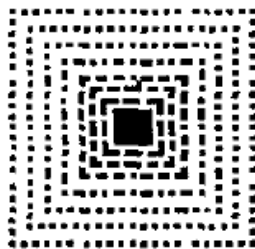
6.2 Motion vector estimation

6.1 MOTION VECTOR VALIDATION

As mentioned, MVs intended thus far might not be correct enough due to the bias in the optimization decisive factor (slightest distortion). This circumstances can be more obvious for pixels in smooth or non-busy areas. To cope with this difficulty, a validate process based on the normal divergence was introduce to remove invalid MVs.

Figure 6.3 Motion Vector Validations

Two situations regarding the MV values are considered. When the estimated MV is zero, we calculate the standard deviation a of SADs (sum of absolute differences)
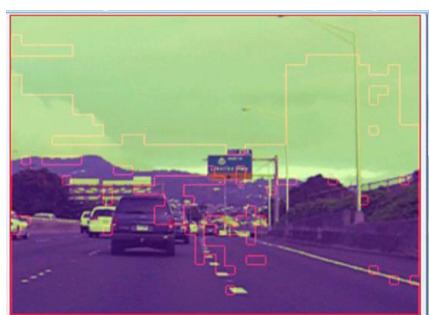
Figure 6.4: Motion Vector Validations

for MV = (- I, - I) - (+l, +I) (i.e., many object around the considered pixel). If a is below a predetermined threshold, a smooth area is thus recognized. In this container this zero MV is regard as invalid. When the predictable MV is not zero, we assume no camera motion. Figure 6.4 illustrates two consecutive frames, both composed of smooth areas except the S-patterned edges. because there are no discernible features except for the S edges, object positions B, C,

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D, and E may all have a comparable charge when identical to the position template. In this case, the criterion of minimum SAD will not be always reliable. Correspondingly, the examination of normal divergence of local matching errors was adopted. If the standard deviation of SADs for positions along the MV direction (Le., the edge orientation) is below a predetermined threshold, again the predictable MV is regard invalid. It is our approach that invalid MVs will not bc considered in following processing,- e.g., camera motion e-
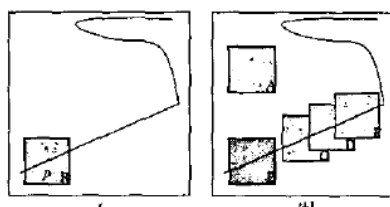
Matching of R at time I to object A, E, C, D, and E at time ti l . The image content is simple with an S-shaped curve.

6.2 CAMERA MOTION PARAMETER ESTIMATION

Generally, cameramen often move the camera in various combined behavior in order to capture preferred situation and their personal expression or preferences. Hence, the analysis of camera motion might make known the importance of the cameraman or even the nature of the event being captured, To estimate camera movement parameters as of validated MVs, the method presented in authors' prior work [9] was adopted. For the camera motion model, i.e., the spatial relative of identical pixels among two consecutive frames, we adopt a 4 parameter model [9]

Figure 6.3: Camera Motion Parameter Estimation

Normally, we use the considered pixel and its communication in the situation frame piercing by MV as the collected data for solving these parameters in least-squares error sense.

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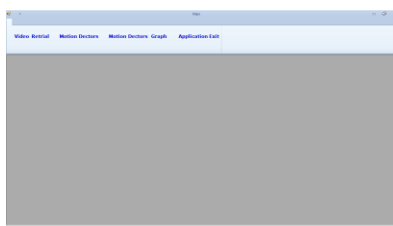
Figure 6.3.1: Video Event detection system

7. CONCLUSION & FUTURE WORK

7.1 CONCLUSION

Research on motion analysis, which is a most consistent feature among all low-level features for videos. The motion retrieval system proposed in the paper is a practical attempt in motion-based video retrieval. For practical video retrieval system, it should support multi-modal and multi-feature retrieval. Thus all these work will be extended to develop retrieval applications based on high-level semantic query combined with multiple features.Presented a novel approach for multi-camera activity correlation analysis and global activity inference over a distributed camera network of nonoverlapping views. To introduce a Cross Canonical Correlation Analysis framework to detect and quantify temporal and causal relationships between local semantic

regions within and across camera views. for each kind of objects, we will learn its corresponding semantic scene specific context information: motion pattern, width distribution, paths and entry/exist points. based on these information, our propose approach efficient to improve object detection and tracking.

7.2 FUTURE WORK

Improvement of the quantity of soccer videos and championship being examine in arrange to acquire additional precise results. Furthermore, dissimilar machine learning method may be functional such as neural networks. The future work consists of two guidelines. Primary, additional kind of low level manifestation and motion features, e.g. Gabor-like filters, will be incorporated in the current technique to get better the performance. More sophisticated sequential filtering approach will be developed to segment the included occurrence sequences will certainly support the investigate of video event detection.

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Integrating Sustainability into CSR Strategies: The Role of Microfinance in Community Development

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Abstract

Over the years, Corporate Social responsibility has evolved from benefiting the immediate society to community development and allocating organizational resources for social, environmental and economic development. Corporate social responsibility strategies have been vitally used to tackle global challenges and creating long term value for the organization and its stakeholders. In this research paper we have analyze, the pivotal role of microfinance institutions in implementing Corporate social responsibility(CSR) strategies for developing communities, creating self-reliant societies, alleviating poverty empowering Indian economy. We have explored how organizations are leveraging services of microfinance in their CSR strategies to maximize its benefits and increase shareholder's value. The study also uncovers various areas like inclusion of fintech in microfinance, gender diversity and corporate governance for fostering sustainability, social innovations as future areas of research.

Keywords: Corporate Social Responsibility, Sustainability, microfinance, empowering, economic development, fintech, CSR

Introduction

Corporate Social Responsibility has now become core business activity from a complimentary function. Once seen as a voluntary practice, CSR is today an integral framework that oversees ethical business practices, environmental stewardship, and social responsibility (Carroll, 1991). Carroll's (1991) CSR pyramid defined four dimensions—economic, legal, ethical, and philanthropic responsibilities—which together structured contemporary CSR practice. The new millennium witnessed a proliferation of CSR reporting, catalyzed by the emergence of sustainability rankings, global environmental pacts, and stakeholder pressures (Kotler & Lee, 2005). In the wake of increasing concerns over climate change, natural resource depletion, and income disparities, corporations are under mounting pressure from stakeholders to align their operational models with sustainable development tenets (Bansal & Roth, 2000). The coverage of CSR has grown enormously since its start, fuelled by the changing governance policies at the global level, increasing consumer consciousness, and changing investor and regulator expectations (Porter & Kramer, 2011). Today, businesses use CSR as a strategic means to promote long-term business sustainability along with tackling important society issues like reducing poverty, education, gender equity, and environmental conservation.

The coverage of CSR has grown enormously since its start, fuelled by the changing governance policies at the global level, increasing consumer consciousness, and changing investor and regulator expectations (Porter & Kramer, 2011). Today, businesses use CSR as a strategic means to promote long-term business sustainability along with tackling important society issues like reducing poverty, education, gender equity, and environmental conservation. Sustainable CSR practices emphasize value creation over the long term and take into consideration ecological preservation, ethical supply chain management, and inclusive business models (Brammer, Jackson, & Matten, 2012).Corporations are adopting shared value strategies, which prioritize the concurrent achievement of business profitability and societal gains (Porter & Kramer, 2011). These include investments in renewable energy, microfinance, circular economies, and sustainable production that aligns with sustainable development goals (UN Global Compact, 2015).

Today, businesses use CSR as a strategic means to promote long-term business sustainability along with tackling important society issues like reducing poverty, education, gender equity, and environmental conservation. Sustainable CSR practices emphasize value creation over the long term and take into consideration ecological preservation, ethical supply chain management, and inclusive business models (Brammer, Jackson, & Matten, 2012).Corporations are adopting shared value strategies, which prioritize the concurrent achievement of business profitability and societal gains (Porter & Kramer, 2011). These include investments in renewable energy, microfinance, circular economies, and sustainable production that aligns with sustainable development goals (UN Global Compact, 2015).

Literature review

Bundling sustainability within Corporate Social Responsibility (CSR) planning has come on strong as an essential method of long-term community building, especially in developing economies (Carroll & Shabana, 2010). Microfinance institutions (MFIs), previously conceived as financial middlemen, are now becoming identified as crucial vehicles for weaving sustainability into CSR platforms (Hermes, Lensink & Meesters, 2011). By providing financial services to poor communities, MFIs play a role in poverty reduction, financial inclusion, and socio-economic empowerment—pillars of sustainable development (Armendáriz & Morduch, 2010). Microfinance initiatives integrated in CSR strategies are more effective at enhancing community resilience and self-reliance. Microfinance has the potential to transform when applied in conjunction with corporate initiatives aimed at education, health, and environmental conservation (Yunus, 2007). Microfinance programs through CSR are mostly aimed at women, promoting gender equality and enhancing household well-being (Kabeer, 2005; Swain & Wallentin, 2009). Additionally, embedding sustainability into CSR via microfinance allows firms to align with the United Nations Sustainable Development Goals (UN SDGs) and, in this case, goals focused on poverty (SDG 1), gender equality (SDG 5), and decent work (SDG 8) (United Nations, 2015). Academicians assert that such embedding not only supports the social license to operate but also promotes stakeholder engagement as well as corporate reputation (Porter & Kramer, 2011; Jamali, 2008). But the literature also emphasizes challenges such as over-indebtedness, mission drift, and regulatory needs (Morduch, 1999; Rhyne, 1998). Hence, sustainable CSR practices need to include impact analyses and inclusive governance frameworks to promote long-term benefits (Epstein & Buhovac, 2014). Microfinance, as argued by Yunus (2007), empowers poor people, particularly women, by offering them the necessary capital to initiate or grow small enterprises. These enterprises benefit the local economy, improve employment opportunities, and foster social stability. Through financial inclusion, microfinance supports

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sustainability objectives, yielding long-term social and economic impacts (Karlan & Valdivia, 2011). Otero (1999) points out that MFIs have shifted roles from being single-purpose financial services providers to changemakers facilitating health, education, and environmentally sustainable lifestyles. Their joint undertakings with companies in CSR activities have fostered activities including clean energy services, health provision, and training programs, all of which contribute to attaining sustainable development (González, 2013).Additionally, linking sustainability to CSR strategies through microfinance can help combat gender inequality. Mayoux (2001) contends that microfinance empowers women because it allows them to create and develop businesses that are socially and environmentally oriented, resulting in sustainable community benefits over time. MFIs targeting women not only contribute to gender equality but also enable community resilience, as women invest more in family and community upgrading (Schreiner, 2002). Still, the success of microfinance to enhance sustainability requires striking a balance between financial and social objectives. Morduch (1999) points out that MFIs need to become financially viable and at the same time achieve social objectives. Financial and social considerations are essential for maintaining long-run community development gains.

Objectives

- To analyze how microfinance institutions apply principles of sustainability to their Corporate Social Responsibility strategies.
- For assessing the effect of eco-friendly CSR-based microfinance programs on community development results.
- To determine challenges and best practices in applying sustainable CSR initiatives through microfinance in disadvantaged communities.

Research Methodology

This research employs a descriptive research design with secondary data to investigate the incorporation of sustainability by microfinance institutions in CSR planning for community development. The data will be obtained from literature on academia, MFIs' CSR and sustainability reports, government documents, and NGOs' publications. Content and thematic analysis will be employed to search for patterns within CSR practice consonant with the triple bottom line—economic, social, and environmental sustainability. The study will systematically record models in place, evaluate their efficiency, and outline best practices and challenges. Outcomes will guide future CSR practices that utilize microfinance for inclusive, sustainable community development.

Results and Discussions

MFIs, includes sustainability in three important dimensions which are economic viability, social equity, and environmental responsibility . These dimensions are very important for the long-term success of CSR activities and are strongly related to the triple bottom line approach—people, planet, and profit. Economic sustainability in MFI-driven CSR activities is mainly concerned with increasing the income-generating ability of marginalized communities. MFIs implement this principle by framing CSR programs aimed at financial literacy, entrepreneurship promotion, and access to livelihood. By enabling clients to earn money in a sustainable manner, MFIs facilitate economic self-reliance in the long term. Companies like Bandhan Bank have adopted CSR activities that involve training in skill development, incubation of micro-enterprises, and financial literacy for women and rural youth. These programs are often designed for local needs and are supported by government

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and civil society partnerships to ensure scalability and context. Social sustainability in the CSR approach of MFIs targets promoting social inclusion, equity, and empowerment. MFIs are important in advocating for gender equality, community engagement, and social cohesion through their CSR programs. Most MFIs operate CSR programs that empower women in leadership, health education, and awareness of rights. For instance, the "Dignity and Empowerment" initiative of Ujjivan Small Finance Bank incorporates social messaging on hygiene, education, and domestic violence into group sessions, thus enhancing the social fabric of communities. Additionally, MFIs employ participatory models to conceptualize and execute CSR initiatives, which is done to ensure that the beneficiaries are consulted in determining the outcomes.

This increases ownership, sustainability, and cultural appropriateness of the programs. These efforts help social sustainability by enhancing social capital and minimizing structural disparities. Social sustainability in MFI CSR strategies focuses on fostering social inclusion, equity, and empowerment. MFIs play a crucial role in promoting gender equality, community participation, and social cohesion through their CSR activities. Many MFIs run CSR initiatives that support women in leadership, health education, and rights awareness. For example, Ujjivan Small Finance Bank's "Dignity and Empowerment" program integrates social messaging on hygiene, education, and domestic violence into group meetings, thereby strengthening the social fabric of communities. Moreover, MFIs use participatory models to design and implement CSR projects, ensuring that beneficiaries have a voice in shaping the outcomes. This enhances ownership, sustainability, and cultural appropriateness of the initiatives. Such efforts contribute to social sustainability by building social capital and reducing structural inequalities.

MFIs are increasingly incorporating environmental objectives into CSR by means of awareness drives, green loan products, and collaborations with environmental groups. Microfinance institutions such as ESAF Small Finance Bank, for instance, have introduced green CSR initiatives involving clean energy solutions, rainwater harvesting, and waste management in the rural sector.

Certain MFIs also encourage environmentally friendly behavior by way of "green loans" that finance the acquisition of solar lanterns, biogas plants, and efficient cookstoves. These activities not only minimize the carbon footprint of rural households but also enhance health benefits and energy access, and they facilitate SDG objectives 7 (Affordable and Clean Energy) and 13 (Climate Action). MFIs bring sustainability to the heart of business operations and decision-making structures and this encompasses adopting Environmental, Social, and Governance (ESG) parameters in risk evaluation, performance appraisal, and stakeholder interactions for CSR approaches to be truly sustainable. MFIs increasingly use social performance management (SPM) models that integrate financial objectives with social and environmental impacts. Instruments such as the Universal Standards for Social Performance Management, prepared by the Social Performance Task Force (SPTF), enable MFIs to institutionalize sustainability in their operations (SPTF, 2021).

Economically, these initiatives offer microloans to environment-friendly initiatives like organic agriculture, renewable energy facilities (such as solar panels and biogas units), rainwater harvesting, and green artisan crafts. Financial access for such green businesses allows low-income earners to earn steady income while maintaining local ecosystems. Consequently, communities benefit from increased economic resilience and decreased reliance on destructive or non-renewable resources. Socially, these initiatives empower marginalized communities and women, who are usually the foremost

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beneficiaries of microfinance services. Through strategic CSR efforts, the beneficiaries are imparted training in sustainable living, entrepreneurship, and environmental awareness. This not only increases their confidence and competence but also encourages inclusive engagement in local economic processes. Community solidarity is also enhanced as joint initiatives towards sustainability create a sense of shared purpose and responsibility. Environmentally, the use of clean energy, organic inputs, and conservation methods results in less pollution, enhanced biodiversity, and enhanced natural resource management. These transformations result in healthier living conditions, lower health risks, and enhanced community awareness of environmental concerns.

One of the main challenges is poor financial literacy among the beneficiaries, which can be a constraint to efficient use of microfinance loans and knowledge of sustainable practices. Infrastructure shortages—like poor market access, electricity, or internet connectivity—can also constrain the success of environmentally friendly projects. Cultural resistance and change aversion can occur, particularly when introducing new technologies or practices. Inadequate monitoring and evaluation systems also make it hard to track impact and provide accountability. Insufficient coordination among CSR programs, microfinance institutions (MFIs), and local stakeholders can result in poorly coordinated efforts lacking scalability.

To address these issues, a number of best practices have been developed. Involvement of the community and participation from the beginning ensures that activities are meaningful and culturally relevant. Offering financial and environmental literacy training enables beneficiaries to make sound choices and utilize resources in a sustainable manner. Capacity-building activities, such as technical training and mentoring, equip participants to run eco-friendly businesses effectively. Integration of digital technologies and mobile platforms can improve outreach, simplify loan disbursals, and enhance transparency. Synergies created by partnerships involving corporates, MFIs, NGOs, and government agencies make programs more robust. Finally, ongoing impact assessment with qualitative and quantitative measures enables real-time feedback and program improvement.

Conclusion

Microfinance Institutions (MFIs) have a transformative role to promote sustainable development by involving CSR initiatives based on the triple bottom line of society—people, planet, and profit. By involving economic viability, social equity, and environmental responsibility, MFIs empower marginalized segments with sustainable livelihood opportunities, enhance inclusion and gender equality, and reinforce environmental stewardship. Institutional programs such as those of Bandhan Bank and Ujjivan Small Finance Bank are good examples of how financial literacy, skill building, and community outreach lead to long-term impact. Green CSR activities by players like ESAF Small Finance Bank promote renewable energy and green conservation, helping in achieving universal aspirations like SDG 7 and 13. Even under hindrances like lack of proper financial literacy and limited infrastructure facilities, MFIs reduce these challenges with participative means, capability development, electronic methods, and smart alliances. By institutionalizing sustainability via models such as ESG and Social Performance Management, MFIs make their CSR interventions effective, scalable, and in alignment with the integrated development of disadvantaged communities.

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THERMAL DELAMINATION OF END-OF-LIFE (EOL) PHOTOVOLTAIC SOLAR (PV) MODULE TO FACILITATE RECYCLING
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Abstract

Solar Photovoltaic (PV) module technology is the most prominent, well-established, and mature source of producing renewable energy. A detailed analysis of the gases evolved during pyrolysis of the End-of-Life (EOL) crystalline silicon photovoltaic (c-Si PV) solar module, focusing on recycling strategies has been reported herein. PV modules encapsulated with Ethylene-vinyl acetate (EVA) – with and without Poly-vinylidene fluoride (PVDF) polymer backsheet were pyrolyzed at 500°C and evolve gases was collected in the gas cell.

The current installed capacity in India is approximately 67 GW. As per a report by a European agency, in April 2022, globally cumulative installed PV capacity has crossed 1TW. PV module installations in india are expected to rise further to 20 TW by 2050. But over the next decade, the problem will magnify exponentially. Such end-of-life (EOL) PV installations are treated as solar waste and they need to undergo a carefully strategized waste recycling route in order to keep the overall carbon and pollution footprints to a bare minimum and to propel the circular economy in the PV sector.

Keywords: Photovoltaic solar module, Recycling, Pyrolysis, End-of-Life module, Thermal delamination, Solar cell.

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1.Introduction

The establishment of recycling and reuse technologies appropriate and applicable to all photovoltaics (PV) modules is a key issue to be addressed as part of corporate social responsibility to safeguard the environment and to implement a fully material-circulated society without any waste. The life of the solar module is to be expected up to 20-30yearsr depending upon environmental factors of field operation [1,2]. Yellowness/browning, discoloration, delamination, cracks, etc. are the main factors associated with the degradation of solar panels.

So, the PV module must be recycled for the benefit of the environment and also the economy [2-6]. To save the environment from PV waste, the European Union (EU) has pioneered the solar PV module panel's waste sanctions and regulations disposal including recycling and reuse of solar panels. In Europe, where Germany and a few other countries have adopted the EU Waste of Electrical and Electronics Equipment (WEEE) guidelines and enacted

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appropriate legislation. But most of the country including China and India have not made any significant progress in this direction [7].

As a result of the tetrahydrofuran-based chemical delamination (THF). The materials from a damaged PV module could be separated. The effectiveness of the chemical treatment approach used was insufficient. Because of the lengthy time required to get satisfactory results, as well as the relatively expensive cost of the solvent utilized, this process is not suitable for commercial PV cell and module recycling. As a result, the thermal way was proposed and researched.

As a result, technologies for recycling solar modules are being developed around the world to lessen the environmental impact of end-of-life modules while also recovering some of their value. Current recycling systems, on the other hand, are largely focused on downcycling processes, which recover just a part of the materials and value, so there is still lots of space for improvement. Furthermore, only Europe presently has a solid legal structure in place to promote recycling, while other nations are beginning to develop PV waste-specific laws. The PV industry's long-term development should be supported by regulatory frameworks and organizations around the world, which is currently not the case. When photovoltaic modules reach their end-of-life (EoL) or are no longer able to produce power, appropriate management practices are required. In comparison to chemical treatment, the method takes substantially less time, and there is no problem with leftover solvent.

2. Literature Survey

In the Photovoltaic (PV) module Silicon is the main and globally used material. In 2010 Global solar PV installations were 19 GW which increases to 24 GW i.e., a 24% increment in one year [1] and according to the latest data, global installations reached 508 GW in 2018. And according to the international technology roadmap for photovoltaic (ITRPV) is predicted to achieve 4500 GW capacity by 2050 [12]. But this causes adverse effects too as significantly E-Waste will increase. PV waste was 250000 metric tons till 2016 and expires expected to reach approx. 6 million tons by 2050 [13].
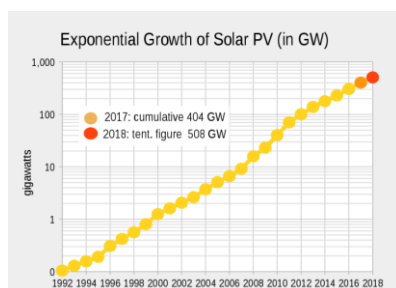
Figure 1.1: Growth of Solar PV vs Year [1]*

Nowadays researchers are focusing based on the 3R strategy, R-Reduce the hazardous components from the solar module, R-Reuse (Generate a robust secondary market for second-hand use of panel even lower rate and lower power rating below 80%), and R-

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Recycle (Major components should be recyclable and it is reusable. Only for encapsulant not clear evidence how to use). For recycling of PV modules generally three different processes namely, physical, thermal and chemical are used.

Photovoltaic technology is the most promising technique for green energy production. It uses solar energy and converts it into electrical energy. These photovoltaic cells are small in size and made up of various semiconductor materials. These solar cells are connected in a chain to produce a large amount of energy and the connected structure is called a photovoltaic module.

2.1 Crystalline Silicon (c-Si) Technology : Crystalline silicon(c-Si) can be either monocrystalline or multi-crystalline and contains silicon as major material. It dominates the current market. The industry now uses aluminium back surface fields (Al-BSF), although passivated emitters and rear cells (PERC) are gaining traction in the market, and it is supposed that these will eventually replace older technologies [1]. There is also a lot of research going on on heterojunction (HIT) cells, which is projected to achieve some traction by 2027. For c-Si-based PV cells, there are different cell structures. In a photovoltaic module, the majority of the weighted portion is glass because the weight of gas is approx. 70% and around 10% weight of polymer and back sheet, aluminium is approximately 8%, silicon solar cell with 5% weight, copper which is used for interconnections is 1% and less than 0.1% silver is used [1]. It also consists of some other metals which are lead and tin. Encapsulant is generally made of EVA which sandwiches solar cells.
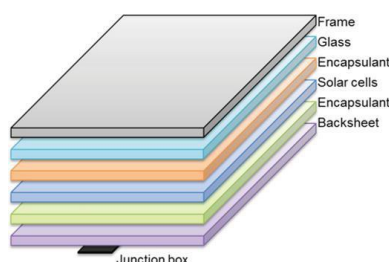
Figure 2.2: Structure of c-Si Solar module [1]

2.2 Thin-Film Technology : Thin films are manufactured by depositing one or more thin layers of a semiconductor on glass, metal, or plastic. It covers 10% of the global photovoltaic market. The cadmium telluride (CdTe) is 65%, Copper Indium Gallium Selenide (CIGS) has approx. 25% of the global market share of thin-film technology. Amorphous silicon is almost 10% of this and they are decreasing because of less efficiency. The target of developing thin-film technology was to produce low cost and have variable geometry. CdTe is widely used but because of the toxic element like cadmium (Cd), it is very dangerous for the environment and mitigates the goal of green energy. Copper Indium Gallium Selenide has a high absorption coefficient. Amorphous silicon has low toxicity but it is also less durable so it is less efficient than others. Current trends show that shortly amorphous silicon technology will be not in use because they are not cost-efficient.

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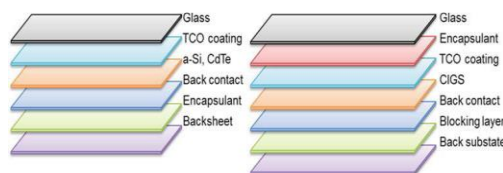
Figure 2.3: Basic structure of thin-film solar module [1]

2.3 Recycling of c-Si PV Modules

The main motive of recycling is to recover maximum material to use for further production and to minimize the amount of remaining waste [9]. A lot of research is going on the recycling of solar modules and considering the situation of collection of e-waste in the coming future. So, the growth of the photovoltaic (PV) industry causes environmental problems considering its end of life (EoL) [14]. Harnessing solar energy through the PV module (Photovoltaic effect) to produce electricity has now become the fastest-growing sector in the renewable energy production industry [1]. A Typical PV module consists of Si solar cells connected in rows and columns by solder and interconnects rails (fig. 2.31). The solar cells are encased in an encapsulant (typically Ethylene Vinyl Acetate, EVA) and fused to glass on the front and with a backsheet. The entire structure is encased in an Aluminum frame.
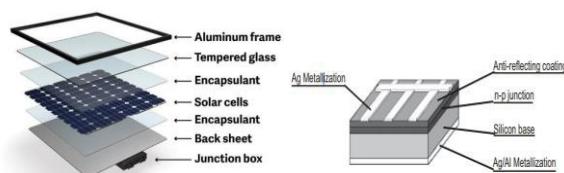
Figure 2.31. Solar module basic structure, and types of material used in solar cell [1].

Recovery option	Applications	Synthesis route	Market value)
Aluminum oxide	Abrasive, refractive, glass, anti-corrosive coating, optical ceramics	Sulphuric acid route to Aluminium hydroxide then through calcination via Bayer process to Alumina	Rs 40/kg
Hydrogen (byproduct)	Petroleum refining, Aerospace applications, Fuel cell, Fertilizer production, Welding, heat-treating metals, Pharmaceuticals, hydrogenation of unsaturated fatty acids in vegetable oil	Collection in a compatible equipment	4500/50L cylinder
Silicon	Semiconductors, SiC – Abrasive, Silicone – Polymers, Silane – Semiconductor	Si – residue from Ag leaching, SiC –t with Coke, SiH$_4$ – react with H$_2$, Steel refining. Price varies a lot depending on the application.	40,000/kg
Silver Nitrate	Medical- Eye drops, Cauterization, Dentistry, Industrial- Electroplating, mirror, dyes, and inks, pesticides	As-is, the leachate contains Silver nitrate; the remaining acidity needs to be neutralized	Rs 34999/kg
Silver Chloride	Medical, antibacterial, wound healing, Industrial, water treatment, mirror polishing, photographic film	Via the HCl route or Sodium chloride route to form Silver Chloride precipitates	Rs 60,000 /kg

3. Experimental work

According to the literature survey recycling of PV modules can be done by using Physical methods, Chemical methods, Thermal methods, and also by combining two or more methods. So here experimental procedure will be discussed and after that some characterization in order to understand the trace element on solar cell surface and analysis of gas collected in gas jar using FTIR.

One of the key challenges in PV module recycling is delamination, i.e., the removal of the solar cell, solar glass, and backsheet. I have successfully delaminated mini modules and separated the solar glass, solar cells, and backsheet by thermal pyrolysis [findings has been reported and accepted, 8]. Figure 3.00 shows the flow chart of previous work carried out and some findings are reported herein. The recovered Solar glass can either be used to

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manufacture new modules – possibly for household and distributed power generation or channeled into the glass recycling process. Flow chart of previous work carried out and proof-of-concept shown in below.
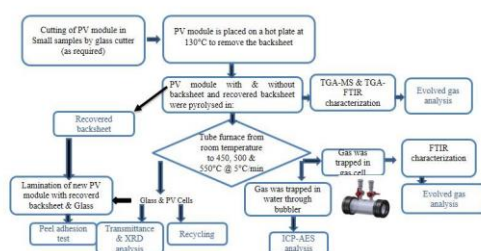
Figure 3.00. Flow chart of previous work carried out and proof-of-concept

3.1 Thermal Approach

The first step in the recycling process of the c-Si PV module is to remove the aluminium frame but, in our case, we have taken a small module and cut it to a size that can be fitted into a tube furnace as we are heating it in a tube furnace. So, we need to remove the back sheet and encapsulant i.e., EVA polymer in our case.

Figure 3.1: Tube Furnace setup with bubbler
(Courtesy PM, lab IITB)

3.1.2 Thermal Approach using Tube Furnace

We have taken two samples named 1 and 2. The weight of both samples was measured. Weights of sample1 and sample 2 were 7.9666 gm and 7.8740 gm respectively before performing the experiment. Both modules have EVA as an encapsulant.

Figure 3.2: Solar cells, Glass, and residual obtained from tube furnace after the experiment

Experimental Work:

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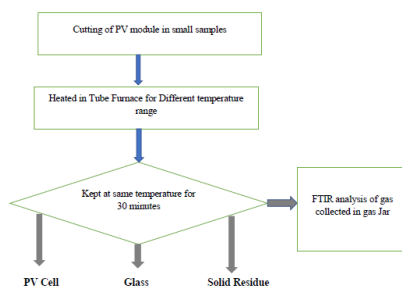
Figure 3.3: Flow chart of Experimental Work

3.1.3 FTIR analysis of PV module

For FTIR analysis of evolved gases during pyrolysis we need to store gases for which we have used gas jar. At first, we cut PV module into small pieces so that it can be pyrolyzed in a tube furnace. We carried out the experiment from room temperature to 450, 500 and 550 °C in a time duration of 1 hr 10 minutes and once the respective temperature achieved, compressed air was passed into the tube furnace which causes the movement of evolved gases outside and then we collected that in a gas jar. Finally, we observed the spectrum of trapped gases using FTIR facility available in SAIF IIT Bombay.

3.1.4 FTIR Analysis of trapped gases

FTIR stands for Fourier transform infrared spectroscopy. It is most useful to identify the functional group present in a material. The frequency of molecular bonding varies depending on the elements and the type of bond. There are several different frequencies at which every particular bond can vibrate. These frequencies correspond to the ground state (lowest frequency) and various excited states, according to quantum physics (higher frequencies). Exciting the bonding by absorbing light energy is one approach to raise the frequency of molecular vibration. So, when infrared is passed through the sample it is absorbed by the molecule and others are transmitted to the detector.
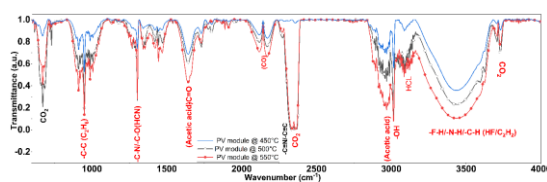
Figure 3.10: FTIR of PV module at 450,500 & 550°C

Matching the peak obtained from FTIR experiment to standard IR library, major elements and fuctional group present are CO_2, -C-C(C_2H_6),-C-N/-C-O(HCN),(Acetic acid)C=O,C-O,HCL, -F-H/-N-H/-C-H(HF/C_2H_2).
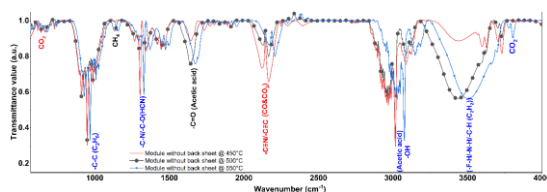
Figure 3.11: FTIR of PV module without back sheet at 450,500 & 550°C

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FTIR data of gas collected in gas jar at temperature 450,500 & 550°C of module without back sheet confirm the availability of various gas and functional group like CO_2,NO_2 ,-C-C(C_2H_6),CH_4,-C-N/-C-O(HCN),(Acetic acid)C=O,C-O,HCL, -F-H/-N-H/-C-H(HF/C_2H_2).
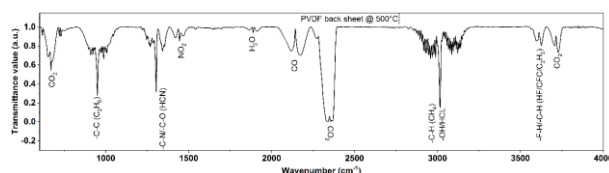
Figure 3.12: FTIR of PVDF back sheet at 450,500 & 550°C

FTIR of gas collected while burning PVDF back sheet shows peak of various functional group like CO_2,-C-C(C_2H_6),CH_4,-C-N/-C-O(HCN),NO_2,H_2O,C-O,-C-H(CH_4),-F-H/-N-H/-C-H(HF/C_2H_2).

3.2.5 TGA-MS of module, module without backsheet, backsheet

In present research, the analysis of evolved gases while burning of c-Si PV solar module having Ethylene vinyl acetate (EVA) as encapsulant material and PVDF back sheet, PV module without back sheet and, only PVDF back sheet in TGA coupled with MS setup were done. Before pyrolysis of the PV module in TGA-MS, the back sheet of the module was successfully manually removed by heating the module at 100°C in a hot plate and the back sheet peeled off. The complete spectra of evolved gas during pyrolysis of photovoltaic solar module are characterized with the help of TGA-MS.

Well established crystalline silicon photovoltaic solar module, having EVA encapsulant and PVDF polymer back sheet, was used for recycling and evolved gas analysis in the TGA-MS setup. At first the module was placed on a hot plate to heat at 100°C to achieve the rubbery stage of the encapsulant. At this temperature, the back sheet was manually separated from the module and thereafter the module containing the glass plate, solar cell, and EVA encapsulant was sent for characterization in TGA-MS. In the present study, three samples were taken (1) PV module, (2) PV module without back sheet, and (3) PVDF back sheet for pyrolysis analysis of evolved gases.
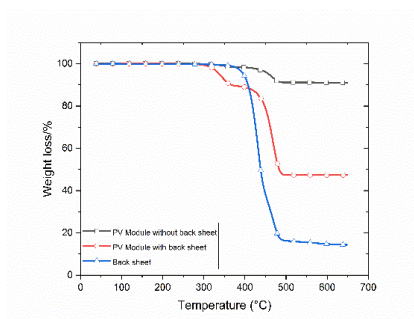
Figure 3.13: TGA graphs of c-Si PV module with, without back sheet and Back sheet

Table 4. Showing elements/compounds of gases with molecular weight (m/e)

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Gas	Molecular weight (m/e)
Hydrogen	2
carbon	12
Oxygen/methane CH4	16
Water vapour	18
fluorine	19
Carbon mono-oxide	28
Ethane C2H6/nitric acid NO	30
Carbon dioxide/propene	44
Acetic acid	60
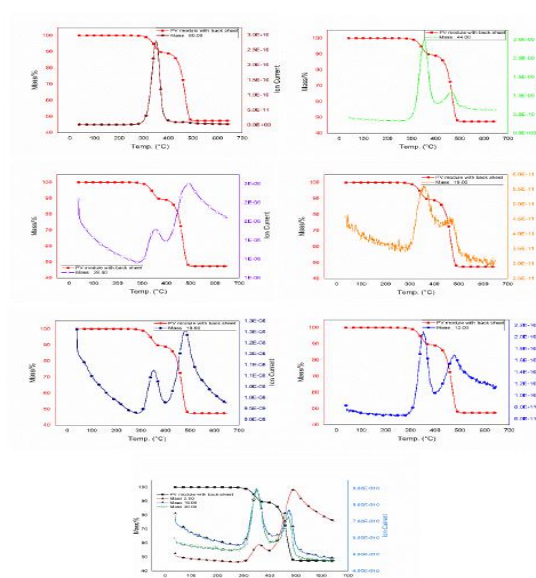
Figure 3.14: TGA-MS graphs of PV c-Si solar cell module having various molecular electron signal spectrum (m/e) having 60, 44, 30, 28, 19, 18, 16, 12, and 2.

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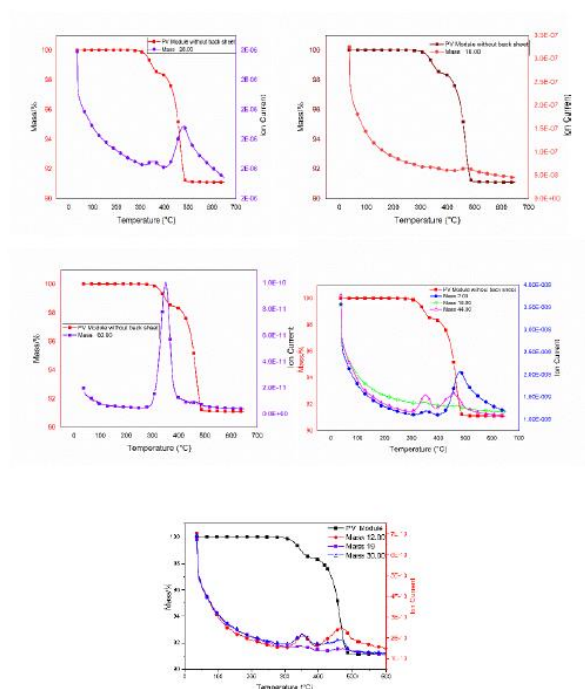
Figure 3.15: TGA-MS graphs of PV c-Si solar cell module without back sheet having various molecular electron signal spectrum (m/e) having 60, 44, 30, 28, 19, 18, 16, 12, and 2.

4. Result and Discussions

The pyrolysis analysis of evolved gas during thermal degradation of EVA was quantified by the Thermo-gravimetric Analysis (TGA) coupled with mass spectroscopy (MS) technique. Thermal degradation of Ethylene co-vinyl acetate (EVA) polymer with 29-32% vinyl acetate monomer of semi- crystalline silicon solar PV module undergoes for two steps degradation. Upon heating, the acetic acetate is first eliminated (deacetalization) in temperature range of 300-400°C and leaving unsaturated polyene. Acetic acid trace is seen at molecular weight (m/e) 60. On Further heating, the polyene undergoes the chain scission reactions and EVA fully degrades at temperatures ranging from 400-500°C [21].

Pyrolysis analysis of waste materials and biomass wastes are analyzed by TGA-MS and TGA-FTIR techniques to understand the complete spectra to identify the volatile species of evolved gas at the time of thermal degradation. Both TGA-MS and TGA coupled with FTIR are valuable techniques for corroborating the thermograph as well spectrograph of volatile species gas evolved during thermal heating. The mass-loss rate of waste materials shows almost similar trends with the same pyrolysis conditions for both setups. The major evolved gas appeared at temperatures ranging from 230-470°C. In the first stage (300-400°C) major gases were characterized as CO_2, CO, NH_3, HCN, H_2. And in the second phase (400-500°C) CO and CO_2 gases are dominants. The emission of CO_2 causes increases in global warming and CO emission is toxic in nature [22].

During thermal treatment (pyrolysis) of solar panels containing hazardous materials like Pb, Cd, and Cr could be released into the environment. For pyrolysis, the PV module is placed inside the closed furnace and heated at 500°C and complete degradation of encapsulant (EVA) was obtained. Further, the trapped gases were analysed to quantify the release of the metal in the gas phase. The results verified that a small number of hazardous metals were also present during the thermal degradation process of the PV module [23].

After that, the removal/delamination of the back sheet and encapsulant from the solar cell and glass plate is a challenging task. Several routes have been employed for the removal ofencapsulants by organic solvent, nitric acid, shockwave recycling, and thermal decomposition. The well-established c-Si solar module back sheet and encapsulant polymers account for 3.6 wt.% and 6.55wt.% respectively and with the majority of aluminium (10.5wt.%) and glass (74.2wt%) of PV module. In-situ pyrolysis was performed in a vacuum atmosphere for c-Si solar PV module having EVA and PVDF back sheet was tested by using TGA-MS and TGA-FTIR with selected molecular fragments ion intensity spectral signals such as m/z= 43, 44, 2, 13, 18 to identified evolved gas during decomposition [24-25].

TGA graphs (Figure 3.13) showing the thermal stability of c-Si solar PV module with and without back sheet. The TGA graph shows the changes in weight of PV module and PV module without back sheet samples, as function of temperature (Ranging from 40°C-650°C @ 6.0K/min, NETZSCH STA 449F1).

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Module contains two steps of mass loss, one is at 300-400°C and another is 400-500°C, depending on the degradation mechanics involved during the exothermic/heating process. The acetic acid is released in the first decomposition stage where approximately 11.11% and 3.10% weight loss for PV module samples and PV module without back sheet respectively were observed. Not only deacetylation, but it also decomposes in the gas phase into smaller fragments like H_2, C, CH_4, H_2O, CHN, NO, CO_2. After deacetylation, β-scission started to start second step mass loss and hydrolytic depolymerisation at 400-500°C. The major weight loss occurs in this phase, where 46% and 7.10% weight loss for PV module samples and PV module without back sheet respectively were observed. The mass loss of PVDF back sheet is only 90% at temperature 500°C. From the TGA graph, it was concluded that the EVA was completely burnt and the mass of the back sheet stuck with the PV module. PVDF membrane exhibited excellent thermal stability up to 440°C, above which it started to decompose to around 15 wt%. This pyrolysis was further analysed by MS spectrograph to complete the picture of evolved gas.

5. Challenges in Recycling of Si-based PV module

1. **Market for recovered Si**: Recovered Si may have different levels of purity like Ferro-Si, metallurgical-grade (MG) Si, or solar-grade (SG) Si. These all have a different level of purity like 75% for Ferro-Si, 99% for MG-Si, and 99.9999% for SG-Si. Purer Si recovery, on the other hand, necessitated additional processes and will be more expensive [2]. With the help of the current recycling technique, we get ferro-Si which is having minimum Si content i.e., 75% [8]. So, because of the process variation, quality issue, and various types of panels in the market, it is very difficult to convert it into Solar grade (SG) and thus restricted to 75% i.e., metallurgical grade (MG).

2. **Cell efficiency standardization:** Cell efficiencies are changing because of the research going on in this field and the life cycle of a solar module is about 25 years so efficiency in this duration changes a lot and recyclers need to wait a lot to get a particular type of panel [2].

3. **Burning of EVA and Tedlar produces heavy smokes:** Thermal way of recycling is more prominent but gases produced on burning of PVA and Tedlar are harmful to the environment and thus mitigate the target of using the solar module. So, research in the area of treatment of gases must be done.

6. Conclusion

Pyrolysis of PV solar module was employed to examine the evolving gases emission. During heating, degradation mechanisms such as; deacetylation, β-scission, and hydrolytic depolymerisation started. TGA-MS is used to characterize the Molecular electron signal spectrum (m/e) having 60, 44, 30, 28, 19, 18, 16, 12, and 2. Emission CO_2 causes the increase of global warming and CO emission is toxic in nature. The major evolved gas appeared at temperatures ranging 230-470°C. The qualitative study shows that the toxic and hazardous gases of pyrolysis of PV module after removal of back sheet is quite less as compared to pyrolysis of whole PV solar module as some of the peak of harmful gases like

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NOx, C=O are small or absent in MS graph in case of module without back sheet, so removal of back sheet before pyrolysis results in less harmful gases.

Transmittance of glass plate after pyrolysis decreases which leads to the performance of the photovoltaic solar module. Pyrolysis at higher temperature is not recommended for higher transmittance value of glass in photovoltaic module lifetime operation. Intact back sheet was successfully mechanically removed at 550°C and intact glass was also obtained after pyrolysis of the module at 500°C and 550°C. The recycled intact back sheet and glass plate may be used for the lamination of new solar cells. FTIR spectral peaks strongly support the TGA-MS results. The emission of evolved gases and fumes during the burning of PV module is much higher as compared to PV module without the back sheet.

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CFD ANALYSIS OF MEMBRANE DISTILLATION PROCESS USING TLC THROUGH MODELING THE HYDRODYNAMICS
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4. Assistant Professor, Mittal Institute of Technology, Bhopal

Abstract

Membrane distillation (MD) has gained significant regard from industrial and academic perspective in

recent years, thus the frequency of publications related to the field has greatly accelerated. New perspectives have boosted the research activities related to deeper understanding of heat and mass transport phenomenon, novel applications and fabrication of the membranes specifically designed for MD. Desalination is one of the proposed methods to meet the ever increasing water demands. It can be subdivided into two broad categories, thermal based desalination and electricity based desalination. Multi-effect Distillation (MED), Multi-Stage Flashing (MSF), Membrane Distillation (MD) fall under former and Reverse Osmosis (RO), Electro-Dialysis (ED) fall under later. MD offers an attractive solution for seawater as well as brackish water distillation. It shows highly pure yields, theoretically 100% pure.

Keywords:

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1.Introduction

Water desalination is a technique of converting saline, impure water from sea or in-land reserve and converting it to potable water. Several desalination techniques exist today, such as, Multi Stage Flash (MSF), Multi Effect Distillation (MED), Vapor Compression Desalination (VC), Membrane Distillation (MD), Reverse Osmosis (RO), Forward Osmosis (FO), Electro-Dialysis (ED) etc. Each desalination technique has its advantages and disadvantages. Membrane distillation is particularly attractive owing to simple construction, inexpensive operation and low maintenance. A MD unit has seawater and coolant separated by a hydrophobic membrane. The feed stream or saline water stream is heated above the temperature of coolant externally. Because of the temperature gradient, there exists a vapor pressure gradient and conjugately a vapor concentration gradient. The concentration gradient drives vapor from the saline channel to the coolant channel. It condenses on the coolant channel to form pure water.
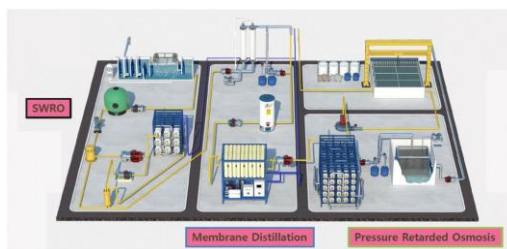
Fig. 1.1. A conceptual design of 3rd generation desalination scheme

Membrane distillation (MD) is AN rising membrane technology supported the vapour pressure gradient across the porous hydrophobic membrane. Since only volatile vapor molecules will transport across the membranes, the feed liquid directly contacting the membrane should not be allowed to penetrate into the dry pores of the hydrophobic membranes. Membrane distillation (MD) was 1st developed in 1963 by Bodel once he patented the vapour diffusion through silicone rubber for saline water distillation [1]. The most used and studied MD configuration is that the direct contact membrane distillation wherever the new feed and therefore the cold permeate solutions are separated by a hydrophobic membrane. The feed resolution comes into contact with the membrane and evaporates, the vapour travels through the pores and condenses on the cold permeate membrane interface.[4].

1.3. Water desalination technologies

Although water is the most common substance in the whole world, this does not mean that it is freely open for domestic applications. Studies showed that 97% of the available water is salty in the oceans, and only tiny 3% is drinkable fresh water [19]. This tiny amount is supposed to supply humans, animals and plants needs, in addition to be available for domestic use at the same time. The shortage of clean water is a problem that is accompanied with other severe problem represented by the high increase of world's population [4].
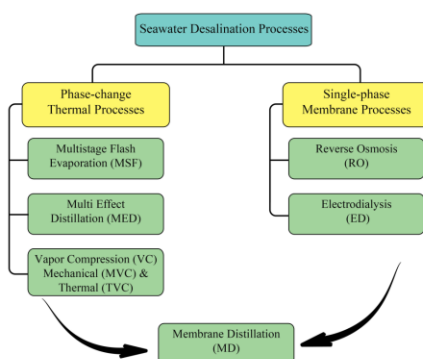
Figure 1.2 : Classification of water desalination techniques.

This sudden introduction of the heated water into the new chamber causes rapid water boiling, or flashing into steam. Generally, only a small percentage of this water is converted to steam (water vapor) [4, 5, 15]. Multi-Effect Distillation (MED) is another example [5],

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where a generated heat is utilized to serve many purposes in the process. The process starts when the first evaporator provides water vapor to condense in the second, and their heat of condensation serve to boil the sea water in the second evaporator. Basically, the second condenser acts as a condenser for the vapors of the first which in turn acts as a heater for the water in that evaporator. Each evaporator in the series is called an effect [16, 25]. It involves boiling the feed water; therefore, this method encounters problems with scaling and has in general more complexity in installation and control when compared to MSF [5, 15]. Fig. 1.3 shows the basic scheme of the MED process.
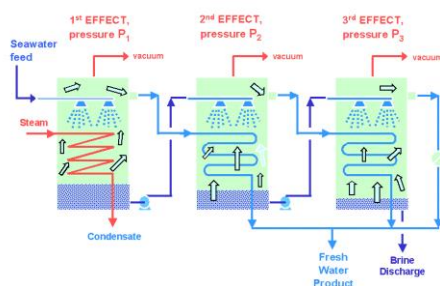
Figure 1.3: Basic scheme of the MED process.

2. LITERATURE SURVEY

Mohammad Mahdi A. Shirazi et al.[1] "Computational Fluid Dynamic (CFD) opportunities applied to the membrane distillation process: State-of-the-art and perspectives", Generally speaking, it ought to be noted that CFD-based models are very qualitative. Actually, in apply the choice of the simplest case, i.e. the particular microstructure for membrane or spacer geometry and also the module geometry includes a trade-off between prices of membranes required to provide the specified production and costs of the energy supply. it's not only the price of the applied membrane; with it comes variety of MD modules, piping, fittings, pumps, compressor and vacuum pumps, and etc. Most of works on CFD approaches are investigated the DCMD method through modeling the hydrodynamics conditions and heat transfer. However, a mix of those things with mass transfer shall be studied a lot of extensively and comprehensively. Moreover, different MD configurations, particularly the SGMD and AGMD, got to be any investigated, within the case of their varied aspects, e.g. the distillate aspect and planned boundary layer conditions, as well. Any to several benefits and opportunities of CFD for modeling MD processes, there are some vital issues that shall be investigated in future works.

Ali Kargari et al.[2] "A Review on Applications of Membrane Distillation (MD) Process for Wastewater Treatment", The MD method has been in the main used for desalination; but, the water recovery from wastewater streams is one in every of the most promising applications of MD for the longer term. It's additionally proved to be an appropriate technology for removal of different impurities Whereas it's capable of treating several sorts of wastewaters and brines, its ability to compete with current technologies, like ro and thermal-based water treating technologies, remains restricted because of its lack of experimental information in

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pilot scale and specific membranes and modules. On the opposite hand, finding new and appropriate applications for the MD method presently looks to be one among the most important impediments to its industrial use. Moreover, there's another major challenge against MD to be applied for wastewater treatment. Wastewater streams commonly embody several chemicals that would probably result in membrane surface fouling and membrane pore wetting. This can be because of the very fact that the deposition of those contaminants on the membrane surface may build the membrane less hydrophobic and result in pore wetting and therefore the flux decline.

This can be the reason that restricted works on wastewater treatment using MD are compared with desalinization. Therefore, fabricating specific membranes for MD application in wastewater process is one in every of the promising future views.

Enrico Drioli et al.[3] "Membrane distillation: Recent developments and perspectives", Membrane distillation could be a relatively new method, investigated worldwide as a low price and energy saving different with respect to standard separation processes (such as distillation and reverse osmosis). it's one among the few membrane operations supported a thermal method. Energy consumption thus is, in theory, a similar because the traditional phase changes method. However, the specified operative temperature is far under that of a traditional distillation column as a result of it's not necessary to heat the method liquids higher than their boiling temperatures. In fact, the method may be conducted at temperatures usually below 70 °C, and driven by low temperature difference (20 °C) of the new and therefore the cold solutions. Therefore, low-grade waste and/or energy sources like star and heat energy may be including MD systems for a value and energy efficient liquid separation system. Consequently, this operation would possibly become one in all the most interesting new membrane techniques. It will overcome not only the limits of thermal systems however additionally those of membrane systems like Ro or NF. Concentration polarization doesn't affect significantly the drive of the method and thus high recovery factors and high concentrations may be reached within the operation, in comparison with Ro method. All the opposite properties of membrane systems (easy scale-up, easy remote and automation, no chemicals, low environmental impact, high productivity/size ratio, high productivity/weight magnitude relation, high simplicity operational, flexibility, etc.) also are present. This technology may be used much during a giant style of industrial and bio-medical processes as for the purification, extraction, concentration (to very high values), and final formulation of organic and inorganic species. a lot of recently, membrane bioreactors (MBRs) with membrane distillation membranes (MDBR) are developed for the treatment of commercial and municipal waters so as to exceed the boundaries of the existing MBR systems (i.e., the problem to retain effectively little size and protracted contaminants).

I. Hitsov et al.[4] "Modelling approaches in membrane distillation: A critical review", Membrane distillation has been discovered 50 years ago, however up to now lacks vital industrial applications. So as to optimize the technology and create it competitive to different separation techniques the MD community should have an in-depth understanding of the processes that occur within the modules and also the membranes. The mass transfer

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modelling of the membrane region has been lined by many alternative mechanistic and statistical models that may predict the flux with variable accuracy. More recent models like the ballistic transport model and also the structural network models are innovative and interesting to the community however haven't however been totally tested and validated. Moreover, a number of the physical phenomena that occur within the membrane like the surface diffusion have forever been neglected in MD modeling which might prove to be necessary for membrane synthesis studies.

3. PROBLEM FORMULATION

While membrane distillation has a tremendous potential as a separation technology for hard streams when waste heat is available, MD is still lacking wide-spread adoption. This could be due to a lack of major reference cases where MD is applied successfully for a significant amount of time. The uncertainty associated with the long term performance and cost of the technology is driving the industry away from MD. One possible way to reduce this uncertainty associated with the technology is to carefully model the process and gather process knowledge. The models can be used to predict the process performance across production scale and operational conditions. However, modeling of MD to date is mostly limited to lab-scale.

4. MODULE DESIGNING FOR MD

After the availability of appropriate membranes for any application, the next most important step is to assemble these membranes in a particular configuration to ensure the required membrane area enclosed in a particular module volume. In addition to provide compactness, an appropriate module design can reduce the thermal/concentration polarization, fouling and energy consumption of the process. These advantages can be realized by disturbing the normal flow pattern that develops along the fiber. Adequate module design can improve the hydrodynamic on shell and lumen side, thus imparting a positive impact on the process. In this context, the module designing provides an economical alternative of the active techniques to change the hydrodynamic conditions in the membrane. Despite of these benefits, the investigations on module design are limited in number generally for membrane operations and particularly for MD. Similar to the other membrane based processes, module design for MD is crucial to use the process more rationally. An appropriate module design for MD applications should take into consideration the minimization of thermal polarization on up and downstream, appropriate packing density to ensure the module compactness, robustness, achievement of high energy efficiency, suitable length, high volume based enhancement factor and relatively easy fabrication with the flexibility to apply for the maximum configurations. In addition, the material implied for module fabrication must ensure the minimum thermal losses and must be heat resistance. There are several different industrial sectors looking at MD with different demands that further underline the importance of flexibility in module design. In MD, several possibilities have been considered to design an appropriate module:

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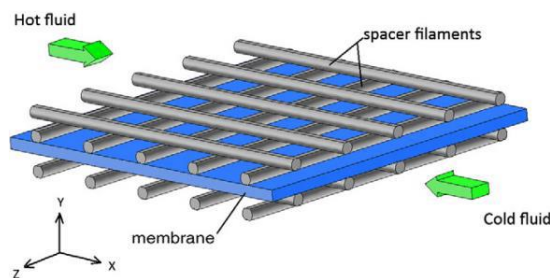
Figure. 4.1. Spacer-filled membrane distillation channels

The concept of heat recovery by interstate heating of the cold feed by using the permeate of previous stage in a cascade of modules. A schematic of the concept used by the author has been shown in Figure. 4.2. The authors have provided a theoretical analysis of countercurrent cascade of cross flow DCMD modules. Such cascades can be useful in improving the recovery and energy efficiency of the system.
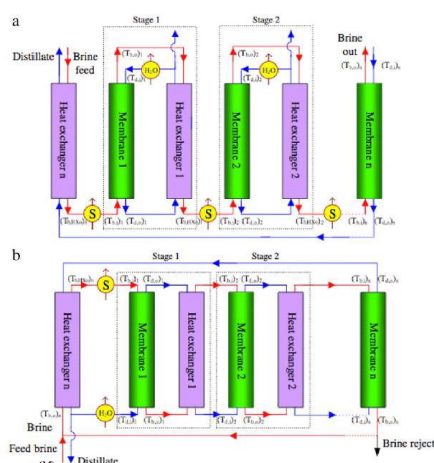
Figure. 4.2. Cascade module design

The authors have claimed a recovery of 60% and gain output ratio of more than 60% for appropriate configurations and temperature difference. Investigated the effect of various fiber geometries on performance of DCMD both experimentally and theoretically. The flux enhancement as high as 300% has been claimed due to reduced thermal boundary layer resistance. Experimental and theoretical feasibility of roughened surface for DCMD process has been demonstrated by [27]. Rotational and tangential to the membrane surface flow have been proven very affective in increasing the performance of the AGMD [129]. Such flow combined with the partial contact of membrane with condensing surface in AGMD has caused synergetic effects. The authors have claimed the permeate flux as high as 119 kg/m2·h at feed inlet temperature of 77 °C. The claimed flux is ~2.5 times higher than the flow observed in traditional AGMD studies carried out under the identical conditions.

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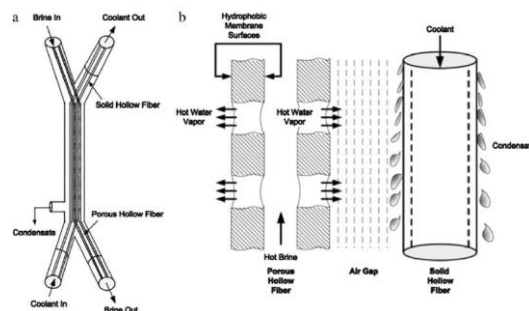
Figure. 4.3. Conceptual mechanism of hollow and heat

In [37] report that the presence of the distillate channel reduces sensible heat losses due to an additional heat transfer resistance; the disadvantage is the reduction of the effective temperature difference across the membrane, which slightly lowers the permeation rate [37]. In module development, PGMD opens the opportunity to integrate an efficient internal heat recovery system as can be seen in Figure. 4.4b. Water vapor passes through the membrane and condenses in the distillate channel. The latent and sensible heat is transferred through the condenser foil to preheat the feed water in the condenser channel by internal heat recovery. An external heat source (e.g. solar collector) heats the feed water until the desiderated temperature (only from 73 to 80 °C in Figure. 4.4b). The activities carried out by [37] prove that, in this configuration, the main effect of the active membrane area increase is the significant reduction in the specific energy demand. This justifies the transfer of the PGMD channel configuration into a compact spiral package where, even without module insulation, only minimal heat losses to ambient occur.
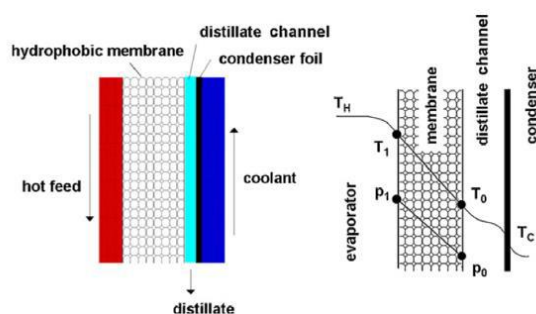
a) Basic channel arrangement and temperature profile for PGMD
b) profile for PGMD
c) **5. METHODOLOGY**
d) **5.1. Water recovery and wastewater treatment using the MD process**
e) **5.1.1. DCMD process**
f) As mentioned earlier, the direct contact MD is the most used mode of the MD process, especially for desalination and water/wastewater treatment. One of the reasons is due to the condensation step that can be carried out inside the MD module enabling a simple MD operation mode. However, it should be noted that the heat transferred by conduction through the membrane, which is considered as the heat loss

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in MD, is higher than in the other MD configurations. During the DCMD process, evaporation and condensation take place at the liquid-vapor interfaces formed at the pore entrances on the feed and distillate side, respectively. A typical DCMD system used for flat sheet, capillary or hollow-fiber membranes is shown in Figure 5.1. It is worth quoting that DCMD is mainly suited for applications in which the major component of the feed stream contains nonvolatile solutes such as salt.
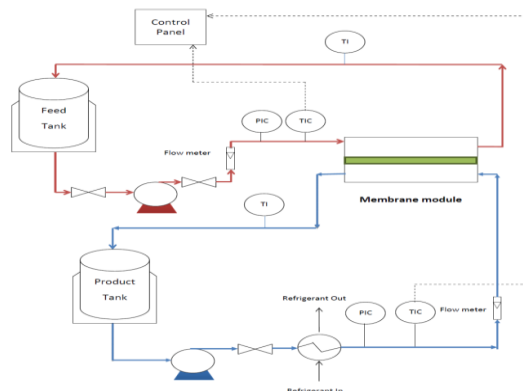
Figure. 5.1. A general scheme of the DCMD process

g) 5.2. SGMD process

Sweeping gas MD consists of a gas that sweeps the distillate side of the membrane carrying the vaporous distillate away from the permeate side. In this configuration, i.e. SGMD, the condensation of the vapor takes place outside the membrane module. Therefore, an external condenser is required to collect the vapor in the distillate stream. It is worth noting that in SGMD, the gas temperature, the mass transfer and the rate of heat transfer through the membrane change considerably during the gas circulation along the MD module, which can potentially decrease the distillate flux. Although, the SGMD process has a great perspective for the future, especially for desalination and water/wastewater treatments, it combines a relatively low conductive heat loss through the membrane with a reduced mass transfer resistance. Similar to the DCMD process, the SGMD can also be used for high-purity water production and concentration of ionic, colloid and/or other non-volatile aqueous solutions. In SGMD, the feed temperature together with the sweeping gas flow rate was found to be the important operating parameter controlling the distillate flux. The change in partial vapor pressure corresponding to the same temperature change increases as the temperature rises.

5.3. AGMD process

As mentioned earlier, the most important drawback of the DCMD configuration is the high rate of heat loss through membrane heat conduction. Furthermore, the need for an outside condenser is the limitation of the SGMD configuration. To solve these drawbacks, a new configuration of MD was introduced, called air-gap membrane distillation (AGMD). In this mode, the temperature difference between the process liquid and the condensing surface is the driving force. As could be observed in Figure 5.2, mass transfer occurs according to the following four steps, including movement of the volatile molecules from the bulk liquid (i.e. hot feed) towards the active surface of the membrane, evaporation at the liquid-vapor interface (i.e. at the membrane pores), transport of evaporated molecules through the

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membrane pores and diffusion through the stagnant gas gap, and condensing over the cold surface.

As the distillate is condensed on a cold surface without direct contact with the membrane surface or condensing fluid, AGMD can be used in the fields where DCMD applications are rather limited.
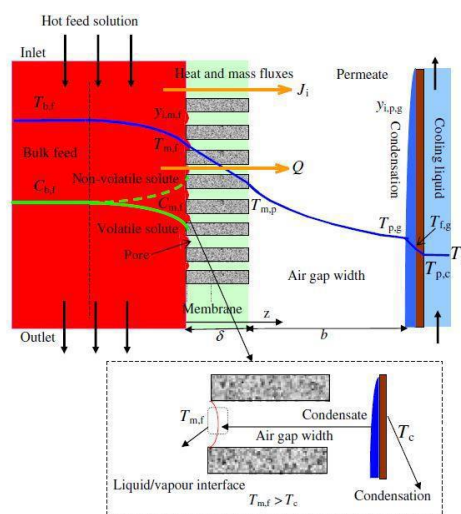
Figure. 5.2. A detailed scheme of the AGMD process

5.4 VMD process

Another possible way to increase membrane permeability in the MD process is removing air from its pores, either by deaeration or by using vacuum in the distillate side. It should be noted that this vacuum must be below the equilibrium vapor pressure, i.e. VMD process. In this configuration, low pressure or vacuum is applied on the distillate side of the module, usually by means of a vacuum pump. As mentioned earlier, condensation takes place outside of the MD

module at temperatures much lower than the ambient temperature, and a nitrogen liquid filled condenser is used in the lab scale. There is a very low conductive heat loss in the VMD process. This is due to the insulation against conductive heat loss through the membrane provided by the applied vacuum, in which the boundary layers in the vacuum side are negligible. Moreover, in the VMD process it is a reduced mass transfer resistance.

5.5. Modelling Methodology

In proposed method three designs is considered for the demenonstartion of Analysis of different Velocity and Temperature on model.

5.5.1 CAD Modeling Design1

The CAD model is developed in CREO 2 which is sketch based, feature based parametric 3d modelling software developed by PTC. The model is developed in parts and then assembled using constraints.

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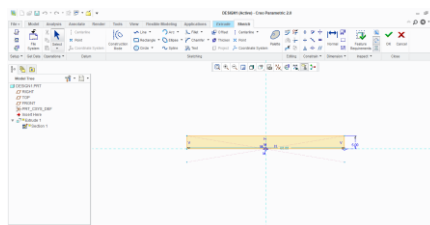
Figure 5.3 Using sketch
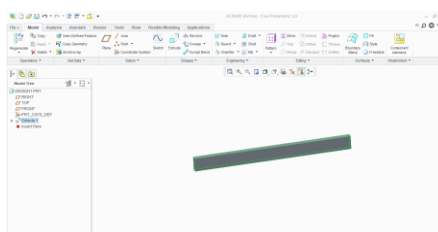
Figure 5.4 using extrude

5. RESULT ANALYSIS

In this section analysis of different result outcome is shown after applied proposed method on three different designs which is considered for the demenonstartion of Analysis of different Velocity and Temperature on model.

6.1 Design1
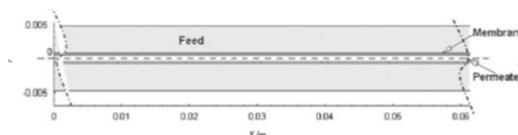
Figure 6.1 Schematic of Design1 of Membrane Distillation

Schematic Design 1 of Membrane Distillation with all parameters is shown in figure 6.1 with feed and permeates points also.
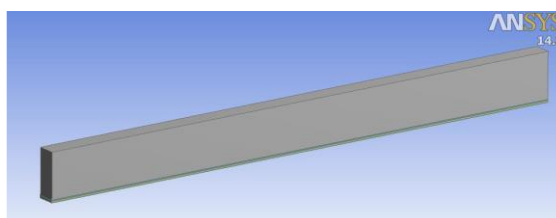
Figure 6.2 One Half Is Modeled and Symmetric Boundary Condition Is Applied

In figure 6.2 ANSYS view of One Half Is Modeled and Symmetric Boundary Condition Is Applied is shown which the Schematic of design1 is.

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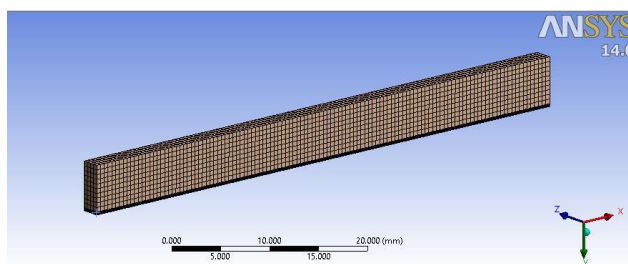
MESHED MODELED

Figure 6.3 Meshed Modeled of design 1

In figure 6.3 ANSYS view of Meshed Modeled and Symmetric Boundary Condition Is Applied is shown which the Schematic of design1 is.
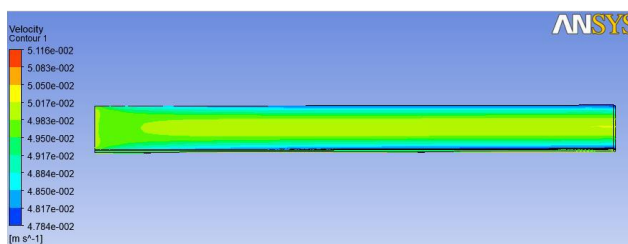
Figure 6.4 Velocity contour design 1

In figure 6.4 ANSYS view of velocity contour 1 on the design 1. In proposed different contour of velocity is taken to examine the work value of design1 is Applied is shown which the Schematic view of design.
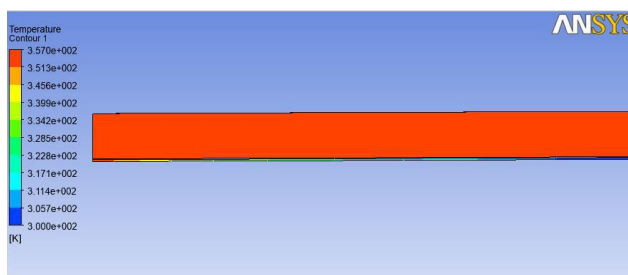
Figure 6.5 Temperature contour of design 1

In figure 6.5 ANSYS view of Temperature contour 1 on the design 1. In proposed different contour of temperature is taken to examine the work value of design1 is Applied is shown which the Schematic view of design.

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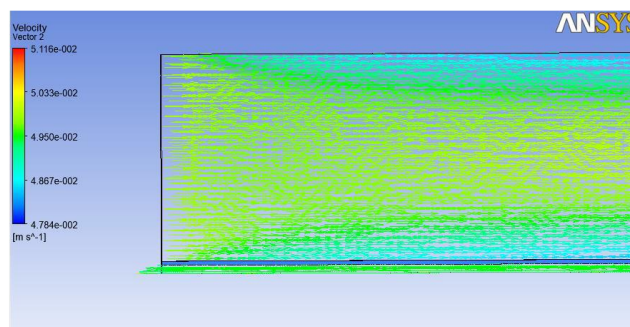
Figure 6.6 Velocity Vector of design 1

In figure 6.6 ANSYS view of velocity vector on the design 1. In proposed different contour of velocity is taken to examine the work value of design1 is Applied is shown which the Schematic view of design.

6. CONCLUSIONS AND FUTURE SCOPE
6.1 CONCLUSIONS

In proposed work is a CAD analysis of Membrane Distillation, CAD model is developed in CREO 2 which is sketch based, feature based parametric 3d modelling software developed by PTC. The model is developed in parts and then assembled using constraints. The MD method has been mainly used for desalination; but, the water recovery from waste streams is one of the most promising applications of MD for the long run. It's also proved to be a suitable technology for removal of other impurities. Whereas it's capable of treating several types of wastewaters and brines, its ability to vie with current technologies, like Ro and thermal-based water treating technologies, is still restricted due to its lack of experimental data in pilot scale and specific membranes and modules. On the other hand, finding new and suitable applications for the MD method currently looks to be one of the main impediments to its industrial use. Moreover, there's another major challenge against MD to be applied for effluent treatment. Effluent streams usually include many chemicals that would doubtless result in membrane surface fouling and membrane pore wetting. This can be because of the actual fact that the deposition of those contaminants on the membrane surface may build the membrane less hydrophobic and lead to pore wetting and thus the flux decline. This is often the reason that limited works on waste material treatment using MD are compared with desalinization. Therefore, fabricating specific membranes for MD application in waste matter processing is one of the promising future views. In proposed work the accuracy is increased by 10 percent better as compared to previous works.

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NUMERICAL ANALYSIS OF DIFFERENT PROCESS PARAMETERS OF HEAT EXCHANGER USED IN AERO ENGINE

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Abstract

The speed of aircraft has increased from subsonic to supersonic over the last decades because of the advent and development of the aircraft jet engine. Recently, the technologic research on the aerospace plane made a higher demand of speed (up to 5 Mach) and as the result, the engine for hypersonic aircraft become a challenge of 21st century. As modern gas turbine used in aero engines, to achieve higher thermal efficiency, the inlet temperature of turbine increases. Heat exchangers are used in aero-space engines have large heat transfer coefficient, large surface area per unit volume and low weight. This study presents the airside performance of fin and tube compact heat exchangers with plain fin configuration. Hot air coming from compressor and flows across the tube bank and cold fluid flows inside the tubes. The effect of fin thickness, fin and tube material on the thermal-hydraulic characteristics is examined. Three-dimensional are carried out to investigate heat transfer and fluid flow characteristics using the Commercial Computational Fluid Dynamics Code ANSYS fluent 16.0. Results are compared for three different materials GH3044, S66280 and GH2132 also find out optimum heat transfer rate. After selecting best material GH3044, we investigate the temperature variation for three different fin thickness 0.08 mm, 0.1mm and 0.2 mm.

Keywords:

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1.Introduction

The aircraft speed has increased from subsonic to supersonic over the last decades because of the advent and improvement of the aircraft jet engine. In recent times, the technologic study on the aerospace plane made a greater demand of speed (up to 5 Mach) and as the outcome, the engine for hypersonic aircraft originate as a contest of modern era. As new gas turbine utilized in aero engines, to attain greater thermal efficiency, the inlet temperature of turbine increases and increasing pressure ratio inside the compressor are most frequently used methods. With the improvement of engine technology, inlet temperature of current turbine is extreme outside the allowable metal temperature ranges, which is impending near about 2000 K. As the factual possessions growth protected overdue the request of applied claim, turbine

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inner temperature augmented more by means of extremely classy chilling methods. Fin-tube dense heat exchangers demonstration possible requests in aero appliances for its excessive effectiveness. As associated with the conventional heat exchangers utilized on the ground, those utilized in aero engines are more compact and undergo higher temperatures and larger difference in temperature. The change in temperature over the exchanger depth and the slope of temperature in the adjacent wall area are more exposed, they may reach a number of hundred degrees.

Heat exchangers are maneuver that comforts the heat altercation among two solutions which are at diverse temperature though having them since intercourse with another. heat exchanger are normally utilized in practice in a wide variety of application, from heating as well as air conditioning systems in a domestic, to chemical processing as well as power production in large plant. A heat exchanger in which two fluids exchange heat by coming into straight interaction called direct contact heat exchanger. The wall may be an easy level wall or tube or a complex arrangement comprising fins, baffles and tubes multiple passes. These units, also called surface heat exchanger, are ordinary utilized as they can be created with huge heat transfer area in somewhat lesser volume and are fit for heating, cooling, evaporating or condensing applications. A periodic flow type heat exchanger called a regenerator. In this type of heat exchanger, the identical space of it consecutively engaged by hot and cold gases between which heats exchanged. Regenerator may discover its assertion in preheaters for condensation influence firm, blast furnaces, oxygen manufacturers, and many more. In order to meet the extensively ranged application, numerous type of heat exchangers is been established which are categorized on the basis of behaviors of heat exchange process, relative path of fluid motion, design and constructional structures, and bodily state of fluids.
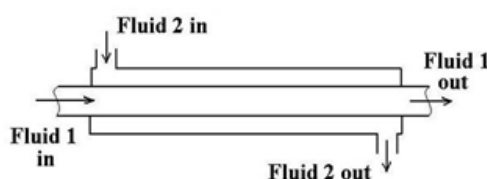
Fig. 1.1 Schematic diagram of a double pipe parallel flow heat exchanger

as well as power production in large plant. A heat exchanger in which two fluids exchange heat by coming into straight interaction called direct contact heat exchanger. The wall may be an easy level wall or tube or a complex arrangement comprising fins, baffles and tubes multiple passes. These units, also called surface heat exchanger, are ordinary utilized as they can be created with huge heat transfer area in somewhat lesser volume and are fit for heating, cooling, evaporating or condensing applications. A periodic flow type heat exchanger called a regenerator. In this type of heat exchanger, the identical space of it consecutively engaged by hot and cold gases between which heats exchanged. Regenerator may discover its assertion in

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preheaters for condensation influence firm, blast furnaces, oxygen manufacturers, and many more. In order to meet the extensively ranged application, numerous type of heat exchangers is been established which are categorized on the basis of behaviors of heat exchange process, relative path of fluid motion, design and constructional structures, and bodily state of fluids.

Fig. 1.1 Schematic diagram of a double pipe parallel flow heat exchanger

with plain finned tube are mathematically projected with attention of the air possessions disparities due to the air temperature change.

Erika et.al [2] the analysis is about the use of dynamic evaluation of fluid studied about the plate heat exchanger which is at constant wall temperature and laminar steady flow of the non-Newtonian fluid and with as well as without use of one pass heat exchangers of U-type plate with several flat plates. They investigated about the transfer of heat and drop in pressure dissimilarity on quantity and the space amongst plates and by the improved Sieder–Tate expressions. The results has been generated from CFD are exactly fitted to an experiential relationship of the friction factors as an analysis of the comprehensive Reynolds number as well as the ratio among the friction individual, length and the length of the movement path.

Khoshkhoo et.al [3] They achieved untried and geometric research with explored CFD modelled solved with the use of Reynolds-Averaged Navier-Stokes (RANS) equations, with user define flow model deposition. The particle size varies from 1μm to 4mm for conducting experimental study and for numerical investigation they used particle size from 1μm to 100μm which is stored in A1 particle category of experiment. Numerical study results show that increases up to 50μm of particle size the particle deposition.

Selma et.al [4] In this contemporary reading agreements with the search of the stage delivery with current rivulets in a perpendicular dense heat alteration located in the end of the cold flow pilot plant and perform experimental and CFD simulation. 3-D capacity of liquid perfect is occupied for imitations are executed. Water and air are taken as working fluids for simulation, and the velocities are varies at inside the distributor for air is 0.9–8.8 m/s and for water is 0.35–0.8 m/s.

Karel et.al [5] This paper performed a comparative study of a numerical simulation with a experimental results. In the simulation work measured device is situated at a heat exchanger with a Centrifugal fan because of a fan the geometrical arrangement and stream flow is relative odd and so the heat transfer is difficult to calculate and also simulation is required time and cost affordable, so a standard k-☐ turbulence model is use for the CFD. They

suggested that similar flow conditions the model could disclose new construction improvements to increase or decrease the heat transfer, depends on the requirement.

Zhang et.al [6] inspected the tools for heat transfer advancement in parallel plate fin heat exchangers comprising the inline as well as astonished variations of OSFs. They have equally reflected the influence of fin thickness and the time inferior flow conduct because of the vortex detaching by solving the fragile force and strength situation. The influence of vortices, which are formed at the leading edge of the fins as well as travel downstream along the fin surface, was equally reflected. From that point think about they create that only the surface pauses increase the heat transfer subsequently they cause the limit films to begin occasionally on fin surfaces and reduce the warm fortification from heat transfer among the fin surfaces and fluid. Though, after a basic Reynolds number the flow finishes up plainly shaky and in this direction the vortices undertake a notable part to escalate the heat transfer by carrying the new fluids constantly from the foremost stream near the fin surface.

Chunxin et.al [7] Have examined heat transfer normal for heat exchanger of compact type using test Information. Their outcomes demonstrate that utilized exploratory information would much be able to enhance the effectiveness of the framework plan and improvement to compact in-flight heat exchangers potentials in each solitary occupied disorder this documents displays a CAAHXs exemplary. ECS ground virtual reality test-bed, the CAAHXs were experienced with the usage of consequences and displays that the general heat transfer model is analysed.

Camilleri et.al [8] They have observed the current spread in dense equivalent current warmth exchangers territory ratio is a prevailing of all-inclusive factor for governing mal-dispersion where this paper delivers the thermal exclusive with the time to evaluate the flow departure in heat exchangers at an initial phase of design as well as study the properties of different boundary limits, geometric condition as well as effective condition. With the help of many imitations find out the major reasons of flow mal-distribution, heat exchanger limits and performance are inspects.

Hossain et.al [9] Have awaited on strategy with reorganizing of dense warmness of changing to be retrofitted in lorry. The makers have done to advance the plan of the heat exchangers with numerical fluid features as well as determine the additional authority this paper displays eventually. This is like shell and U-tube sort of heat exchanger is designated for the estimations of numerical calculations were achieved out to advance the design of the heat exchangers as to figure the additional effort that might be achievable by applying these pancake-shaped heat exchangers to be augmented.

2.3 Problem Formulation

□ Analyzing the effect of different materials on the air exit temperature used for tube and fins manufacturing that is GH2132, GH3044 and S66280.

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☐ Also finding out the value of different parameters that is heat transfer rate and heat transfer coefficient.

☐ Finding out the effect of change in fins thickness, here it considered three different fin thickness i.e. 0.07, 0.1, 0.2 mm for analyzing the air temperature distribution, heat transfer coefficient and heat transfer rate.

☐ Observing the effect of change in gap in between the two fins and analyzing the effect on parameters.

☐ Also calculating the efficiency for different fin thickness.

3. METHODOLOGY

3.1 Steps to be followed

These are the following steps: -

☐ Study of heat exchanger used in the aero engines and fins out the parameters on which its performance is depend.

☐ Literature survey and find the scope of further research.

☐ Finding out the process parameters on which the performance parameters depends.

☐ After developing the solid model numerical model of heat exchange is develop.

☐ Validation of CFD model of heat exchanger with the analysis performed in the base paper.

☐ Three different materials is used for tubes and fins that is GH2132, GH3044, S66280 and find out the air exit temperature for all the three materials.

☐ With material having least exit temperature, it considered the three different fins that is fin having thickness 0.07 mm, 0.1 mm and 0.2 mm.

☐ Find out the effect of change in fin thickness on the air exit temperature.

☐ Also calculating the fin efficiency for different fin thickness.

☐ And then finding the effect of these parameter on the air exit temperature

3.2 Material Used

For the primary investigation it's been occupied the material identical as that of taken by Lingdong et.al [1].

Table 3.1 Properties of material GH2132

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Properties	Values
Density	7.99 g/cm^3
Specific heat	447 J/kg-k
Thermal conductivity	14.2 W/m-C

3.3 Development of CFD Model

In direction to advance the CFD model of the heat exchanger investigation altered sub system or stages have to be executed. Changed phases are vital for the expansion of CFD model is accomplish in this segment. To upsurge the enactment of heat exchanger utilized in aero engines work, it find out the influence of dissimilar material utilized for the creation of tubes as well as fin in heat exchanger.

3.3.1 Developing Solid Model

In order to attain the above aim here initially it has to advance the solid model of heat exchanger established on the structure utilised shown in
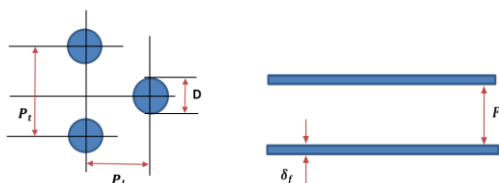
Lingdong et.al [1] the symmetrical requirement of heat exchanger utilized in the inspection is essential where the tube bank formations contain the tube outside diameter (D), transverse tube pitch (Pt), longitudinal tube pitch (Pl), and number of tube rows (N). They are picked as D = Pl = 3.0 mm, Pt = 6.0 mm and N = 12 in this research. The plain finned tube formation comprises additional constraints with the fin pitch (Fp) and fin thikness (df), which are specified to be Fp = 1.1 mm and df = 0.1 mm. because of the periodicity and regularity of the heat exchanger structure for mathematical exploration it deliberated the two dimensional that is 2D airflow channel as shown in the fig. here the solid model of the heat exchanger is equipped in the project segmental of Ansys.
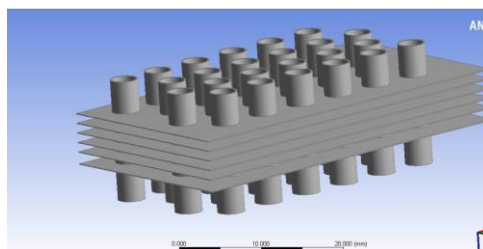
Fig.3.1 showing the geometric condition of tube

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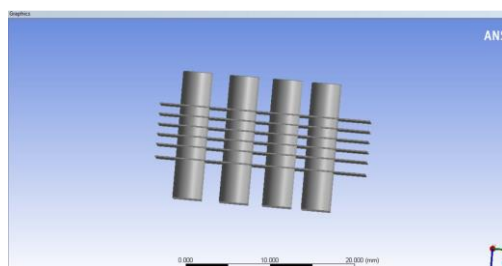
Fig.3.2 (A) and (B) shows the solid model of compact heat exchanger used in the analysis
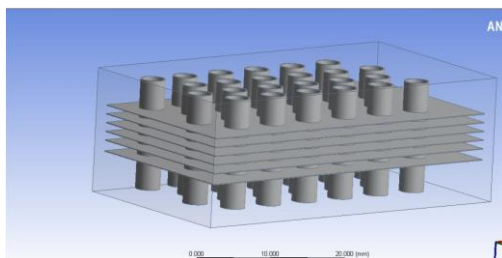
Fig.3.3 Solid model for computational analysis
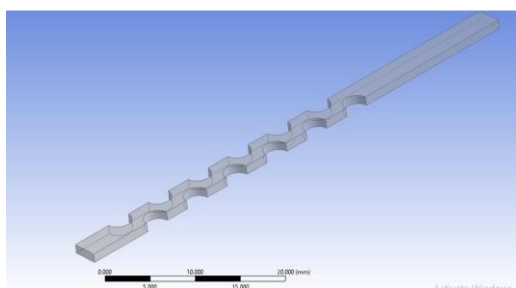
Fig. 3.4 Geometric 2D model used for analysis

Fig.3.5 shows the computational domain which is considered during the analysis. The fin domain is inside this computational domain which is used for to increase the heat transfer rate. The model showing the fin inside the computational domain is shown in the fig.3.5

Fig 3.5 Solid model for computational analysis

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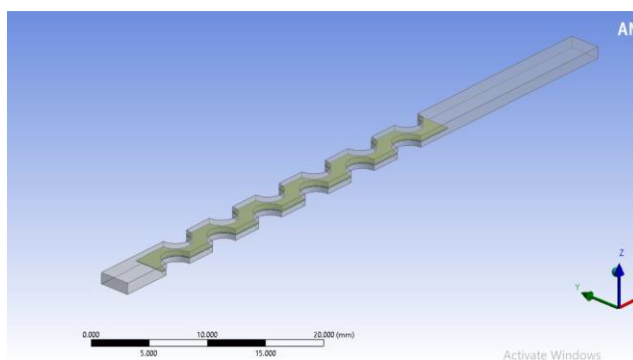
4. MATHAMETICAL MODELS AND DATA REDUCTION

4.1 Assumptions:

During the mathematical calculation some assumptions were taken as follows

• The heat exchanger is a thin fin, horizontal compact heat exchanger. The fluid can be modeled as a three dimensional fluid flow through a computational domain. Viscous dissipation and viscous work were neglected. Body forces are neglected.

4.2 For calculating the maximum velocity

Maximum velocity of airflow inside the compact heat exchanger are calculated based on relation given for the staggered tube arrangement in Cengel. The relation used for calculating maximum velocity inside the computational domain is given below.

$$V_{max} = \frac{P_t \times V}{2(P_d - D)} \qquad ($$

Where; D = diameter of tube

V = velocity of air at inlet

P_t = transverse distance in between the two tubes of same row

P_d = diagonal distance between the center of two tubes of adjacent row

4.3 For Calculating the Reynolds number

To calculate the Reynolds number of air flowing inside the computational domain, maximum velocity of air flowing inside the domain were considered in a particular case of staggered fin tube type compact heat exchanger [29]. For calculation following relation were used.

4.5 Heat transfer

In order to calculate the heat transfer from hot air to fin and tube following relation were use. During the heat transfer from hot air to cold fluid flowing inside the tube, many researcher have found that the thermal resistance during the heat transfer from tube to cold fluid is less as compared to the thermal resistance, during heat transfer from air to tube and fins [6, 22, 29]. So during the calculation of heat transfer and heat transfer coefficient it mainly concern toward the heat transfer from air to fin and tube and neglect the thermal resistance toward the cold fluid domain which is very less as compared to the thermal resistant toward the air side. Due to this here it calculate the local heat transfer coefficient in between air and tube, and not calculating the value of overall heat transfer coefficient

5. RESULT AND DISCUSSION

5.1 Validation of CFD Model and Computation

In order to validate the CFD model of heat exchanger used in aero engines, here it first find out the temperature of air at the exit of heat exchanger for different velocity. Here in this work we have considered the four different velocity that is 5, 10, 15, 20 m/s and in each case air exit temperature get calculated and then based on the temperature at the exit here we have calculated the heat transfer rate (q), the value of heat transfer rate calculated with the help of

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numerical method is then compared with the value of heat transfer rate given in the base paper Lingdong et.al [1]. Here in this analysis it considered the material GH2132 for tube and fins. The thickness of fins for this analysis is 0.1 mm, whereas the gap in between the two fins is near about 1.1 mm.

Case 1 velocity 5 m/s

Here in this case velocity of frontal air is 5 m/s and the temperature of air at the inlet is 653.98 K. After applying the boundary condition it find out the air exit temperature. The contour plot of air temperature distribution for this case shown in fig.
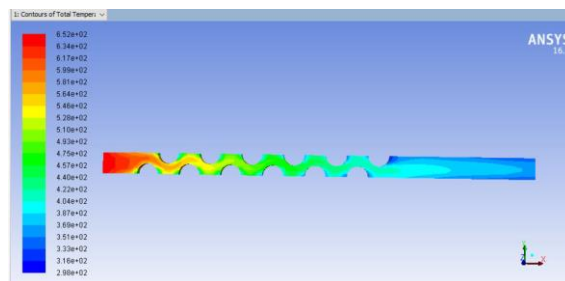
Fig.5.1 Temperature contour of heat exchanger at 5 m/s velocity- case 1

From the above analysis, it observe that the temperature of air at the exit of heat exchanger is 421 K from the numerical analysis it also find out the change in velocities and velocity vectors.
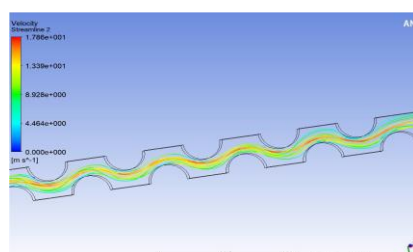
Fig.5.2 Velocity contours for case 1

☐ Case 2 velocity at 10 m/s

Here in this analysis the velocity of frontal air coming to heat exchanger is 10 m/s and the temperature of air at the inlet is same as that of case 1, other boundary conditions will also remain same as that of case 1. The temperature distribution profile for this case shown in fig.
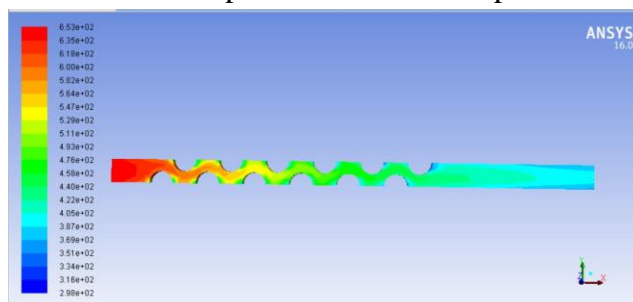
Fig.5.3 Contours of temperature for velocity 10 m/s – case 2

From the above fig. it is find that the temperature of air at the exit of heat exchanger is near about 440 K. The temperature distribution at the exit is shown in the below fig. through the

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contours of temperature at the exit it is find that the exit average temperature is near about 440 K.

☐ Case 3 Velocity at 15 m/s

Here in this analysis the velocity of frontal air coming to heat exchanger is flowing at a speed of 15 m/s and the temperature of air at the inlet is same as that of case 1, other boundary conditions will also remain same as that of case 1. The temperature distribution profile for this case is shown in fig.
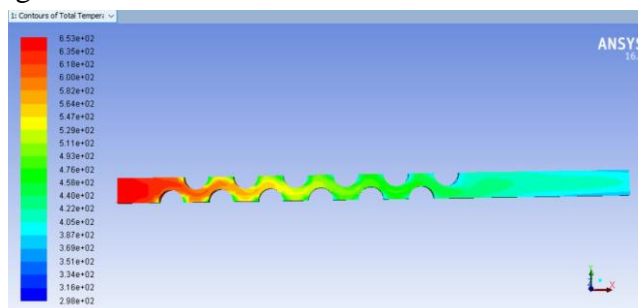
Fig.5.4 Contours of temperature distribution at velocity 15 m/s - case 3

Through this analysis, it is find that the temperature at the exit of heat exchanger is near about 449 K, which is higher than the temperature at 10 m/s velocity case it shows that as the velocity of air increases the temperature of air at the exit is also increasing. Likewise the above three cases we can also calculate the value of temperature for the fourth case that is 20 m/s.

To calculate the heat transfer rate eq. 6 used at different velocity

we have calculated the value of heat transfer rate for different velocity. Table 4.4 showing the value of air exit temperature of different velocity and the value of heat transfer rate at different velocity

S.N	Velocity (m/s)	Temperature of air at the exit (K)	Heat transfer rate (W)
1	5	421	18.15
2	10	440	33.24
3	15	449	47.9
4	20	457	54.059

Velocity (m/s)	Temperature at the wall of tube (K)	Temperature of air at inlet (K)	Temperature of air at inlet (K)	Logarithmic mean temperature difference (K)
5	298	421	653.99	219
10	298	440	653.99	232.83
15	298	449	653.99	239.02

Table.5.2 showing the ΔT_m value for material GH2132 at different velocity of air

Comparison of value of temperature of air at the exit and heat transfer coefficient calculated through numerical analysis with the value of temperature and heat transfer coefficient given in the base paper.

Table.5.3 Comparison of numerical values and base paper

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Velocity (m/s)	Heat transfer coefficient (h) (W/m²K) calculated through numerical analysis	Heat transfer coefficient (h) (W/m²K) from base paper	Error (%)	Heat transfer rate (W) calculated form numerical analysis	Heat transfer rate (W) values from base paper	Error (%)
5	588.88	550	7.06	18.15	18	14.62
10	1018.6	985	3.4	33.24	31	7.2
15	1335.53	1300	2.7	47.9	44	8.86
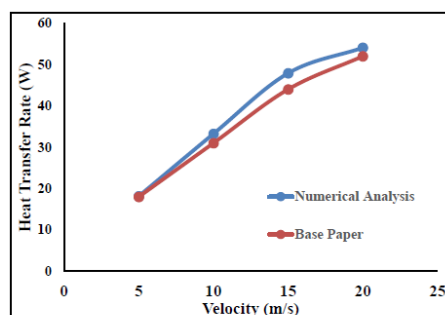
Fig.5.5 Comparison of heat transfer rate at different velocity of air
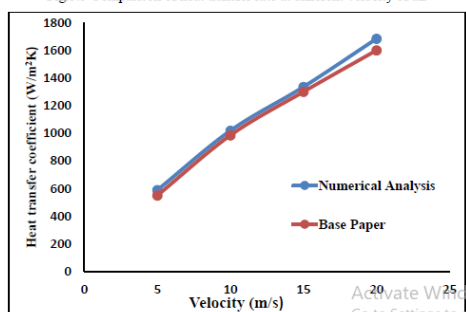
Fig.5.6 showing the comparison of heat transfer coefficient for different velocity

From the above comparison it is shown that the value of temperature at the exit of heat exchanger obtained from the CFD analysis is closer to the value of temperature obtained from the base paper. It also analyzed that the value of heat transfer rate at different velocity of air obtained from the numerical analysis is close to value obtained from the base paper and follow the same trend as follow in the base paper. So after analyzing the graph it shows that the CFD model of heat exchanger that is developing in this work is correct.

After validation of the CFD model of heat exchanger, here it optimized the different parameter to enhance the heat transfer rate. To increase the heat transfer rate here in this analysis it has considered the two different materials that are GH3044 and S66280, which are also a steel alloy.

6. CONCLUSIONS AND FUTURE SCOPE
6.1 CONCLUSIONS
☐ Here it find out the effect of material on the temperature of air at the exit, for analyzing the effect, it consider the different steel alloy which is GH2132, GH3044 and S66820.
☐ From the graph it is found that as the velocity of air increases the value of heat transfer increases for all the three material.

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☐ GH3044 shows the maximum value of heat transfer as compared to the other material. From the graph it is conclude that the value of heat transfer for GH3044 is on an average 12 % more than the GH2132 material.

☐ it is found that as the thickness of fin increases from 0.08 mm to 0.2 mm the heat transfer rate increases, whereas beyond 0.2 mm thickness value of heat transfer again start decreasing.

☐ It is concluded from comparison graph of fin thickness that the use of fin thickness 0.2 mm is better as compared to the other fin thickness and shows 10 % increment in heat transfer as compared to 0.1 mm fin thickness.

6.2 Future scope

☐ Researcher can work on the design pattern of fins, so that the heat transfer rate get increased. During the design of heat exchanger, space is the limitation, so it is necessary to build high heat transfer rate compact heat exchanger.

☐ To increase the heat transfer rate, researchers can work on the flow pattern of heat exchanger. They can also work on the coolant fluid having high heat transfer coefficient and specific heat

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IMPROVEMENT IN LEACH PROTOCOL USING HAMMING DISTANCE & RECURRING AVERAGE ENERGY
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Abstract
Assessment of plastic Injection moulding process is important for the manufacturing of plastic products to achieve higher standards of quality and customized products. Designing an effective evaluation process for Injection moulding process itself is an intensive task and aims to intelligently combine process parameters that improve the competitiveness aspects of the Injection moulding process and may bring about improvement in the system. This thesis presents process parameters based multi-response optimization approach using hybridization Taguchi with Desirability function application as a tool to prioritize and ranking of Injection molding process parameters and to analyze an optimal process parameter settings evaluation of Injection molding process in plastic manufacturing industry perspectives. The aim is to encourage more efforts in this regard for more great benefits and applications.

Keywords: Desirability Function, Minitab-16, Machine cycle time, Tensile Strength

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1.INTRODUCTION

Injection Molding is being used. John Wesley Hyatt and his brother Isaiah, both American inventors, came up with the idea for the machine in 1872 and patented it the following year. The machine was simple in Ashutosh

comparison to the sophisticated equipment that is used nowadays. To inject plastic into a mould via a heated cylinder, it operated much like a big hypodermic needle, with a plunger being usedto push the material forward. Plastic goods have not been used in the production of items needed in day-to-day life since 1978, despite the fact that the manufacturing technique of injection moulding is no longer in demand. Nevertheless, as time goes on, items made of plastic materials are gradually replacing those made of metals and non-metallic materials. The rise in industrialization and general

societal progress over the last three decades is largely responsible for the meteoric rise in demand for this particular piece of equipment. Toys, home goods, automobile components, and consumer electronics are all examples of things that are made using the injection moulding method since it is so prevalent in modern life. An injection moulding machine may

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also make containers buckets, plastic toys, plastic toys, goods for medical equipment, tiny plastic fasteners, and bottles, among other things.

When producing high-quality plastic goods, the producer will often take into consideration many components of the manufacturing process. The products have to be able to fulfil the requirements laid out by the customers, the amount of energy used and the cost of production have to be kept to a minimum, the mechanical properties of the plastic product, which are gained by the product during the

processing and are dependent on the parameters, can be regulated to ensure that the product is free of flaws.

1.2 Historical context of the study

Injection moulding is the most adaptable method for the production of complicated plastic items. However, it is also the most labor-intensive method due to the fact that it can handle the intricate geometry of the products in an effective manner. Injection moulding operations, on the other hand, may occasionally provide the mould designer with a problem in terms of designing a mould that produces

products with a low defect rate. This is due to the fact that plastics are readily useful even if they have faults of this kind. Warpage, shrinkage, weld lines, and air traps are all issues that may occur (Saman et al. [2009]) [1] Also, Molding materials having variable thermal characteristics that impact the mechanical qualities of plastic components during the injection moulding process. These attributes may be affected by mould materials. Molds may be made from a variety of materials, including steel, aluminium, and others; however, an aluminium mould offers several benefits in comparison to other mould types, including lower manufacturing costs, lower weight, and better heat transmission (Ozcelik et al. [2010]).[2] The design of plastic moulds is not only a vital step in the production process that is most usually utilised, but it is also necessary for controlling parameters in order to produce goods that are free of defects. The procedure of moulding the hot injection material involves letting it freeze within the mould before continuing. When the mould is opened, the finished product, which has now hardened into the form of a net, is ejected from it. Despite the fact that this procedure is straightforward, there are several factors involved in the manufacturing process, which makes it difficult to forecast the end product's level of quality (Mathivanan et al.) [2010] [3]. As a consequence of this, the process of enhancing and testing in the research parameters to maximise the effectiveness of the injection moulding process that may be included into the process. In a general sense, there is an absolute need for an optimization process to be carried out. Inconsistencies might occur in the production process of plastic components because of erroneous information and a general lack of expertise.

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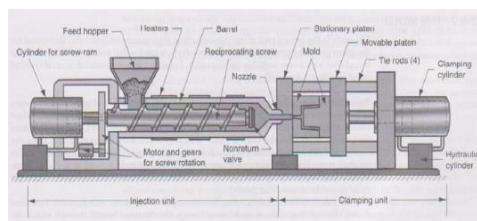
Fig. 1.1: Single screw injection molding machine

2. LITERATURE REVIEW

2.1 Process parameters optimization and simulation methods

Both the injection moulding process's settings and its environment may have an impact on the final product's quality (discussed in section 2.1). Several factors, including processing temperature, processing length, pressure, and environmental conditions, might alter conditions during the injection processing phase. All of these parameters have the potential to influence the injection moulding process in some way, including the dimensional errors, mechanical quality, and manufacturing cycle times. There has been a major transition away from the traditional injection moulding technique and toward the gas injection moulding process due to advancements in the moulding of larger, more complex parts. This shift has occurred throughout the last several decades *(Guo et.al.[2014] [4]).* Because frequent testing and inspections ensure that the machinery is in good working order. There still has to be a floor under the product's quality, however. When there are numerous unseen factors, such as variation in physical properties (for example, when regrind resins are used), changes in the ambient environment (for example, humidity or temperature in the shop), and characteristics of the machine, the procedure conditions are re-read to lower the quality of the part within the tolerance limit (especially when using hydraulic power). Many experts have spent the better part of the past two decades studying effective process control systems. These researchers have used automated and adaptive quality control in addition to specialised control methods to address the aforementioned challenges. The machine was simple in comparison to the sophisticated equipment that is used nowadays. To inject plastic into a mould via a heated cylinder, it operated much like a big hypodermic needle, with a plunger being used to push the material forward. Plastic goods have not been used in the production of items needed in day-to-day life since 1978, despite the fact that the manufacturing technique of injection moulding is no longer in demand. Nevertheless, as time goes on, items made of plastic materials are gradually replacing those made of metals and non-metallic materials. The rise in industrialization and general societal progress over the last three decades is largely responsible for the meteoric rise in demand for this particular piece of equipment. Toys, home goods, automobile components, and consumer electronics are all examples of things that are made using the injection moulding method since it is so prevalent in modern life. It is difficult to develop a practical method of control without first gaining a thorough understanding of the relationships between all of these factors (Chen and Tung [2005]) [5].

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The specific effort required to locate the optimal solution is proportional to the impact that the parameters have on the answer. The injection pressure must be raised to account for the greater temperature of the molten material if it is too hot. The composition contains a biodegradable component, yet the melting point of that chemical is rather high. There may be a fast shot and a lot of flash within the material if the injection pressure can be maintained exceedingly low (Mok et. al.[1999]) [6]. Thus, to reduce defects as much as possible, it is preferable for the interaction between melting temperature and injection pressure to be larger than that between holding pressure and injection pressure (Kamaruddin et. al.[2010]) [7] .

Key factors include barrel melting temperature, mould temperature, and mould cooling temperature, as well as injection pressure, packing pressure, cooling time, packing time, injection time, and injection environment. The air current, humidity, and temperature are all examples of parameters that play important roles in this scenario (Parey, A. et al. [2007]) [8]. The qualities of the procedure are what ultimately decide the product's final form. There have been several studies using a wide variety of adaption strategies based on the circumstances of the components impacting the injection moulding process (Pandey and Panda [2014]) [9]. Solutions to this kind of issue may be found in a number of different places. These techniques use the process's characteristics to determine the best areas to concentrate product development efforts. Optimization strategies including the response surface model, bringing model, artificial neural network, and genetic algorithm have been provided, along with hybrid strategies that take into account their characteristics, advantages, downsides, and scope, as well as the worries of previous researchers (Singh, S. et al. [2013]) [10]. There are three primary types of optimization strategies: those that do not rely on gradients, those that do rely on them, and hybrid strategies that include aspects of both. It is possible to classify various numerical optimization techniques into subgroups according on the degree to which they move the design goal forward with each iteration. In brief, it consists of the following: The objective function f (x) used in the non-gradient-based technique is independent of derivatives of x, which sets it apart from other optimization strategies (x). Optimization strategies that don't use gradients include adaptive simulated annealing, Hooke-Jeeves direct search, and the genetic algorithm. However, these optimization strategies need a large number of function evaluations to get a globally optimal answer. For instance, the genetic algorithm is a well-known substitute for gradient-based optimization. This method is an evolutionary descendant of stochastic search and optimizationalgorithms. References are made to the works of Saurabh Kumar Gupta et al [11]. The gradient of the function at any given time is used to generate search vectors in a gradient-based method. There is a great deal of variability among gradient-based optimization techniques. Examples of well-known optimization methods include Davidson-Fletcher-Powell, mix integer optimization, sequential linear programming, sequential quadratic programming, and generalised reduced gradient. When there are fewer variables, gradient-based methods tend to converge quickly; but, as the number of variables.

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2.4 Problem statement

1. To investigate the influence that certain process factors, including as melt temperature, injection pressure, packing pressure, packing time, and cooling time, have on the results of the experiment, particularly process cycle time, tensile strength of components, and dimensional defect warpage.

2. The combining of a number of distinct optimization methodologies, such as the Utility idea and the Desirability concept, with the Taguchi method, which encourages the optimum combination with the least amount of error.

3. What kinds of opportunities exist for the hybridization of desirability functions in the injection moulding of polypropylene plastic components?

4. How can the polypropylene components produced via the injection moulding technique help to the best hybridization components.

3. DESIGN OF EXPERIMENTS AND ITS

ASSOCIATED OPTIMIZATION METHODS

A test is considered to be planned if some relevant adjustments are made to an input variable of a process or system in order for changes in the response to be observed and recognised according to the output. This allows for a designed experiment to be carried out. Methods of experimental design are an extremely important component in the process of developing and enhancing procedures. "Designing for value" may be greatly aided by the careful planning and execution of experiments. When preparing experiments, researchers usually take into account the design of the experiment to answer certain questions. This serves as a viewpoint. These aspects of the design of experiments may be enumerated as follows:

1. Does the usage of a product fulfil the purpose for which it was designed in a way that is both safe and effective?

2. Which aspects of the production process are responsible for the variations in the product's quality and accuracy?

3. Modifications made to the parameters of the process will have an effect on the manufacturing process.

4. Determine whether an immediate solution may be implemented to facilitate an improvement in the production process.

5. Is there a possibility that the interplay of the process parameters will have an effect on the final product's quality.

6. Under what conditions is it possible to carry out an effective experiment that, when accounting for both costs and the amount of time required, results in the best \ possible solution.

Experiments that may increase product quality while reducing costs and time spent making it should be performed in order to build a manufacturing process that is helpful. Methods that are referred to as process processing are those that are used to enhance both the quality of the

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design and the quality of the product itself. These methods are regulated by the parameters of the manufacturing process that are referred to as the processing of an item. Treatments and experimental units, which are given for treatment of the responses, may be used to describe a short experiment. The solution and treatment approach are going to be different depending on the units that are imposed and the responses that are assessed.

3.1 The Constituent Parts of an Investigation

The following is a list of the components that make up an experiment.

1. Treatment: a remedy that was chosen for a specific

   purpose

2. Experimental units: The process factors that are to blame

   for the cause

3. Methods of assignment refer to the approach that was

   used for the specific treatment.

4. The experimental strategy includes the distribution of

   the therapy.

5. When a user designs experiments in order to study a process, the analysis is contingent on the design of the technique. This is due to the fact that the design of the experiments has a significant role in determining the right analysis.

3.2 Definitions of Terms Employed in an Experiment

There are several different phases involved in the scientific study. It begins with the preliminary experiments, followed by the collecting of data, the conduct of experiments, the analysis of the data using various techniques as shown in Fig.3.1, and the discussion of the various words that had been used in experimental data. These terms are as follows:

Treatments: A treatment is any of a number of possible treatments that are evaluated for its effect on the patient.

The terms "experimental units" and "units of experiment" refer to the same thing. Experimental units are the objects that are applied to the therapy. Responses are the findings measured after applying treatment in a pilot experiment. Responses are also known as responses. The answer provides an accurate account of what took place throughout the experiment.

Randomization is a recognised usage, which explains the probable processes for allocating treatment to units. Randomization is one of these uses. Error in the Experiment The term "error in the experiment" refers to the random variation in each of the experimental outcomes. It is sometimes the case that repeated trials of the same treatment will have varied answers in various tests. This is because different experimental units will produce different responses to the same treatment. The experimental mistake does not relate to the abuse of the exam, nor does it refer to leaving the test early.

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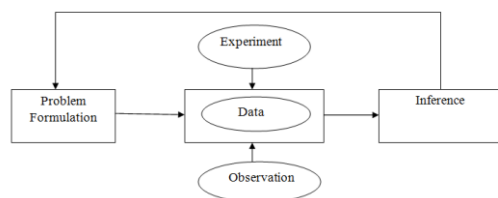
Fig. 3.1 Critical stages of Statistical input in scientific investigations

3.3 Taguchi's Method

The all-encompassing quality control system that Taguchi developed is one of the most significant technical accomplishments of the 20th century. This approach places more of an emphasis on the practical implementation of engineering concepts as opposed to more complex statistical methods. It encompasses quality engineering at both the upstream and shop floor levels. Upstream approaches include conducting trials on a smaller scale in order to minimise variability in an effective manner while still preserving designs that are both cost-effective and resilient for mass production and the market. The technology used on the shop floor offers ways for quality control and maintenance that are both cost-effective and real-time. When a quality approach is adopted up front, it not only has numerous benefits over improvements, but it also decreases both the cost and the amount of time required.

Taguchi does not agree with the conventional interpretation of the term "quality." He uses the divergence from the on-target display as an example of what he means by "quality." He has articulated an unique conception of what constitutes product quality. According to him, "the quality of a manufactured product is the total loss that is generated by society by that product, which is sent from

that time, apart from any damage caused by internal work." In other words, the quality of a manufactured product is the total loss that is generated by society by that product. The term "Taguchi from loss" refers to the loss that occurs as a result of the variable nature of the function and the damage

that is brought on by adverse side effects. Even if the product is untrue or does not fall within the parameters of the specification, if the goal value of the product is exceeded, that product will be held responsible for the loss. Dr. Taguchi suggests using a three-part approach in order to accomplish the product quality goals that were set forth in the design phase.

Taguchi's Loss Function

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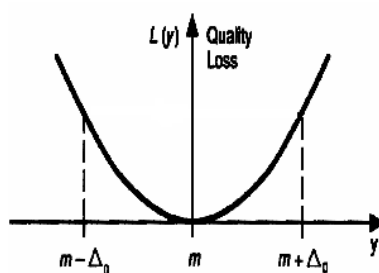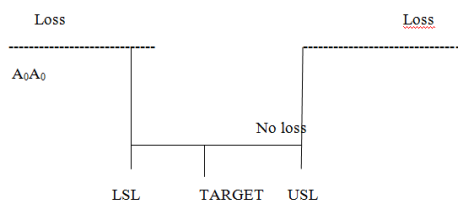
Traditional (Goal –Post) Approach

Injection moulding is a manufacturing method that may be used to produce pieces from plastic materials that can either be thermoplastic or thermosetting. The material is loaded into a heated barrel, where it is mixed before being pressed into a mould cavity. There, the material cools and solidifies into the shape of the mould cavity as it hardens. After the product has been designed, which is typically done by an industrial designer or an engineer, a mould maker or toolmaker will make moulds out of metal, typically steel or aluminium, in order to produce the production facilities, production engineers, and the desired part that is produced by the exact machine. Injection moulding is a common technique that is utilised in the production of a broad variety of parts, ranging from the tiniest components to the full body. One is an injection unit, and the other is a clamping unit. These are the two primary components. Injection moulding machines have the capability to hold fresh moulds in either a horizontal or vertical orientation. The majority of machines have a horizontal orientation, however some specialised applications, such as insertion moulding, need for vertically oriented machines so that the machine may make use of gravity. A chosen plastic compound, which are often given in the form of pellets, is the first step in the process. On the injection moulding machine, these pellets are first deposited in a hopper, and after that, they are heated up within the hot barrel. A screw is housed inside the barrel, and the friction that occurs between the barrel wall and the screw causes heat to be generated. This heat is then used to melt the pellets as the screw revolves.

Fig. 4.1: Injection molding machine uses for Experiment

5. EXPERIMENT DATA ANALYSIS

The examination of the experimental investigation of tensile strength and cycle time, using polypropylene plastic goods, is the primary topic of this chapter. In this case, the analysis is carried out by combining elements of the Taguchi method with those of the desirability function.

5.1 Polypropylene that has never been used is comprised

Melt temperature, packing pressure, injection pressure, and packing duration were all chosen as process factors, and three levels each were tested using a Taguchi orthogonal array to

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organise the trials. Results from nine separate trials using 100% virgin polypropylene are summarised in Table 4.8.

5.2 Multi-response optimization of 100% Virgin Polypropylene composition with hybridization of Taguchi with Desirability Function For each unique combination of quality attributes, a unique Desirability index is computed in order to describe the level of desirability. According to this research, a higher tensile strength indicates a better kind of material, but a lower cycle time indicates a better type of material.

6. RESULT AND DISCUSSION

6.1 Polypropylene is 100%

Both the contour plot and the surface plot of the tensile strength in respect to the processing parameters IP and MT are shown in figure 6.1. Figure 6.1.a shows the contour plot, while figure 6.1.b shows the surface plot. It is clear from looking at this figure that in order for thin shell semi-crystalline plastic materials to attain their optimum tensile strength, the injection pressure must be raised to a high level and the melt temperature must be raised to a moderate level.
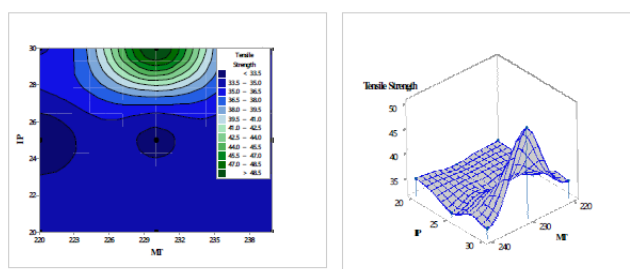
Fig.6.1: (a) Contour Plot and (b) Surface Plot for Injection Pressure (IP) Vs. Melt Temperature (MT) for Tensile

Strength of Virgin Polypropylene
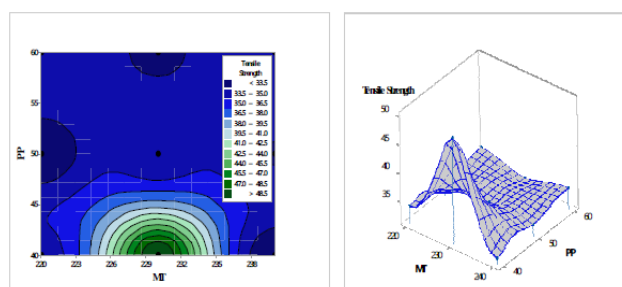
Fig.6.2: (a) Contour Plot and (b) Surface Plot for Packing Pressure (PP) Vs. Melt Temperature (MT) for Tensile strength of Virgin Polypropylene

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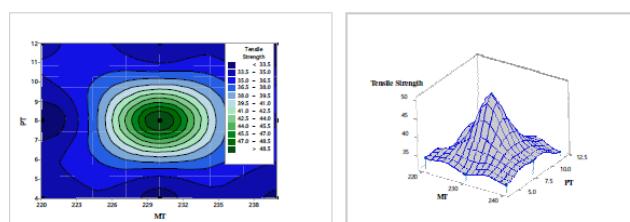
Fig.6.3: (a) Contour Plot and (b) Surface Plot for Packing Temperature (PT) Vs. Melt Temperature (MT) for Tensile

strength of Virgin Polypropylene

Both the contour plot and the surface plot of the tensile strength in response to the processing parameters PP and IP are shown in Fig.6.4 (a) and Fig.6.4 (b), respectively. In thin shell semicrystalline plastic materials, the greatest tensile strength may be attained at Injection Pressure, at a high level, and Packing Pressure, at a low level, as shown in the figure. This can be seen by comparing the Injection Pressure to the Packing Pressure.
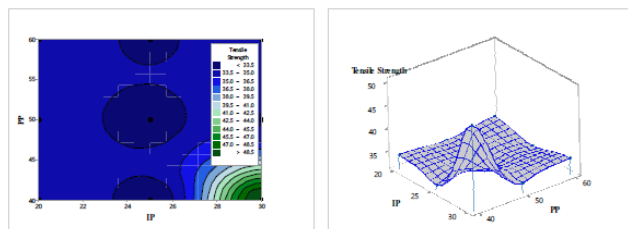
Fig.6.4: (a) Contour Plot and (b) Surface Plot for Packing Pressure (PP) Vs. Injection Pressure (IP) for Tensile

Strength of Virgin Polypropylene
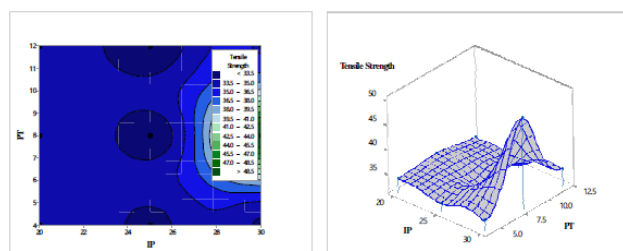
Fig.6.5: (a) Contour Plot and (b) Surface Plot for Packing Time (PT) Vs. Injection Pressure (IP) for Tensile Strength of Virgin Polypropylene

Fig.6.6 (a) represents the contour plot and Fig.6.6 (b) represents the surface plot of Tensile Strength in relation to the processing parameters PT and PP. From this figure, it can be observed that maximum Tensile Strength can be achieved at Packing Time, at medium level and Packing Pressure, at a low level for thin shell semi-crystalline plastic materials.
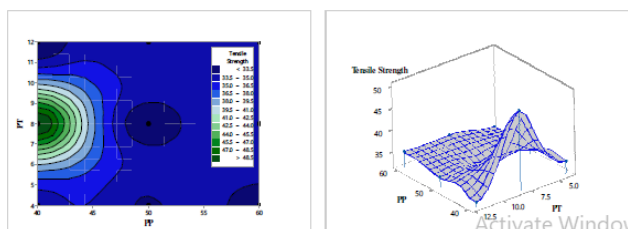
Fig.6.6: (a) Contour Plot and (b) Surface Plot for Packing Time (PT) Vs. Packing Pressure (PP) for Tensile Strength of Virgin Polypropylene

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6.2 Optimal combination of process parameters with the help of Taguchi with Desirability Function

On the basis of the total desirability value calculation described in chapter 5, figure 6.8 is shown here. As a result of its Melt Temperature being at Level 2, Packing Pressure being at Level 3, and Injection Pressure also being at Level 3, Packing Time being at Level 1 has a greater attractiveness value.
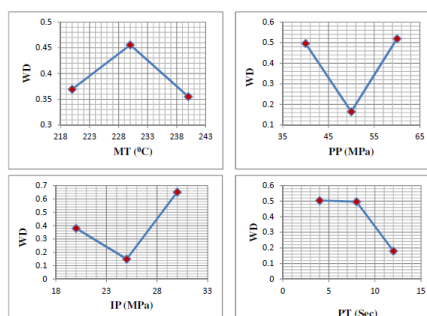
Fig. 6.7 Evaluation of optimal setting for overall desirability Value for Virgin Polypropylene

Table 6.1- Optimal setting for the 100% Virgin Polypropylene Composition by Desirability Function.

Melt Temperature (^{0}C)	Injection Pressure (MPa)	Packing Pressure (MPa)	Packing Time (Sec)
230	30	60	4

6.3 Confirmation Test

For the purpose of carrying out the confirmation test based on a higher desirability value from Fig.

6.32, the melt temperature was set at 230 degrees Celsius, the injection pressure was set at 30 megapascals, the packing pressure was set at 60 megapascals, and the packing time was set at four seconds. This resulted in a tensile strength of 51.34 megapascals and a cycle time of 22 seconds (Table 6.2).

Melt Temperature (^{0}C)	Injection Pressure (MPa)	Packing Pressure (MPa)	Packing Time (Sec)	Tensile Strength (MPa)	Cycle time (Sec)
230	30	60	4	51.34	22

The error of experiment was found to be 3% after a confirmation test and an experimental run, which demonstrates that this method is appropriate for the maximisation of tensile strength and the minimization of cycle time of the plastic products. According to the findings of the investigation, both approaches are appropriate for the procedure.

7. CONCLUSION & FUTURE WORK

From the optimizational study the concluding remarks drawn are as follows:

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1. Tensile Strength can be maximum.

2. Melt temperature at 2300C and 30 MPa injection pressure

3. Melt temperature at 2300C and packing Pressure at 40 MPa

4. Melt temperature at 2300C and 7.5 sec .packing time

5. Injection pressure 30 MPa and 40 MPa packing pressure

6. Injection pressure 30 MPa and 7.5 sec. packing time

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PROLONG THE LIFE TIME OF NETWORK USING MINIMUM ENERGY CONSUMPTION IN MANET

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Abstract

Mobile Ad hoc Network (MANET) are self-structured, individual nodes or routers networks that move about freely, organize themselves randomly and are attached through wireless links that when synchronized, form a dynamic topology. The nodes are required battery power for communication and it is very crucial matter to utilize the battery power of nodes efficiently in network. The battery changing and charging is not possible in that kind of network and the limited nodes lifetime imposes a limitation on the network performance. To take full advantage of the lifetime of nodes, traffic should be finding in a way that energy consumption is minimized. The energy efficient routing is improves the battery life and routing capability of nodes. Proposed a new energy efficient routing scheme with AODV routing protocol to improve the capacity of data delivery and energy utilization. The proposed scheme is efficiently utilizes the energy of mobile nodes through change in the energy of nodes on the basis of their radio range in network utilization. It means the nodes are only contact to nearest neighbor by that the less amount of transmission and receiving energy is required for communication. In this approach the energy utilization and consumption is possible that reduces the improper energy depletion of mobile nodes. The routing performance is calculated through performance matrices and the proposed scheme is provide better performance as contrast to normal energy routing with AODV routing protocol.

Keywords: - MANET, AODV, DSR, CMM-BCR, DREAM, Nodes energy, Routing, Consumption, Delay.

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1.INTRODUCTION

1.1 MOBILE AD HOC NETWORK (MANET)

Mobile Ad hoc Network (MANET) consists of a group of mobile nodes that can be communicated with each other by radio waves without the need to any existed infrastructure. MANETs in general are known with its dynamic topology. The nodes are mobile and their flow is random. MANET"s dynamic topology makes link breakages a continual habit. This

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habit causes many complications such as data loss, delay, and others which degrade the performance of the MANETs protocols. In order to minimize the damage size of this aspect, the idea of link breakage prediction has appeared. In link breakage prediction, a link failure can be predicted before its real occurring so route maintenance can start before they appear of the problem to avoiding the problems that come with a link breakage. In the link breakage prediction, a node in an active route can predict if the link between it and its previous hop will break soon. In this case it can notify the source node about the problem and the source node, if still needs the route, will be able to construct a new route which bypass this soon to be broken link. It has been found that this procedure has made a good change in the performance of the mobile ad hoc network"s protocols, but the problem is that the focusing during constructing a new route was only on rejects the link that was predicted to have a link breakage. This mechanism may cause constructing a new path with some or all bad links from the current used route which are weak but did not predicted to be broken yet. These links may break during or after the constructing of the new route which will cause a high decrease in the packet delivery ratio and a high increment in the packet loss and delay.

In order to improve the idea of link breakage prediction a new approach for link breakage prediction in MANETs. In this new approach, the source node of an active route, after being learned about a link breakage in its current used route, will construct a new route which avoids the use of any link from the present used route. That means excluding all the links in the current route, or in other words, excluding the all current used route not just the soon to be broken link.

1.2 INFLUENCES LINK BREAK ON AD HOC NETWORK

Though there are so many benefits offered by wireless ad hoc networks, the main fragility of the networks is the problem of a broken link. A link is a physical medium, a cordless medium in wireless networks, which connects two or more network devices such as a computer, a router, or a mobile node together. Owing to mobile node motion, the link break problem always occurs in wireless ad hoc networks. The problems greatly clout the throughput, delay, jitter, and other performance metrics of a routing protocol. So, this article is proposed to evaluate the effect of link break problem on routing protocols for wireless ad hoc networks. More precisely, would like to explore the influence of the problem on two type of routing protocols, i.e. table driven and ondemand routing protocols.

1.3 Classification of routing Protocols in MANET's

Classification of routing protocols in MANET"s can be done in multiple ways, but most of these are done depending on routing strategy and network setup [32, 36]. There are various ways to classify MANETs based on the characteristics of their routing protocols. Some typical ways to classify them are the following.

Table-driven routing protocols attempt to continue reliable, up-to-date routing clue from each node to each other node in the network. These protocols demand each node to maintain one

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or more tables to store routing in sequence, and they take action to changes in network topology by propagating updates throughout the network in order to manage a consistent network view. A different method from table-driven routing is source-initiated on-demand direction-finding. This type of direction-finding creates routes only when desired by the basis node. When a node requires a route to a goal, it initiates a route discovery technique within the network. This process is done once a route is found or all possible route permutations have been examined.
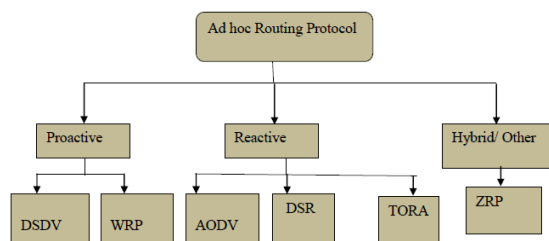
Figure: 1.1 Classification of Routing Protocols in Mobile Ad-hoc Networks [32].

2. . LITERATURE REVIEW

Sheetal Sisodia, Sandeep Raghwanshi et al.[1] "Performance analysis of a Table Driven and On- Demand Routing Protocol in Energy Constraint MANET" during this title addresses energy conservation that may be a important consider Energy Constraint Mobile ad-hoc Networks (MANETs) and attempt to scale back routing overhead for economical functioning of the network. Each protocol offers completely different results relying upon the appliance. Here a tendency to square measure scrutiny to completely different protocols in context of energy Conservation and routing overhead.

Peyman Arebi et al. [2] during this title an approach to projected novel technique supported energy estimation to revive broken links and re constructs the ways of them. Therefore investigate result of broken links on topology management and routing method in unintended network. it absolutely was indicated that these effects were harmful within the mentioned few network parts. During this title has been used Hardware technique for estimation energy in adhoc node, therefore this technique features a high speed.

Ramesh et al. [3] have studied the matter of link breakage prediction within the DSR routing protocol. Their plan is that in the route discovery method, the supply node builds 2 routes that square measure the supply route and another route is used as a backup. The backup route is used if the first route (source route) was foretold to possess a link breakage shortly.

Li et al. [4] have studied the link prediction within the AODV routing protocol by establishing an indication intensity threshold that is Pr-threshold. If the received signal intensity is under the brink, the upstream node can calculate the space between it and therefore the causing node through the intensity of the received data signal, and estimate the

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relative speed between it and therefore the causing node through the time distinction of the neighbouring received information and therefore the intensity of the packet signal. Then, in line with the relative position and therefore the relative speed with the causing node, a node will estimate once to send a RRER to the causing node to warning it a few link failures. Once the supply node received this RRER message, it'll begin its repaired method looking out its routing table and realize another route to the destination.

Qin & Kunz [5] have handled the matter of link failure prediction by proposing associate degree equation to calculate the precise time that a route breakage will occur. They named their technique the link breakage prediction formula. In their plan, every node maintains a table thatcontains the previous hop node address, the worth of the received packet signal power, and therefore the time that this information packet has been received. Once receiving 3 information packets, a node can calculate the link breakage time and compare it with a hard and fast threshold. If the node foretold that the link with its previous neighbour can have a link breakage shortly, it'll send a warning message to the supply node of the active route to warn it concerning the link breakage chance. If the supply still desires the route it'll perform a route discovery method to determine a replacement route to the destination. Their plan has been enforced victimization DSR routing protocol.

Ying Zhu et.al[47] has been projected a "Energy-Efficient Topology management in Cooperative Networks" during this work man of science introduce a brand new topology management downside: name is energy-efficient topology management problem with cooperative communication, and projected 2 topology management algorithms to create cooperative energy spanners during which the energy potency of individual methods square measure secured. Each projected algorithms will be performed in distributed and localized fashion whereas maintaining the globally economical methods by projected mechanism and management the topology amendment behaviour on the bases of energy economical mechanism.

3.PROBLEM IDENTIFICATION & METHODOLOGY

There are so many asset offered by wireless ad doc networks, the main fragility of the networks is the problem of a broken link. A connection is a physical medium, a wireless medium in wireless networks, which connects two or more network devices such as a computer, router, or a mobile node together. Owing to mobile node movement, the link break problem always occurs in wireless ad hoc networks. The problem greatly influences the throughput, delay, jitter, and lots of performance parameter of a routing protocol. Hence, this article is proposed to evaluate the effect of link break problem on routing protocols for wireless ad hoc networks. Some of the problems related to wireless communication are multipath propagation, path loss, interference, and limited bandwidth spectrum. Multipath Propagation is, when a signal travels from its source to destination, among there are obstacles which make the signal propagate in paths beyond the direct line of sight due to reflections, diffraction and scattering. Path loss is the attenuation of the transmitted signal energy as it propagates away from the source. Path loss can be determined as the ratio between the

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powers of the forwarded signal to the receiver signal. This is primarily dependent on a number of factors such as radio frequency and the behave of the area. It is sometimes important to estimate the path loss in wireless communication networks. Due to the radio frequency and the nature of the network are not same everywhere, it is hard to estimate the path loss during communication. This time a number of signals in the atmosphere may interfere with each other resulting in the destruction of the real signal. Limited Bandwidth Spectrum is where, frequency bands are shared by many wireless technologies and not by one single wireless technology [25, 26].

3.1 PROBLEMS IN MOBILE AD-HOC NETWORK FOR COMMUNICATION:

Asymmetric links: Most of the wired networks depend on the symmetric links which are always fixed. But this is not a case with ad-hoc networks as the nodes are mobile and regularly changing their position within network. For example consider a MANET (Mobile Ad-hoc Network) where node B forwards a signal to node A but this does not

tell anything about the quality of the connection in the reverse direction [35].

Routing Overhead: In wireless ad-hoc networks, nodes often change their location within coverage area. So, some stale routes are generated in the routing table which leads to redundant routing overhead.

Interference: This is the main problem with mobile ad-hoc networks as links come and go depending on the forwarding characteristics, one transmission might intersect with another one and node might overhear transmissions of other nodes and can fraudulent the total transmission.

Dynamic Topology: This is also the major complication with ad-hoc routing since the topology is not fixed. The mobile node might move or medium characteristics might change. In ad-hoc networks, routing tables must somehow reverse these changes in topology and routing algorithms have to be adapted. For example in a fixed network routing table renovate takes place for every 30sec [35]. This updating frequency might be very low for ad-hoc networks.

Energy Problem: Mobile nodes are typically powered by batteries with limited energy supply. When a node drains its available energy then in that condition it stops their functioning. This failure may potentially result in partitioning of the entire network. Limited battery power in MANET is the crucial issue and their utilization is also necessary to improve the routing capability.

3.2 METHODOLOGY

Our aim is to minimize routing overhead and save wasteful energy consumption, which helps in

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increasing network lifetime and also helps network work efficiently. To achieve this aim introduced two modules, details of which are provided in our work below. Network parameters taken in consideration are routing overhead, node energy analysis, throughput, end-to-end delay, packet delivery ratio etc. In our work divide our problem statement in two parts named as destination location estimation module and node energy aware methodology that all together improve the efficiency of the network. Here we describe all modules step by step as follows:

4. PROPOSED WORK

4.1 PROPOSED SCHEME FOR ENHANCE ENERGY UTILIZATION

Finally, in this approach apply minimum power requirement base connection creation mechanism that provides efficient way of communication between senders to receiver. Here initially get energy of each node, sending as well as receiving power requirement of each node and routing protocol, after that if sender wants to contact with receiver node than sender initiate route call message and broadcast them that packet received by any node, very first inquiry is a receiver or a forwarder, if that node as a forwarder than calculate energy change by the formula and forward the packet to next hop, at the end if get receiver node by more than one path with loop freedom, than analyse both path power requirement of single packet and select minimum power requirement path for further communication.
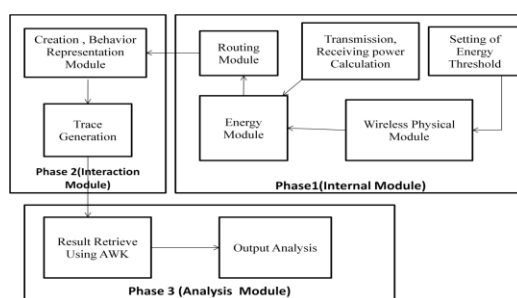
Figure 4.1 Proposed Energy Saving Model

4.2 PROPOSED ALGORITHM

Parameter:

E: Energy

TX: Transmission Power

Rx: Received Power

Txt: Transmission time in sec.

Rxt: Received time in sec.

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Deng: Discharge Energy

Dengit: Discharge Energy in case of transmission power

Dengir: Discharge Energy in case of receiving power

Initialization:

M: {m1, m2........mp..mq..mz} // Mobile node's

S: {s1, s2........si..sj..sn} //set of sender

R: {r1, r2........rk..rl..rm} //set of receiver

E: {e1, e2........ep..eq..ez} //set of energy

AODV: Routing Protocol

MAC 802.11: MAC Protocol

Routine:

S-Broadcast (sid,did,rpkt)

Check if (Node in range)

{

While (i-node==true && i-id != did && ep ==true)

{

If (ep >10)

Forward rpkt to next-hop //calculate tx and rx power of node

{

Dengit = txtit * txit

Dengir = Rxtir * Rxir

Store (Dengir, Dengir,i-id)

}

Else {

Energy is zero

}

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}

If (i-id==did && path > 1)

{

Calculate consume power of each path using Dengir, Dengit

If (path1 consume power < path2 consume power)

{

Select path1

}

Else {path2}

}

}

Else {node out of range}

Algorithm for Route Repair

Routine:

If (established path break)

{

Find reason of disable

If (i-node of established path ep ==0)

{

Search new route from S to R node

Call routine of initial module

}

Else {node out of range}

}

Stop

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5. EXPERMENTAL SETUP

5.1 INTRODUCTION

Network Simulator (Version 2), widely known as NS2, is simply an event driven simulation tool that has proved helpful in studying the dynamic nature of communication networks. Simulation of wired as well as wireless network affairs and protocols (e.g., routing algorithms, TCP, UDP) can be done using NS2. In general, NS2 provides users with a way of identifying such network protocols and simulating their corresponding behaviors. Due to its flexibility and modular nature, NS2 has achieved constant popularity in the networking research community since its birth in 1989. Ever since, all revolutions and revisions have marked the growing maturity of the tool, thanks to substantial contributions from the players in the area. Among these are the University of California and Cornell University who defined the REAL network simulator,1 the foundation which NS is based on. Since 1995 the Defense Advanced Research Projects Agency (DARPA) supported designed of NS through the Virtual Inter Network Test bed (VINT) project. Currently the National Science Foundation (NSF) has added the ride in development. Last but not the least, the group of researchers and developers in the community are regularly working to keep NS2 strong and versatile.

5.2 CONFIGURING AND RUNNING SIMULATION

This step implements the design it consists of two parts:

Network configuration phase: In this phase network components (e.g., node, TCP and UDP) are created and designed according to the simulation design. Also, the events such as data transfer are scheduled to start at a fixed time.

Simulation Phase: This phase starts the simulation which was configured in the Network Configuration Phase. It manages the simulation clock and executes events chronologically. This phase usually runs until the simulation clock reached a threshold cost specified in the

Network Configuration Phase. In most cases, it is convenient to describe a simulation scenario in a Tcl scripting file (e.g., <file>) and feed the file as an input argument of an NS2 calling (e.g., executing "ns <file>").

5.3 SIMULATION ENVIRONMENT

Below shows energy based color code if node energy is greater than the 10 joule that means node is green color but less than 10 joule but above the 1 joule that coded via yellow color and if energy value is zero that means node color is red and all other color represent as sender and receiver node this simulation scenario generated via actual transmission and receiving time, here we also use annotation that represent data transmission between node's.

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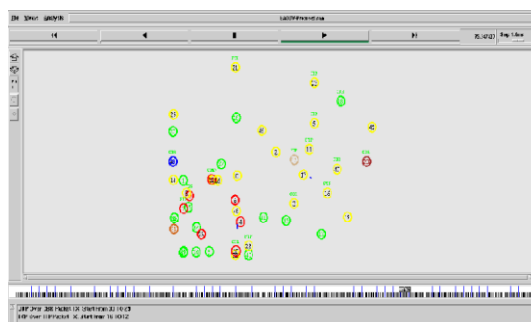
Figure 5.2 Simulation Environment

5.4 SIMULATION PARAMETERS

The following simulation parameters are used to evaluate the performance of normal energy scheme and proposed energy efficient scheme.

PARAMETERS	VALUE
No of Nodes	50
Dimension of simulated area (meter)	800*600
Routing Protocol	AODV
Simulation time(seconds)	100
Transmission range (meter)	250
Transport layer protocol	TCP,UDP
Traffic type	FTP,CBR
Packet size(bytes)	512
Number of traffic connections	12
Maximum speed(m/s)	30

Table 5.A simulation parameters

5.5 SOFTWARE AND HARDWARE REQUIREMENT

Hardware :	
Processor	2.53GHz Intel
Main Memory	2.00 GB
Hard Disk	80 GB
Software :	
Operating System	Windows XP/7
Software	NS 2 (Network Simulator 2.31) MS Word 2007, MS-Excel 2007

Table 5.B Software and hardware requirement

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6. RESULT ANALYSIS

6.1 Died Node Analysis of Nodes in Normal Routing and Proposed Routing

The number of no nodes died in network or completely failure for communication in a given time is mentioned in Table 1. The nodes are utilizes their energy for communication but in proposed energy efficient scheme not a single node is died in network it implies that the nodes having a sufficient amount of energy and not reaches to fully end level.

Table 3 Died Node Analysis

Normal Routing		Proposed Routing	
Time	Node_No	Time	Node_No
57.62497	4	-	-
97.38806	5	-	-
62.14967	6	-	-
80.92668	8	-	-
81.96179	22	-	-
95.0284	23	-	-
54.27771	25	-	-
77.81074	26	-	-
12.0624	29	-	-
29.08781	30	-	-
34.31015	31	-	-

6.2 Lingering Energy Analysis of Normal Routing and Proposed Routing

The Lingering energy analysis or Remaining energy calculation in condition of normal energy aware routing and proposed energy efficient scheme is mentioned in table 2. The proposed scheme is represents that the more amount remaining energy is remains in network that is utilizes for further connection in network. The energy threshold value minimizes the link breakage and limited energy depletion long the network life time in network.

Table 4 Lingering Energy Analysis

Normal Routing		Proposed Routing	
0	17.24666	0	10.12879
1	26.74408	1	69.69549
2	13.04743	2	9.997498
3	17.44575	3	9.997618
4	0.150277	4	10.23502
5	0.042761	5	9.995882
6	0.039734	6	10.12782
7	12.46378	7	57.26759
8	0.31233	8	10.69325
9	51.94572	9	55.5119
10	1.102002	10	12.60523
11	17.65904	11	10.68405
12	58.37517	12	44.29076
13	52.83432	13	43.91882

6.3 Summarized Analysis of Energy AODV And Proposed Energy AODV

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The overall summarized analysis represents the exact network performance i.e. evaluated by performance matrices in case of AODV routing protocol with energy and proposed energy efficient scheme with AODV is mentioned in table 3. The performance of proposed scheme is much better in network because of utilizes the energy for data communication in network but in normal energy with AODV utilizes the more amount of energy in retransmission because of link breakage so, the data receiving in network is about 60 % as compare to proposed routing scheme.

Table 5 Summarized Analysis

PARAMETER	NORMAL AODV	PROPOSED ENERGY AODV	DIFFERENCE	EAODV improvement in %
SEND	3206	5657	2451	43.35
RECV	2805	5232	2427	46.38
ROUTING PKT	10038	4879	5159	51.39
THROUGHPUT	400	850	450	52.49
PDR	87.49	92.49	5	5.40
NRL	3.58	0.93	2.65	74.02
NO of Dropped Data PKT	401	425	24	5.65
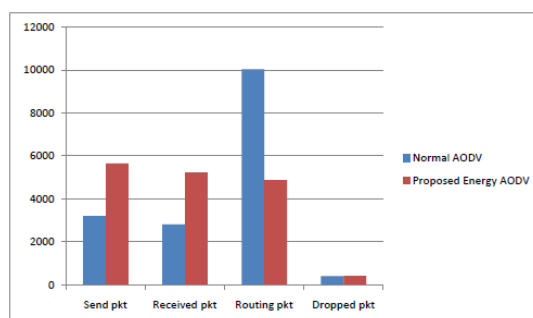
Figure 6.1 Overall analysis graphs

6.4 Packet Delivery Ratio (PDR) Analysis

The packet delivery ratio (PDR) analysis is measured through the packets percentage receiving at destination in a given simulation time in network. The percentage analysis is completely depending on the ratio of numerator and denominator. This graph exemplified the PDR analysis in case of normal energy routing and proposed energy efficient routing in network that minimizes the energy consumption in network. The PDR in normal routing is about 87 % but in case of proposed scheme is about 92 % in network at the end of simulation. The difference of 5 % represents that the improvement in percentage of data receiving. The proposed scheme utilizes the maximum amount of energy in data delivery in network by that the packets receiving is improves in network i.e. also enhance the network performance.

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Simulation time (second)	PDR analysis normal AODV	PDR analysis proposed AODV
10	89	90
20	90	91
30	89	89.5
40	88	90
50	89	91
60	90	92
70	90	91
80	88	91
90	87	92
100	87.5	92.5

Table 6 Packet Delivery Ratio (PDR) Analysis
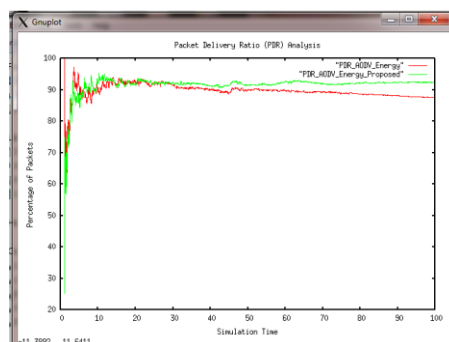
Fig. 6.2 PDR Analysis

7. CONCLUSION & FUTURE WORK

7.1 CONCLUSION

Mobile Ad hoc Network devices connected either directly or indirectly through other nodes and the aim is only one to deliver the data successfully in network. These nodes are typically powered by batteries with limited energy supply. When a node discharges its available energy then in that condition it stops their functioning. This failure may potentially result in partitioning of the entire network. The limited battery power in MANET is the crucial issue and their utilization is also necessary to improve the routing capability. Different study suggests different techniques to handle energy issue in different way. Energy efficiency continues to be a key performance metric as efficient utilization of energy increment the network longevity hence critical in enhancing the network capacity. So this research effort is made to reduce the energy consumption through proposed scheme. The proposed energy saving scheme aim is to minimizing the total power consumption of all nodes in the group i.e. minimizes the number of nodes used to establish connectivity, minimize the control load and so on and at maximizing the life span should be considered. The simulation results are shows that the new scheme is minimizes the energy consumption in retransmission and utilizes the energy for data delivery that enhances the network performance and degrades the possibility of link failure.

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7.2 FUTURE WORK

MANET (mobile ad hoc network) devices mainly based on energy. In future we can use shortest path algorithm with energy constraint. Also use multipath routing protocol for minimize end-toend delay with energy protocols.

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Simulation of Helical Coil Double Tube Heat Exchanger with Baffles by Numerical Investigation
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Abstract
The project aims to study the comparison of nusselt number on the behalf of Reynolds number and baffles in spiral coil tube in tube device. A spiral coil tube in tube device with variety of turns adequate to two and that accommodates three ring formed baffles that area unit placed in annular space between these two spiral tubes is taken into account for study. The most aim of providing baffle is to extend the turbulence so that it increase the convection and the baffles are also provides to support and helps to keep up two coils concentric . The design was modeled exploitation Ansys 16. The hot fluid flows through the tube and cold fluid flows through annular space. The fluid considered is water. The analysis is completed exploitation Ansys fluent. The heat transfer in spiral coil device is analyzed by varied the rate of hot fluid and rate of cold fluid is kept constant. The laminar and turbulent flows are considered for study. K–ε model is employed to model the turbulence within the flow and also the flow is analyzed for counter flow device setup. The variation of Nusselt number with the amendment in Reynolds number of hot fluid is studied. The coil diameter of the spiraling coil is additionally varied to check the result for each laminar and turbulent flow. The D/d magnitude relation is varied from ten to twenty five in steps of five.
Keywords: Helical coil heat exchanger, Baffles, Nusselt number

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1.Introduction

1.1. HEAT EXCHANGERS

Heat exchanger is that devices that square measure used for the transferring heat between totally different temperature fluids which can be directly in grips or could also be flowing severally in two tubes or in two channels[25]. various applications of heat exchangers are often determined in our day these days life, to mention a number of square measure condensers and evaporators employed in refrigerators and air conditioners and just in case of thermal station heat exchangers square measure employed in, condenser, boilers, air coolers and chilling towers[31]. Just in case of cars heat exchangers square measure within the sort of radiators or within the sort of oil coolers in engine. Giant scale method industries and

chemical industries use heat exchangers for the transferring heat between totally different temperature fluids that square measure single section or two section.

1.2. TYPE OF HEAT EXCHANGERS:

Based on Heat transfer method

1. Direct Contact heat exchanger

In direct contact heat exchangers two unmixable fluids are directly mixed and heat transfer happens between two fluids. The specialty of this kind of heat exchangers are the absence of wall separating the hot fluid stream and cold fluid stream. the appliance of this sort of heat exchangers are often found in several places like in air conditioners, water cooling, humidifiers, industrial predicament heating and compressing plants.

2. Transfer type of device

In Transfer style of device two fluid at the same time flows through two tubes separated by walls. This are the foremost usually used sort device owing to simplicity in its construction

3. Regenerators type device

A regenerative device is that style of device within which hot fluid heat is intermittently keeps during a thermal medium so it'll be transferred to the cold fluid. To realize this initial the new fluid is allowed to return in grips with the thermal medium that is sometimes the wall of heat transfer so the fluid is replaced with the cold fluid which can absorb the warmth from the medium.

Based on Constructional options

1. Tubular device

This type of heat exchangers contains two coaxial tubes within which one in all the fluid flows through the tubing and also the second fluid flows through the annulated area. Each the fluids square measure separated by the wall and heat transfer happens through the walls

2. Shell and Tube device

This type of heat transfer contains tube bundles that are ready of tubes and a shell. The fluid that is to be heated or cooled is contained in one set of those tubes. The second fluid flows over the tubes that have to be heated or cooled during this manner fluid are often either heated or absorb the warmth needed.

3. Finned tube device

The principle that is in cooperated during this style of heat exchanger are that with the introduction of fin within the heat money handler the heat transfer capability of the heat

exchanger are often improved. This is often principally employed in gas to liquid style of device and whereas victimization this fin is employed in gas aspect[24].

4. Compact device

A compact device are often outlined as device that has space density (The magnitude relation of the heat transfer area of a device to its volume) for gas worth larger than 700 m2/m3 and for liquid or two-phase stream operation it's greater than 300 m2/m3. Compact device square measure usually cross flow sort wherever two fluid flow perpendicular to every different.

Based on flow arrangement

1. Parallel Flow : In parallel flow heat exchangers the new and cold fluid flows parallel to every different which means within the same direction.

2. Counter Flow In counter flow heat exchangers each the fluids flows in wrong way.

3. Cross Flow In cross flow heat exchangers the two fluid flow perpendicular with relevance each other.

1.3. HELICAL COIL HEAT EXCHANGERS

Helical coil device are recent development that has several blessings compared with straight tube heat exchangers [26].

Advantages:

a. Heat transfer rate of whorled coil is giant compared thereupon of straight tube device.

b. It's a compact structure and needs less floor space compared to different heat exchangers.

c. Self-cleaning.

d. surface area for heat transfer is massive

The application of warmth exchanger covers following areas

1. Air conditioning

2. Power generation

3. Crude oil industry

4. Chilling towers in Thermal station

5. Refrigeration

6. for warmth recovery

2. LITERATURE REVIEW

2.1. INTRODUCTION

In recent decade there was massive growth in computing power and memory capability that has junction rectifier to extend interest for soul, engineers and researchers to simulate their drawback victimization procedure and numerical strategies. Several procedure tools (software packages) and strategies are developed since the last decades to analyses several engineering issues associated with fluid dynamics, combustion, and numerous modes of warmth transfer. Heat exchangers are used for an oversized sort of applications which are a magnet for the researchers and scientists to try and do research associated with heat exchangers [40].

Naphon et al. (2005) has studied heat transfer characteristics of spiral coil device that is subjected to wet-surface conditions, they need done each experimental and numerical studies to seek out heat transfer rate also on predict spiral coil heat exchangers performance. For the analysis they used cooling and dehumidifying condition. The result that they got suggests that rate of mass flow and temperature of body of water air affects temperature of water and air at the outlet. The outlet temperature of air and water decrease with increase in water mass flow. With increase in mass flow of air and water rates the wetness effectiveness and enthalpy decrease.

Kumar et al. (2006) investigated heat transfer characteristics and fluid mechanics of tube in tube whorled coil heat exchanger the experimental work was done on counter flow setup of warmth exchanger and overall heat transfer coefficients was evaluated. The Nusselt selection and friction constant for outer tube conjointly as conduit was calculated thus it's compared with numerical values got from CFD code package FLUENT.

The observation created by them is that overall heat transfer constant increase with inner coil dean selection for constant flow in annulus region

Jayakumar et al. (2008) has done each numerical and experimental study on whorled coil device and he has thought of fluid to fluid heat transfer. the various boundary conditions into account wherever constant heat flux, constant wall temperature and constant heat transfer constant .The observation created was constant values of transport properties and thermal properties of warmth transfer medium ends up in inaccurate heat transfer constant and conjointly in several sensible applications like heat transfer in fluid to fluid heat exchangers discretionary boundary conditions like constant heat flux and constant wall temperature are much not applicable. Supported numerical analysis and experimental work conducted and development of correlations was done to calculate the inner heat transfer constant of whorled coil among bound error limit.

Kharat et al. (2009) has done experiment on concentric whorled coil device to review the warmth transfer rate and develop the warmth transfer constant correlations. The impact of assorted operational variables like diameter of tube, gap between the concentric coils and coil diameter. The gap between concentric coils and tube diameter affects the warmth transfer constants and results obtained by them suggests that with increase in coil gap ends up in the decrease of warmth transfer constant and once tube diameter increase the warmth transfer coefficient will increase.

Jayakumar et al. (2010) has done each experimental and numerical analysis thus on establish the native Nusselt variety variation on circumference and conjointly on length of whorled coil. Variations were created on pitch circle diameter, pipe diameter and tube pitch and the way they have an effect on heat transfer rate was acknowledged. Within the literature Nusselt variety prediction was conjointly done. The variation of Nusselt variety admire angular location of purpose position was conjointly foreseen. The conclusion created by them counsel that heat transfer constant and thus on the bound of whorled coil Nusselt variety isn't uniform and that they have derived associate expression for conniving the Nusselt variety at completely different points on the bound of the whorled coil within the totally developed region. The impact of pipe diameter was conjointly studied and results suggests that for low pipe diameter, the secondary flow is weak and fluid mix is a smaller amount when the diameter of the coil will increase the warmth transfer at the outer surface is highest.

3. FORMULATION

3.1. BASIC ASSUMPTIONS

1. Steady state heat transfer conditions where assumed.

2. Counter configuration is considered for heat exchangers.

3. Conjugate heat transfer between two fluids considered.

4. Natural convection and radiation was neglected.

5. Laminar and turbulent flow cases are considered

3.2. PROBLEM SPECIFICATION

In my study I have considered helical coil tube in tube heat exchanger with ring baffle. The number of turns considered is two. In the inner helical tube hot fluid is flowing and in the outer helical annular region the cold fluid is flowing the ring baffle is placed in the annular region. Number of baffles placed is three and is placed at equal distance from inlet to the outlet. The coil diameter (D) is varied from 125 mm to 250 mm . The thickness of inner pipe and outer pipe is not considered. The pitch is considered as 30 mm. The inner diameter of the pipe (d1) is 8 mm and that of the outer diameter (d2) is 17 mm. The material considered for the pipe of the heat exchanger is copper. Water is used as hot and cold fluid.

In the problem tube diameters are fixed and the coil diameter is varied for both laminar and turbulent flow to study the effect of curvature ratio (D/d).
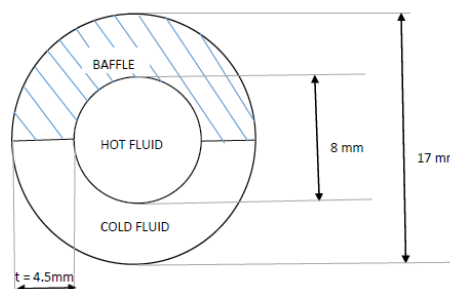
Figure 3.1: Cross section of helical coil tube in tube heat exchanger at the baffle

The thickness of the baffle along the radius in the annular region is varied to study the effect of thickness. The values chosen for the study are t= 3.5, 4, 4.5 mm. and helical coil heat exchanger without baffle is also considered for the study.
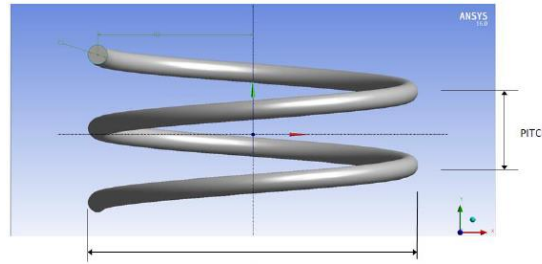
Figure 3.2: Specification of geometry

Table 3.1: Dimensions of helical coil tube in tube heat exchanger

DIMENSIONS	
Coil diameter	variable
Inner tube diameter(d_1)	8 mm
Outer tube diameter(d_2)	17 mm
No: of turns(n)	2
Pitch(H)	30 mm
No: of baffles	3

3.3. CASES CONSIDERED FOR STUDY

Table 3.2: Cases considered for study

SI NO:	CASE NAME	VARIABLES	VALUE RANGE
1	D/d=10 Laminar	Reynolds number and baffle thickness	Re=1500,2000,2500,3000 t (mm)=0,3.5,4,4.5
2	D/d=15 Laminar	Reynolds number and baffle thickness	Re=1500,2000,2500,3000 t (mm)=0,3.5,4,4.5
3	D/d=20Laminar	Reynolds number and baffle thickness	Re=1500,2000,2500,3000 t (mm)=0,3.5,4,4.5
4	D/d=10 Turbulent	Reynolds number and baffle thickness	Re=5000,7500,10000,12500 t(mm)=0,3.5,4,4.5
5	D/d=15 Turbulent	Reynolds number and baffle thickness	Re=5000,7500,10000,12500 t(mm)=0,3.5,4,4.5
6	D/d=20 Turbulent	Reynolds number and baffle thickness	Re=5000,7500,10000,12500 t(mm)=0,3.5,4,4.5

4. METHODOLOGY

4.1 CREATION OF GEOMETRY

The geometry was created in Ansys workbench Design modeler

4.1.1 CREATION OF HOT FLUID REGION

In the inner helical coil, hot fluid is flowing. The sweep option in the design modeler is used for creating the hot fluid zone. For using sweep option a profile and a path is required. The profile and path is created in XY plane. The profile here is a circle whose diameter is the diameter of the spiral pipe and which is at a distance equal to the radius of the coil from the origin. The path here is a straight line along the Y-axis and whose length is equal to the product of number of turns and pitch. The profile and path are created in different sketches in the XY plane. The helical coil is generated by selecting profile, path and number of turns..
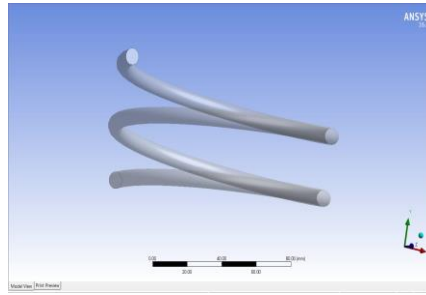
Figure 4.1: Geometry showing hot fluid region

4.1.2 CREATION OF BAFFLES

For creating baffles also we are using sweep option. Semi-circular ring baffles are used in the heat exchanger for creating that the cross section of the baffle in created in a new sketch in the XY plane. The newly created sketch act as the profile .Another straight line in a new sketch is created along the Y-axis this will act as the path .Two such line are created, the length of the line is equal to product of number of turn and pitch after doing two sweep operations we will get two solid bodies then Boolean operation is used .The subtract option in Boolean operation is used and the tool body is not preserved. The same procedure is carried out for making the other two baffles also
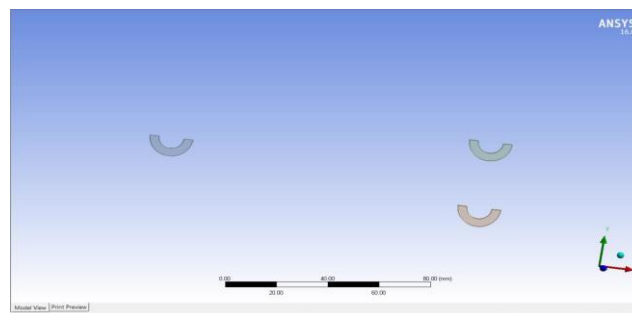
Figure 4.2: Geometry showing Baffles

4.1.3 CREATION OF COLD FLUID REGION

For creating cold fluid region the outer helical coil is made. Sweep option is used for this, the profile used is circular shape with diameter equal to the diameter of the outer helical pipe and the centre is at a distance which is equal to radius of helical coil from the origin .The cold fluid region is obtained by using the Boolean subtraction, the baffles and the hot fluids region are subtracted from the larger helical coil to obtain the cold fluid region.
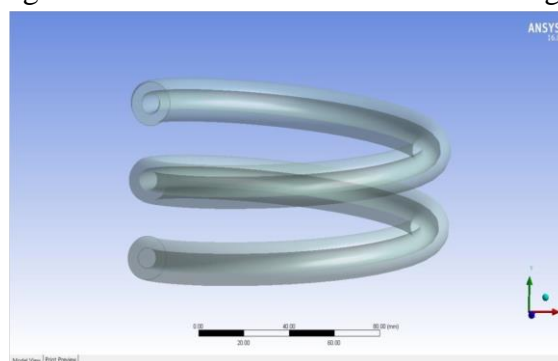
Figure 4.3: Geometry showing cold fluid region
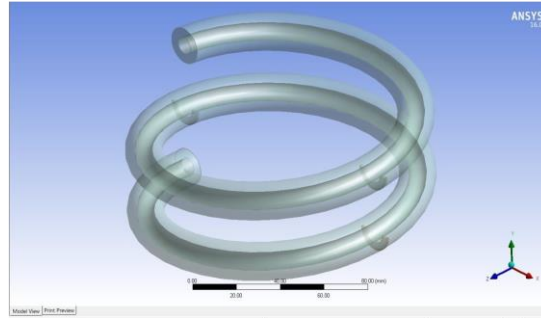
Figure 4.4: Geometry showing hot fluid region, cold fluid region, Baffles

4.2 MESH GENERATION

The geometry should be made sweep able before generating mesh .We can check whether a body is sweep able or not by right clicking on the mesh then go to show option and in that go to sweep able bodies then it will show the sweep able bodies in green colour. Our geometry is not sweep able because it has the imprints of baffles on the hot fluid region and cold fluid region .So now we have to use the slice option (available under create) in design modeler and we should slice the geometry along the planes where the imprints are formed which help us to separate the hot and cold fluid into different small pieces and the body can be made sweep able.
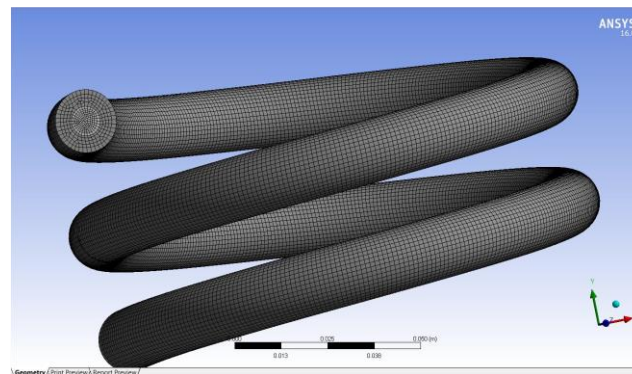
Figure 4.5: meshing of geometry

To apply inflation layer in hot and cold fluid region we have to use inflation option select geometry as hot fluid and boundary as hot fluid wall. In the same way in the cold fluid region inflation layer can be provided
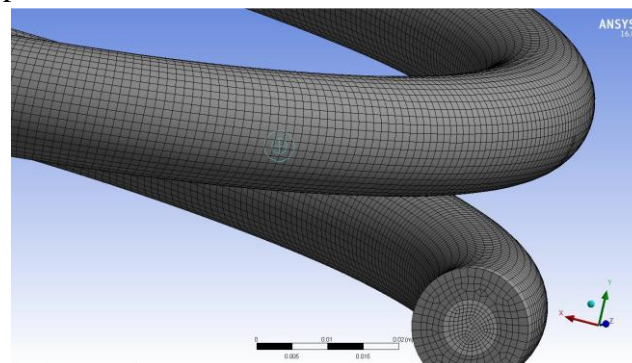
Figure 4.6: Image showing the inflation layer

5. RESULTS AND DISCUSSIONS

5.1 VARIATION OF NUSSELT NUMBER WITH REYNOLDS NUMBER FOR DIFFERENT CURVATURE RATIO

5.1.1 LAMINAR CASE
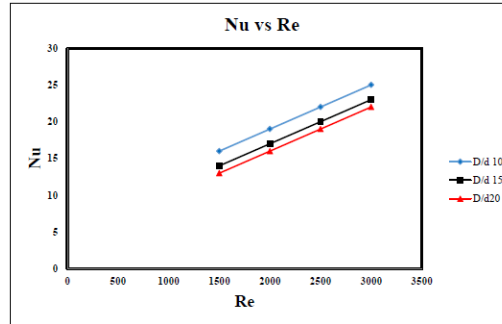
Figure 5.1: Variation of Nu with Re for different D/d ratio for laminar flow

With the increase in value of D/d ratio the value of average Nusselt number is decreasing that is for a particular value of Re the value of Nu will be maximum for D/d = 10 as the value of D/d ratio increases the effect of curvature decreases and the action of the centrifugal force reduces and that is the reason for the decrease in the Nu value. The effect of curvature is the main reason for increase of centrifugal force as the centrifugal force increases it will accelerate the particle and thus results in the increase in velocity of fluid in the helical coil heat exchanger. As the Re increases the value of Nu increases for a particular D/d ratio. The more velocity of the flow will be toward the outer walls in case of helical coil and for less D/d ratio the secondary flow which is the main mechanism of heat transfer in helical coil heat exchanger is also enhanced. As the coil diameter increases the behaviour of Helical coil is tending to that of a straight tube heat exchanger.

5.1.2 TURBULENT CASE
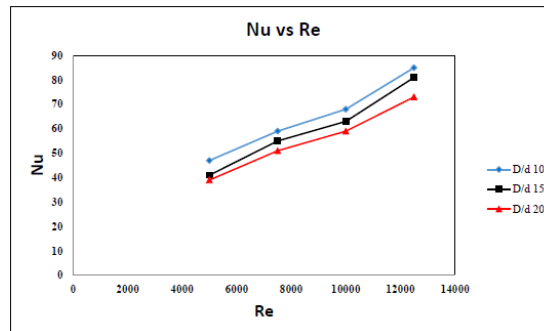
Figure 5.2: Variation of Nu with Re for different D/d ratio for turbulent flow

For turbulent flow also with the increase in D/d ratio the Nu value is decreasing for the same flow rate of the hot fluid as in the case of laminar flow. The reason for reduction in Nusselt number can be explained in the same way as explained for laminar case.

5.2 VARIATION OF NUSSELT NUMBER WITH DIFFERENT THICKNESS OF BAFFLE

.
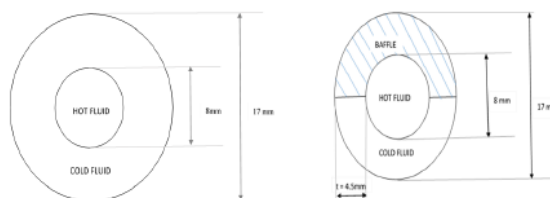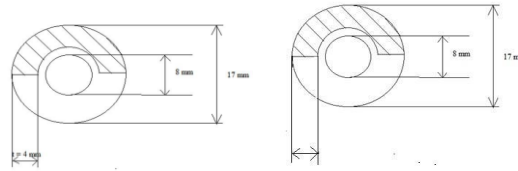
Figure 5.3: Schematic showing the variation in thickness of baffle.

5.2.1. LAMINAR CASES

5.2.1.1. D/d =10
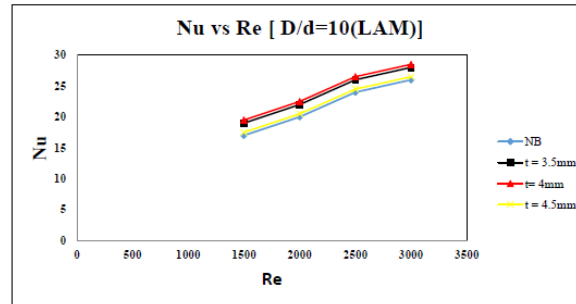
Figure 5.4: Variation of Nu with Re for D/d=10 Laminar flow with different thickness of baffle

The graph above shows the variation of Nu for different Re for hot fluid. The graph shows there is an increase in the Nu value for the case considered with baffle to that without baffle. Nu values.
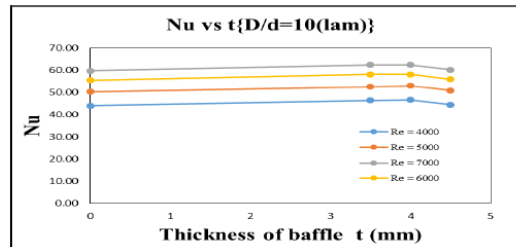
Figure 5.5: Variation of Nu with t for D/d=10 Laminar flow for different Re values

The result shown above clearly indicates that with decrease in thickness of baffle the Nu value is increasing. The lowest value of average Nusselt number is obtained for the case without baffle. For thickness of 3.5mm and 4 mm the value of Nu is more compared to that with no baffle. For baffle thickness of 4.5 mm the value of average Nusselt number is decreasing compared to that with t = 3.5mm & 4mm.

The reduction in Nu value for t = 4.5 mm can be due to the following reason. For t = 4.5 mm the contact area of cold fluid with hot fluid walls is little reduced because the baffle is occupying that area and as the area reduces the convection also reduces which results in low value of Nu. In case of t=3.5 mm and t=4mm there is a gap between the baffle and the hot fluid wall and this gap is very small when flow of cold fluid occurs through this narrow gap the velocity of the flow near the hot fluid wall increases and as a result the convection increases.

5.2.1.2. D/d = 15
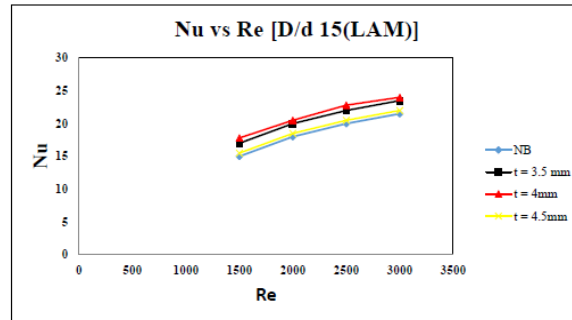
Figure 5.6: Variation of Nu with Re for D/d=15 Laminar flow with different thickness of baffle

The figure above shows the variation of Nu with Re for different thickness of baffle. The Nu value increases with increase in Re value because with the increase in the velocity of the flow convection increases because velocity is an important factor which affects convection.
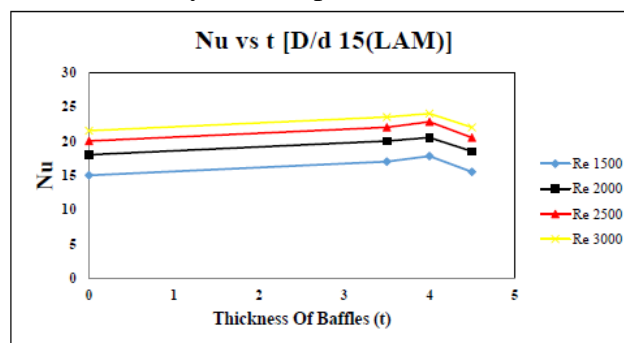
Figure 5.7: Variation of Nu with different thickness of baffle for D/d=15 Laminar flow for different values of Re

This case also follows the same trend as that of D/d = 10 that is with the reduction in baffle thickness the Nu value is increasing. This case shows that for moderate values of D/d ratio the variation of Nu with Re is same as that for low values of D/d and proves that curvature ratio does not have any effect.

5.2.1.3. D/d=20
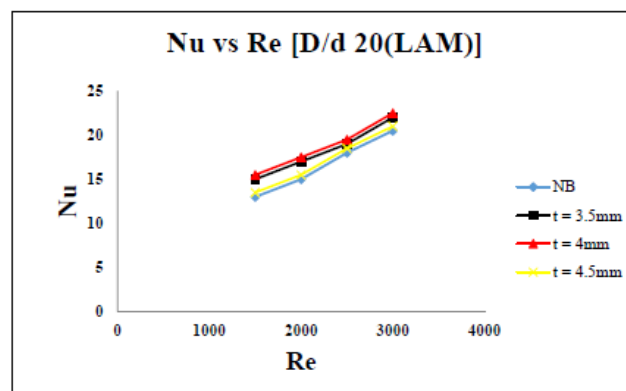
Figure 5.8: Variation of Nu with Re for D/d=15 Laminar flow with different thickness of baffle
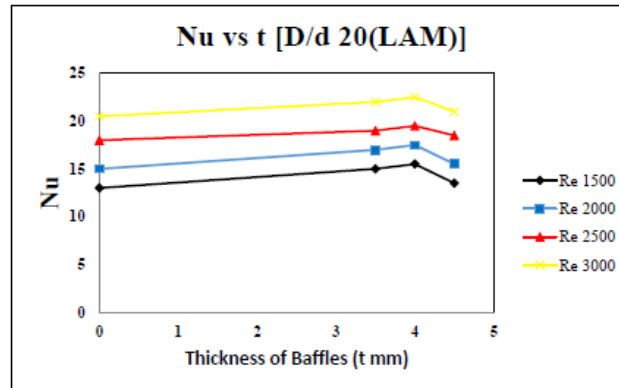
Figure 5.9: Variation of Nu with different thickness of baffle for D/d=15 Laminar flow

This case also follows the same trend as that of D/d = 10 and D/d = 15 that is with the reduction in baffle thickness the Nu value is increasing. This case shows that for high value of D/d ratio the variation of Nu with Re is same as that for low values and moderate values of D/d and proves that curvature ratio does not have any effect.

6. CONCLUSIONS AND FUTURE SCOPE

6.1 CONCLUSIONS

Numerical simulation of helical coil tube in tube heat exchanger has been done with Ansys fluent and the variation of Nusselt number with different baffle thickness and for various D/d ratio and different flow rate of hot fluid has been plotted.

The conclusion drawn are as follows

➢ With increase in D/d ratio the Nusselt number is decreasing, the Nusselt number is maximum for D/d=10 for a particular value of Re this is due to the effect of centrifugal force which is more for small D/d ratios and for high D/d ratio the behavior of helical coil tends to that of straight tube.

➢ For laminar case with baffle thickness of t=3.5 mm and t=4 mm the Nusselt number is increasing compared to case without baffle and thickness of t=4.5 mm.

➢ For Laminar flow for different D/d ratios the Nu variation with Re follow the same pattern.

➢ For turbulent case with baffle thickness of t=3.5 mm and 4mm the Nusselt number is slightly increasing and for thickness of t=4.5mm for low Reynolds number the value of Nu is decreasing and for high Reynolds number Nu value is increasing.

6.2 FUTURE SCOPE

Along with numerical simulation experimental validation can also be done to check whether the results obtained are correct or not.

With the study we were not able to finalize the thickness of the baffle .The thickness of baffle can be optimized for obtaining maximum value of Nusselt number

Now the shape of the baffle is ring shape this shape can be modified. The shape of baffle can be optimized so that less obstruct will occur for the flow

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Innovations in Green Supply Chain Management: Strategies for Enhancing Sustainability in Global Markets

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Abstract

The deepening ecological concerns and growing consumer consciousness have driven sustainability to the forefront of international business strategies. This paper discusses the cutting-edge strategies under GSCM that are propelling sustainability across international markets. It looks at major areas such as green design, sustainable procurement, environmentally friendly logistics, minimization and recycling of waste, and collaborative partnerships. Green Supply Chain Management (GSCM) becomes an important framework for organizations that aim to reduce their environmental impact while being economically competitive Additionally, the paper addresses the contests hindering the widespread adoption of GSCM and suggests solutions for developing a greener and more resilient global supply chain.

In the age of rising environmental issues and heightened consumer consciousness, the need for ecologically friendly business practices cannot be underestimated. This paper examines the pivotal role played by Green Supply Chain Management (GSCM) in pursuing sustainability across global markets. We examine cutting-edge approaches utilized at every phase of the supply chain with a focus on reducing environmental harm, encouraging resource optimization, and supporting circular economy. This study examines new trends in GSCM, such as the incorporation of Industry 4.0 technologies such as blockchain and IoT to improve transparency and traceability, the use of closed-loop supply chain designs for minimizing waste and recovering resources, and the practice of green procurement to promote sustainable sourcing. In addition, we analyze the difficulties and possibilities confronting organizations in managing the intricacies of applying GSCM programs across different global environments, taking into account differences in regulatory regimes, technology infrastructure, and cultural values. The results of this paper help further the understanding of how new GSCM approaches can support the shift towards a more sustainable and resilient global economy, offering insights of importance to businesses, policymakers, and researchers. In conclusion, this study promotes a comprehensive strategy to GSCM that exploits technological innovations, partnership collaborations, and environmental responsibility to attain long-term sustainability gains in fast-changing and competitive global markets.

Keywords: Green Supply Chain Management, Sustainability, Innovation, Global Market

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Introduction

The complex and interconnected supply chains of a global economy bring goods and services to consumers around the world. However, traditional approaches to supply chain practices often cause significant environmental harm, such as resource depletion, pollution, and greenhouse gas emissions. As society becomes more aware of the impact of environmental sustainability, businesses are facing pressure to change their practices to be more sustainable. Green Supply Chain Management (GSCM) takes a strategic approach to sustainability issues by recognizing and incorporating environmental considerations into the entire supply chain, from product design and raw materials sourcing through the manufacturing of products, shipping, and end-of-life considerations.

This paper examines the GSCM strategies aimed at improving sustainability in global markets, specifically various practices and technologies that help transform dysregulation supply chains into environmentally responsible and economically sustainable supply chains.

Core Components of Green Supply Chain Management:

GSCM includes many different processes aimed at reducing the carbon footprint of the supply chain.
Key areas include:

• Green Design: Environmental considerations are integrated into the design of a product to reduce consumption of resources, waste, and pollution over the entire lifecycle of the product. Strategies for green design may include design for end of life, durability, and disassembly, as well as the use of sustainable materials.

• Sustainable Sourcing: It is important to choose suppliers that exhibit commitment to environmental responsibility. This includes evaluating the environmental practices of suppliers, advocating for equitable labor practices, and selecting suppliers who use renewable energy and waste reduction efforts.

• Eco-Friendly Logistics: Transportation and distribution have a major contribution to the carbon footprint of the supply chain. Green logistics involves reducing emissions by optimizing delivery routes, employing fuel-efficient vehicles (electric and hybrid), implementing alternative modes of transportation (i.e. rail and sea), and consolidating shipments

• Waste Minimization and Recycling: It is important to reduce waste at all stages of the supply chain. This can include lean manufacturing, the use of packaging that can be reused or optimized to reduce waste, and have mechanisms in place for recycling of materials and components.

Innovations in Green Supply Chain Management:

Several innovative strategies are emerging within GSCM to enhance sustainability and optimize performance in global markets:

•   Principles of Circular Economy: Circular economy principles go beyond linear take-make-dispose paradigms and are about designing closed-loop systems where resources are

reused and recycled without end. Such techniques include designing durable, repairable, recyclable products and implementing take-back strategies for products, remanufacturing, or material recovery.

• Blockchain Technology for Tracking and Transparency: Blockchain technology creates a secure and transparent platform for tracing products and materials throughout the supply chain. It has the potential to support transparency and accountability, facilitating organizations in verifying suppliers' sustainability credentials as well as verifying eco-friendly products.

• Artificial Intelligence (AI) and Machine Learning (ML): AI and ML can be applied to optimize logistics routes; track and manage demand and inventory levels; and detect the potential for risk in environmental practices in the supply chain. These applications can assist in significantly lowering transportation-related costs, waste, or emissions.

• Sustainable Packaging Innovations: It is crucial to create fresh and innovative packaging techniques that consume fewer resources and produce less waste. This may include providing biodegradable and compostable materials, lightweighting packaging, and exploring reusable packaging alternatives.

• Carbon Footprint Exposure and Reduction Measures: To expose potential carbon footprint and reduction measures, it is necessary to accurately measure the carbon footprint associated with the supply chain. This would include investing and supporting renewable fuels.

•Collaborative Partnerships: It is important to collaborate with suppliers, customers, and other stakeholders to promote sustainability along the wider supply chain. This could include exchanging best practices, co-developing sustainability initiatives, and addressing environmental issues cooperatively.

• Smart Monitoring & Sensor Technology: Employing sensor technology to measure energy consumption, waste creation, and the use of water, can sample data in real time to assist in identifying inefficiencies and addressing resource management.

• Green Finance & Impact Investing: Gaining access to green finance and bringing in impact investments can provide the capital necessary to implement sustainable supply chain initiatives. That could include green bonds, sustainability-linked loans, and other innovative finance.

Review of Literature

2.1. Green Supply Chain Management
Businesses worldwide are acknowledging the significance of viewing environ-mental management programs and operations as continuous efforts that extend be-yond their organizational boundaries [10]. However, past efforts to enhance effectiveness were adversely affected by energy inefficiencies and environmental issues [43]. Therefore, the implementation of GSCM as a viable solution for environmental improvement has gained traction among both scholars and professionals. While the concept was first introduced in the early 1990s, it gained significant recognition and interest around the year 2000, as evidenced by a noticeable rise in scientific publications on the topic [44,45]. GSCM refers to the

incorporation of environmental considerations throughout the entire supply chain, encompassing aspects such as product design, material procurement, manufacturing procedures, product delivery, and post-use product management [46]. According to [47], GSCM encompasses eco-initiatives that span the entire product life cycle, including design, production, distribution, customer use, and disposal. Ref. [48] suggested that GSCM involves integrating eco-friendly principles into every aspect of the supply chain, from material sourcing and product design to transportation, manufacturing, storage, packaging, recycling, and proper disposal at the end of a product's life cycle. While variations exist in the definitions, several shared terms are evident, as identified by [49]. These include 'supply chain environmental management' [50], 'green purchasing and procurement' [51], 'green logistics and environmental logistics' [52], and 'sustainable supply net-work management' [53].

In light of this, GSCM includes various aspects such as designing environmentally friendly products, managing the environment, ensuring high quality, using eco-friendly packaging and procurement methods, implementing green distribution practices, and taking initiatives for the end-of-life of products [54]. Several research studies have shown that GSCM is an emerging and highly important trend in the business environment. Ref. [55] presented a comprehensive framework for a green supply chain, illustrating how GSCM practices cover various aspects such as sourcing raw materials, incorporating sustainable practices in product development, and effectively managing pollution from distribution to disposal and recycling. The categorization of GSCM practices by [56] encompasses a range of areas, such as distribution strategies, transportation, warehousing and green building, reverse logistics, cooperation with customers (CWC), investment recovery, eco-design and packaging, and internal management. According to [57], there are several practices within GSCM, such as managing internal environmental factors, implementing green purchasing, collabo-rating with customers, incorporating eco-design, and ensuring investment recovery. Ref. [58] provided a classification of GSCM practices, including eco-design, environ-mental cooperation, reverse logistics, and GP. Similarly, Ref. [7] categorized GSCM practices as clean production, GP, patents, internal service quality, eco-design, and green innovation.

In the current study, we have implemented practices that have received extensive attention and discussion in the existing literature, specifically, eco-design, green purchasing (GP), and internal environmental management (IEM) [10,12,15,40,42,57]. These practices can be divided into two main categories: those that address the internal aspects of the organization, such as eco-design and internal environmental management, and those that relate to the external environment, such as green purchasing. These practices are crucial strategies that can effectively reduce the environmental impact of an organization's supply chain operations [59]. In addition, they exert significant impact on essential organizational facets such as corporate reputation, competitive edge, and marketing presence [60].

Green Supply Chain Management (GSCM) has emerged as a critical approach for businesses to integrate environmental concerns into their supply chain operations. This literature review aims to explore the evolution, key strategies, challenges, andfuture trendsin GSCM. By synthesizing relevantresearch from various disciplines, this review provides insights into the current state of GSCM and identifies areas for future research and practice.

Evolution of Green Supply Chain Management (1990s-2000s):

The concept of GSCM gained prominence in the 1990s as companies began to recognize the environmental impacts oftheir supplychain activities (Srivastava, 2007). Early studiesfocused onthe integration of environmental considerations intotraditional supplychain managementpractices (Pagell& Shevchenko, 2014). For instance, Carter and Rogers (2008) discussed the importance of green purchasing and supplier selection in reducing environmental footprints.

Key Strategies in Green Supply Chain Management (2010s):
During the 2010s, researchers emphasized the adoption of specific strategies to promote eco-friendly practices within supply chains. Reverse logistics, for example, gained attention as a means to manage product returns and reduce waste (Govindan et al., 2015). Collaborative initiatives such as eco-design and green sourcing also emerged aseffective strategies for integrating sustainability into product development and procurement processes (Zhu et al., 2018).

Challenges and Barriers (2010s):
Despite thegrowing interestin GSCM, severalchallenges hinderits widespread implementation. These include regulatory pressures, lack of stakeholder collaboration, and limited technological capabilities (Seuring& Müller, 2008). Moreover, conflicting objectives between economic and environmental goals often pose dilemmas for organizations seeking to balance profitability with sustainability (Chopra et al., 2011).

Research Methodologies
This research paper aims to explore and analyze various strategies for implementing eco-friendly business practices through Green Supply Chain Management (GSCM). The study focuses on the design and methods employed to investigate the effectiveness of GSCM strategies in promoting sustainability and environmental responsibility within supply chain operations.

Research Design:
The research design for this study is a systematic literature review. This design was chosen to comprehensively gather and synthesize existing knowledge on green supply chain management strategies. By reviewing and analyzing peer-reviewed articles, conferencepapers, andrelevant publications, weaim toprovide acomprehensive overview of the current state of GSCM practices. The systematic literature review approach ensures a rigorous and unbiased synthesis of existing research, allowing for the identification of key trends, challenges, and effective strategies in the field of green supply chain management.

Data Collection Methods:
The primary method of data collection for this research is a thorough review of academic databases, including but not limited to PubMed, IEEE Xplore, ScienceDirect, and Google Scholar. A comprehensive search strategy will be developed using relevant keywords such as "green supply chain management," "sustainable supply chain practices," and "environmentally friendly logistics." The searchwill berestricted to peer-reviewed articles, conference papers, and reputable industry reports publishedwithin thelast decadeto ensure the relevance and currency of the information.

Results:

1. *Adoption of Green Procurement Practices: The literature consistently highlights the adoption of green procurement practices as a fundamental component of GSCM. Organizations are increasingly recognizing the importance of sourcing materialsand productsfrom environmentallyresponsible suppliers. This includes evaluating supplier sustainability practices, adherence to environmental standards, and the overall ecological footprint of the entire supply chain.*

2. *Environmental Performance Measurement: The paper identifies the growing emphasis on measuring and monitoring environmental performance across the supply chain. Key performance indicators (KPIs) such ascarbon emissions, energyconsumption, andwaste generationare crucialfor evaluating the effectiveness of green supply chain initiatives. Advanced technologies, such as blockchain and IoT, are discussed as potential tools for real-time tracking and reporting.*

3. *Collaboration and Partnerships: Collaboration emergesas arecurring themein the literature, emphasizing the need for close cooperation among supply chain partners. Establishing strong partnerships with suppliers, manufacturers, and distributors enables organizations to implement sustainable practices collectively. Collaborative efforts can lead to shared resources, knowledge exchange, and the development of innovative eco-friendly solutions.*

4. *Regulatory Complianceand Certification: The reviewunderscores thesignificance of regulatory compliance and certification in driving green supply chain practices. Organizations are compelled to adhere to environmental regulations and obtain certifications like ISO 14001 to demonstrate their commitment to sustainable operations. Compliance not only mitigates legal risks but also enhances corporate reputation and customer trust.*

Discussion:
1. *Challenges in Implementation: Despite the evident benefits, the literature acknowledges challenges in the implementation ofgreen supplychain practices. These challengesinclude initialinvestment costs, resistance to change, and the complexity of integrating sustainable practices into existing supply chain processes. Addressing these challenges requires a strategic, long-term approach with strong leadership commitment.*

2. *Consumer Influenceand Market Trends: The discussionhighlights thegrowing influence of environmentally conscious consumers on market trends. Organizations that adoptgreen supply chain practices not only meet regulatory requirements but also gain a competitive edge in the market. Consumer preferences for eco-friendly products and transparent supply chain practices are shaping industry norms and driving companies to prioritize sustainability.*

3. *Innovation and Technology Adoption: The incorporation of innovative technologies emerges as a key enabler of green supply chain management. Technologies such as artificial intelligence, big data analytics, and renewable energy sources contribute to the optimization of supply chain processes. Organizations that embrace technological advancements are better positioned to enhance efficiency, reduce environmental impact, and stay ahead in the evolving landscape of sustainable business practices.*

4. *Future Directions and Research Gaps: The review concludes by identifying potential areas for future research and addressing existing gaps in the literature. Further investigation into the socio-economic impact of GSCM, the role of governmentpolicies in promoting sustainability, and the integration of circular economy principles are suggested as avenues for advancing knowledge in the field.*

The researchpaper providesa comprehensiveoverview ofthe strategiesemployed byorganizations in adopting green supply chain management practices. The results underscore the importance of collaborative efforts, technology adoption, and regulatory compliance in achieving eco-friendly business practices. The discussion highlights challengesand opportunities in the field, offeringinsights for both researchers and practitioners aiming to navigate the complex landscape of sustainable supply chain management.

Challenges to Implementing Green Supply Chain Management:
Despite the growing momentum behind GSCM, several challenges hinder its widespread adoption:

• Lack of Awareness and Understanding: Some organizations may not fully understand the advantages of GSCM and what actions they can take.

• Cost Concerns: Implementing GSCM initiatives typically requires initial investment in different technologies, processes, and training, which can be a disadvantage for some organizations, especially small and medium-sized enterprises (SMEs).

• Complexity and Coordination: Managing a global supply chain involves working with multiple stakeholders, and different environmental management systems; this can increase complexity and coordination requirements.

• Lack of Standardized Metrics and Reporting: There is a lack of standardized metrics and reporting frameworks, which can make it challenging to compare environmental performance across supply chains and assess the effectiveness of GSCM initiatives.
• Conflicting Priorities: Organizations may experience competing priorities from environmental sustainability versus economic profitability that can deter prioritization of GSCM initiatives, creating a difficulty for organizations to weigh their financial decisions against the environmental consequences for their supply chain.

• Data Availability and Accuracy: Accurate and reliable data representing environmental performance is required for implementing GSCM. However, this type and level of information is often difficult to obtain, especially from suppliers located in developing countries.

• Geopolitical Risks and Disruptions: Global supply chains are liable to geopolitical risks, natural disasters, and other disruptions that may impact environmental performance.

Strategies for Fostering a Greener Global Supply Chain:
To overcome these challenges and accelerate the adoption of GSCM, the following strategies are recommended:

•Promoting Awareness and Providing Education: It is important to promote awareness of the benefits of GSCM and provide education and training to organizations on the sustainable supply chain practices.

• Standardizing Metrics and Reporting Framework: By establishing standardized metrics and reporting frameworks, researchers and organizations can benchmark environmental performance against one another for comparative purposes across supply chains.

• Financial Incentives and Assistance: Government and other organizations can provide financial incentives, including tax breaks and grants, to reward businesses for exercising GSCM practices

.• Regulatory Frameworks: Government can implement and strengthen environmental compliance regulations to ensure businesses operate leveraging sustainable practices throughout their supply chains.

• Collaboration and Knowledge Sharing: Involving collaboration and knowledge sharing within businesses and governments can provide opportunities for organizations, and stakeholders to implement best practices, and support the adoption of greener global supply chains.

• Developing and Investing into R&D: Organizations should invest in research and development as it could lead to new technologies and elevate the sustainability of supply chains further.

• Implementing Robust Risk Management Strategies: Organizations should implement robust risk management strategies to mitigate potential disruptions and manage the potential environmental impacts of those disruptions to their supply chains.

• Focusing on Long-Term Value Creation: Organizations should focus on long-term value creation by integrating sustainability into their business models.

Conclusion:
GSCM has transformed from a niche concept to a crucial necessity for organizations that function in a global marketplace. Innovative strategies such as circular economy principles, blockchain, AI-driven optimization, and collaborative partnerships enable businesses to reduce their environmental footprint, while also increasing their competitive advantage. Although obstacles exist, collaboration from businesses, government, and other allied stakeholders to advocate for awareness, standardized metrics, financial incentives, and collaboration can lead to a greener and more resilient global supply chain network. Organizations that leverage GSCM can help to advance the future sustainability of our society.

Future Research Directions:
o   The impact of GSCM on financial performance and competitiveness.
o   The role of government policies and regulations in promoting GSCM.
o   The development of standardized metrics and reporting frameworks for GSCM.
o   The application of emerging technologies, such as AI and blockchain, to enhance GSCM practices.

o The challenges and opportunities of implementing GSCM in developing countries.

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A Review of Current Fake News Detection Trends on Social Media

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Abstract

In the past ten years, social networking platforms and microblogging sites like Facebook, Twitter, Instagram, and SinaWeibo have become an essential part of our day-to-day activities. These websites are widely used all over the world by billions of users to share their perspectives and circulate information in the form of messages, pictures, and videos. In addition, social networking platforms have become an integral part of our day-to-day activities. Due to the fact that this type of communication can reach a large number of people in a short amount of time, even governmental organizations make use of it to disseminate vital information through the verified Facebook profiles and official Twitter handles of their organizations. On the otherhand, users can be led astray on a daily basis by a variety of deceptive activities such as propaganda and rumor. In these times of COVID, fake news and rumors are particularly common. They are also spread in a large quantity, which has contributed to the chaos that exists during this difficult period. As a consequence of this, the requirement for identifying instances of fake news in the current environment is unavoidable. In this study, we provide a survey of recent research on the many methods that have been proposed for detecting fake news on the Internet. In particular, we begin by having a conversation about fake news and many different terminologies associated with it that have been thought about in previous research. The second thing we do is bring attention to the many different datasets and online technologies that are openly accessible to the public and that can disprove fake news in real time. Thirdly, we describe approaches for detecting fake news based on two more general domains, namely, the content of the story and the social context in which it was published. In the final part of this article, we take a look at the numerous methods that may be utilized to disprove fake news.

Keywords: Fake news detection, machine learning, deep learning, social media, ensemble techniques, N-gram analysis, Clickbait Detection.

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Introduction

In today's highly connected world, one of the most discouraging things is the prevalence of fake news.The dissemination of fake news occurs at a breakneck speed, affecting millions of individuals every day in the form of clickbait and trigrams [1]. As a result, detecting fake news has become an important issue that is attracting significant research efforts. Fake news detection on social media continually presents a fresh set of difficulties. It is purposely written on social media to give the reader the wrong impression. During the presidential election in the United States in 2016, Facebook was used more for the dissemination of fake news than legitimate news [2]. The detection of false news on social media has drawn the

attention of politicians and scholars. The identification of fake news on social media is particularly significant due to the fact that fake news has the potential to alter the mentality of individuals, societies, and even entire nations. Therefore, it is very vital for readers who read news on social media on a daily basis to be aware of whether or not the news they are reading is true or fake. Therefore, people make it a point to read news from reputable websites or authors at all times. In this study, we give a survey on the state of the art on the many types of fake news and the possible solutions that are currently being discussed. The research in this sector has been going on for a long time, and in the context of India, the negative impacts of propagating fake news are very different from what one may expect they would be. When compared to other social networking sites like Facebook and Twitter, WhatsApp is the primary medium via which fake news is disseminated, in contrast to the situation in other nations. Because of the rise in the number of people using the internet in India—from 137 million in 2012 to over 600 million in 2019—the country is currently confronted with a variety of new issues on a daily basis.

Fig.1:CBSEFake News Datesheet

As a direct result of the Corona virus, the year 2020 was a complete pandemic year. Consequently, the postponement of all of the school and university tests for a period of many months was announced. The CBSE 10th and 12th examinations are typically held in the month of March; however, because to thepandemic crisis, the examinations have been moved to the months of May and June. The only information on the exam that was made public was the timetable; nevertheless, on some social media sites, the actual date of each paper was also displayed, which was incorrect. Students allowed their minds to become distracted by the fake news, and as a result, they began to follow the fake timetable for the exam. All of the students feel a great deal of disappointment after learning that CBSE has not yet published the exam schedule's timetable. This information comes as a surprise to them. This one example of fake news demonstrates how much of a negative impact fake news can have on the lives of actual people. Fake news has the potential to distort people's perceptions of

society and can alter the way that people think. Because of this, it is of the utmost importance to identify fake news before it is disseminated. Therefore, there is a need for a robust and effective module that can quickly be made available in order to spot fake news. Additionally, there should be a reduction in the cost of the module in order to make it accessible to everyone and every requirement.

 Following are the types of fake news:-

1.for entertainment purpose

2.Use a fake image or title for irrelevant content.

3. Misinterpreted information

4. Completely baseless content.

5.Rumors spread by blind followers.

These are examples of the kind of fake news that are widely disseminated via social media. Although the majority of fake news is not inaccurate, it is published for the only aim of providing pleasure. However, because readers do not comprehend the reality of the situation, they alter their behavior in accordance with the topic of the news. Therefore, it is quite difficult for readers to comprehend the goal of news stories, regardless of whether they are published for the purpose of pleasure or for any other purpose. Because of this, it is extremely important to devise a model that is capable of clearly indicating the mission statement of the news organization, so that readers do not become confused.

2. FAKE NEWS

Fake news is described as "false stories that are created and spread on the Internet to influence public opinion and appear to be true," as stated by the Cambridge Dictionary. The term "fake news" has been around for quite some time and has a long history that dates back to the invention of the earliest writing systems. However, with the rise of social media over the past decade, there has been a shift in how news is disseminated that is quite different from the way it is reported by traditional media. The various social media platforms have evolved into an ideal environment for the dissemination of computational propaganda as well as trolling. The expression "fake news" can refer to a number of other things, including satire, yellow journalism, hoax, propaganda, misinformation, disinformation, rumor, and so on. Some of these other concepts are defined further down in this article. Figure 2 provides a visual description that is comparable to the first.

• Propaganda: Propaganda refers to news stories which are created and propagated by a political entity to influence political view.

• Misinformation: It is inaccurate information that is deliberately created and is intentionally or unintentionally disseminated disregarding the true intent.

• Disinformation: It refers to false or incomplete information that is disseminated with the intention to manipulate facts and mislead the target audience.

• Rumors and hoaxes: are interchangeably used to refer to deliberate falsification or fabrication of information that is constructed to seem valid. They present the unverified and inaccurate claims as validated by traditional news outlets.

• Parody and Satire: usually use humor to give news updates and typically mimic mainstream news media.

• Clickbait: Sensational headlines are often used as clickbaits to draw the attention of users and encourage them to click and thus redirecting the reader to a different site. More clicks on the advertisements mean more money.

Figure2:Keyterms relatedtoFake News

RegularInternetusersmayfinditdifficulttodifferentiatebetweeninformationthatisrealandcontent thatisfakenewsasaresultofthegrowingprevalenceofpropaganda,hoaxes,andsatireonline,in additiontotruenewsandreputablecontent.However,thereareavarietyofonlineprogrammesthat can debunkfakenews,suchasAltNews,APFFactCheck,BSDetector,Hoaxy,ReverseImageSearch, Snopes,andPolitiFact.Inaddition,thereareavarietyoffact-checkersallovertheworldwhohavebeen accred online e foun
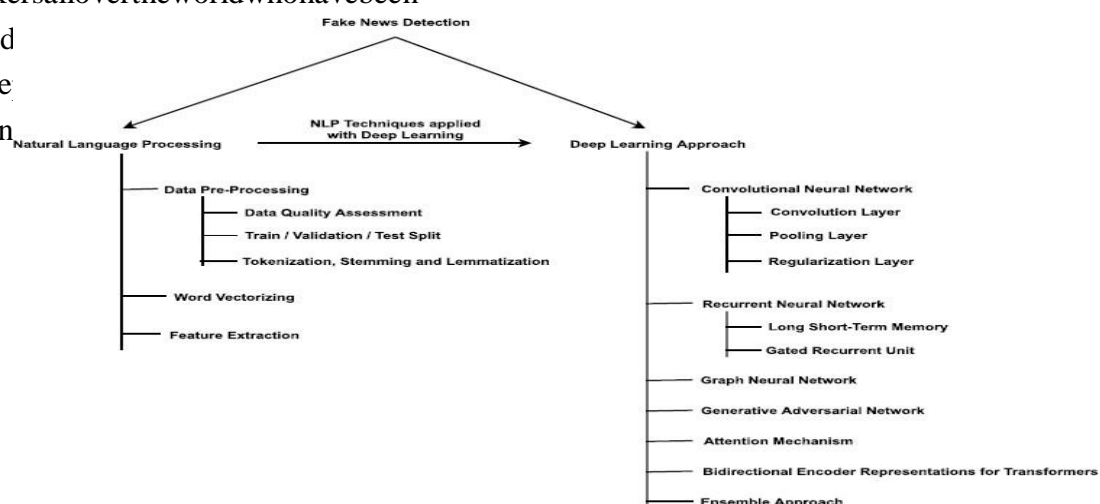
Figure 3:Taxonomyofdeep learning-based fakenewsdetection.

III. BENCHMARK DATASET

In this section, we will talk about the datasets that were used in a variety of different investigations. Benchmark datasets were utilized for both the training and the testing processes. The lack of a labeled benchmark dataset that has ground truth labels that can be relied on in addition to a large dataset is one ofthe obstacles that makes it difficult to spot fake news. Researchers are then able to obtain practical features and create models based on this information [3]. Over the course of the past few years, large datasets have been gathered in preparation for multiple applications in DL and ML. The datasets are extremely distinct from one another due to the various research focuses that were pursued. For instance, some datasets are composed solely of political statements (like the one found on PolitiFact), while others are composed entirely of news stories (like those found on FNC-1) or social media posts (like those found on Twitter). Data sets can be differentiated from one another according to their modalities, labels, andsizes. As a result, we classify these datasets in Table 1 according to the characteristics we just discussed.

Articles that are known to be false are typically culled from dishonest websites that were created with the express purpose of spreading misinformation. These fake news reports are eventually posted on social media platforms by the individuals who created them. It is possible for malicious individuals or bots, as well as inattentive users who do not bother to check the source of the story before sharing it on social media, to contribute to the propagation of fake news. However, the vast majority of databases only include content from news sources. However, the linguistic characteristics and writing style that are now available are not adequate for the development of an effective detection model.

The most well-known datasets that are freely accessible are Fake News, Twitter15, and Liar. However, other studies trained their models using the datasets that they themselves developed [4]. These datasets were categorized as self-collected in our system. It is difficult for us to make an accurate comparison with other research because little information is supplied about

their self-collected datasets. Using the benchmark dataset, however, it is possible to build a comparative study using current state-of-the-art approaches for detecting fake news. They reported an accuracy of 93.50%, which is the highest when using the same dataset for fake news detection, and they did this by doing a comparative study of their suggested model with existing approaches using the Kaggle dataset. This study was conducted by Kaliyar et al. [5,] who used the dataset. Figure 4 provides a pie chart representation of the benchmark datasets that were utilized.
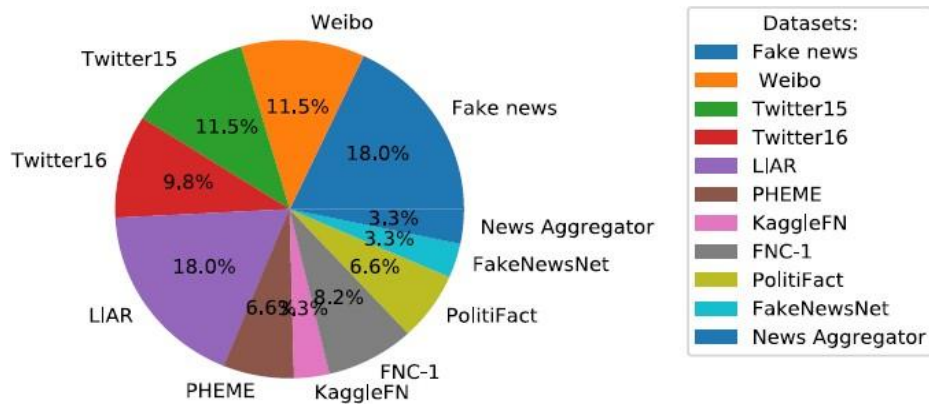
Figure4: Piechart ofthebenchmarkdatasetsoffakenewsdetection.

Dataset	Modality	Size	Labels	Type	URL
Fake news	Text	20,800	Unreliable, reliable	News articles	https://www.kaggle.com/c/fake-news/data.
Weibo [27]	Text & image	40k tweets	Rumor, Non-rumor	Social media data	https://drive.google.com/file/d/14VQ7EWPiFeGzxp3XC2DeEHi-BEisDINn/view
Twitter15 [28]	Propagation trees	1,381 propagation trees, 276,663 users	Unverified, true, false, non-rumor	Social media data	https://www.dropbox.com/s/7ewzdrbelpmrnxu/rumdetect2017.zip?dl=0
Twitter16 [28]	Propagation trees	1,181 propagation trees, 173,487 users	Unverified, true, false, non-rumor	Social media data	https://www.dropbox.com/s/7ewzdrbelpmrnxu/rumdetect2017.zip?dl=0
LIAR [29]	Text	12.8K	Pants on fire, false, barely true, half-true, mostly true, and true	Political statements	https://paperswithcode.com/dataset/liar
PHEME [30]	Text	5800 tweets	Rumor, Non-rumor	Social media data	https://figshare.com/articles/dataset/PHEME_dataset_of_rumours_and_non-rumours/4010619
FNC-1	Text	75K	Agrees, disagrees, discusses, unrelated	News articles	https://github.com/FakeNewsChallenge/fnc-1
FakeNewsNet [31]	Text	5K	Fake, real	News articles, social media data	https://github.com/KaiDMML/FakeNewsNet
News Aggregator	Text	422,937	Real	News articles	https://www.kaggle.com/uciml/news-aggregator-dataset
Bend the truth [32]	Text	900	Fake, real	News articles	https://github.com/MaazAmjad/Datasets-for-Urdu-news.git
FacebookHoax [33]	Text	15,500	Hoax, non-hoax	scientific news	https://github.com/gabll/some-like-it-hoax/tree/master/dataset
Twitter [34]	Text and Image	992	Rumor, non-rumor	Fact-checked claims	https://github.com/MKLab-ITI/image-verification-corpus/tree/master/mediaeval2015

IV. RELATED WORK

Traditionally, the majority of approaches for detecting fake news focus on analyzing the textual content only and utilized hand crafted textual features for the same. But, with an increasing number of articles which are attached with images over the Internet and the extensive use of social media networks, the multimodal features and social-context play a very vital role in better understanding the overall heuristicsof the content. The traditional machine learning and rule-based algorithms are inefficient to detect the patterns in today's information age. Hence, to take advantage of big data Deep learning techniques are investigated for fake news detection.

In the article [6], H. Ahmed and colleagues offer a method for the identification of false news that makes use of the N-gram model to differentiate between true and false information through the application of machine learning strategies. They conducted experiments with linear-based as well as nonlinear-based classifiers and compared the following six different machine learning techniques that are effective at detecting fake news: K-Nearest Neighbor, Support Vector Machine, Logistic Regression, Linear Support Vector Machine, Decision tree, and Stochastic Gradient Descent. The authors have demonstrated their experimental findings by utilizing compiled datasets obtained from truth and inappropriate news sources; hence, there is a high level of anticipation regarding the outcomes of their work. In their trials, they made use of a 5-fold cross-validation method, which meant that around 80% of the validation of datasets was utilized for training datasets, while the remaining 20% was used for testing datasets. Through the utilization of unigram methods and a linear support vector machine classifier, the authors were able to accomplish the highest level of accuracy possible, which was 92%.

The authors of [7] propose a model that, when implemented, would result in the creation of a whole network for the simultaneous learning of a portrayal of news, reports, authors, and titles. They have employed a number of machine learning algorithms, including the following: Long-Short-Term Memory, Support Vector Machine, Convolutional Neural Networks, and K-means closest neighbors and Naïve Bayes both come into play here. The author proposed a model that was originally tested initially using a CNN-based machine learning algorithm that delivers accuracy with 94% in a combined dataset (Liar and Kaggle). However, it has been seen that utilizing the KNN model only predicts 70%, making it the very poorest model. When they have finished analyzing their dataset with SVM, which had an accuracy of 73% and was practically identical to their earlier approach, they will need to present their model after analyzing it with Naive Bayes, which had an accuracy of 91% and was significantly superior. The author has tested their models on information that was obtained from large datasets containing 25680 different pieces of data. Through the utilization of LSTM, it has ultimately accomplished greater accuracy of 97%. The author of this piece of work has committed to achieving the objective of constructing the reliability count with the news by putting feature extraction and credibility scores in a sequential order. This objective will be accomplished via the examination of short phrases and relevant news. Last but not least,they determined that their total accuracy was 94% by using a combination

of three algorithms, namely Naive Bayes, CNN, and LSTM. Furthermore, they determined that, based on their accuracy, recall, and F-1 count on each step, they had successfully attained their performance and effectiveness. Jain et al. (2019) have presented a model that utilizes ML and NLP approaches with the support of a Support Vector Machine (SVM) to compile articles and determine whether the news is authentic or fake in [8]. They have systematized the articles through the use of a support vector machine technique for binary classification, and based on that model, they are able to classify the articles as either real or fake.They have implemented three primary modules in their proposed models, namely an aggregator, an authenticator, and a suggestion or recommendation system, in order to improve the quality of the articles or materials they have produced. The accuracy of 93.50% was attained by the combination of these three algorithms, namely Naive Bayes, SVM, and NLP. In this work, they also tested the articles to determine if they were true or false using the Naive Bayes algorithm. Pew Research Centre in the United States of America published a survey in [9] that suggested that adults acquired almost 70 percent of their news from social media. This information has led to a rise of 9 lakh and 60,000 new members on Facebook as a direct result of the news that Donald Trump has been electedpresident. In this particular piece of research, linguistic elements as well as visual features play a part. Moving on to the network features, it addresses both co-occurrence networks and diffusion networks in its discussion. Therefore, the authors have reached an accuracy level that is approximately 83 percent.The authors of [10] studied the impact that individuals have on social media and found that in 2016, 62 percent of American adults depended on social media for their news, which is 13 percent more than in 2012. Television is the primary medium through which information is obtained. As we have shown, this information can be obtained for either no cost at all or at a very cheap cost, which paves the way for the spread of fake news on this platform. It was the same year, 1439, that the printing press was invented, and this coincided with the beginning of the spread of fake news.

According to the authors of [11], fake news can be broken down into three categories: clickbait, influential, and satirical. The methods of spam detection, stance detection, and benchmark datasets were implemented in an effort to put an end to the spread of fake news. After looking at it further, the author discovered that NLP approaches included sentiment analysis. A topic of fake ne ws that has been discussed is titled "China Airport Security Robot Electroshocks." This event took place in 2016 and wasthe cause of more than 12 thousand fake news stories in China in 2016. These fake news stories were published on 244 different websites as sources. According to the authors of [12], the effect of fake news on our day-to-day lives is much more widespread than previously thought. They talked about the Naive Bayes method, the neural network technique, and the support vector machine method for detecting fake news. The accuracy result for recognizing fake news using Naive Bayes is 96.08%, whereas the accuracy result for detecting fake news using the other two methods, namely Neural Network and Support Vector Machine, is 99.90%. Naïve Bayes is the simpler of the two approaches. The authors of this research are making an effort to convey, through their work, the extent to which the influence of fake news may be felt in the lives of individuals.

They analyze the case of Thailand (2017), which is on the brink of a major catastrophe due to the widespread dissemination of fake news regarding the climate. The authors state that in order to clean the data, they first employ the normalization method before turning to the Machine Learning method.

In [13] the writers observed how to determine whether or not news messages on Twitter were fabricated using the posts. In general, the Authors are working on the Twitter post, specifically determining whetherit is true or fake. They discuss the false information that spread regarding the earthquake in Chile in 2010 as well as the election for president of the United States. The use of NLP has been suggested as a method for identifying fake news. First, the news must be categorized in order to determine whether it is true or fake; then, after that, a variety of models must be employed in order to obtain the result. The primary objective of the writers is to improve the effectiveness of the identification of fake news. As a result, they have incorporated a method of word length that includes calculating the number of words contained within a sentence. Python is the chosen programming language for this project, and the authors have utilized a total of five distinct machine learning techniques. Naive Bayes, Logistic Regression, Support Vector Machine, Recurrent Neural Network, and Long-Short Term Memory are the five various methodologies that fall under the umbrella of machine learning (ML). Because the authors focus on text data, they have used a variety of processing strategies, such as word embedding, count vectors, and TF-IDF, in order to deal with the dataset. The authors have also suggested the use of four feature vectors, which are referred to as Count Vectors, Word-level Vectors, N-Gram Vectors, and Character Level Vectors respectively. The following is a ranking of the machine learning algorithms, which were mentioned before, based on the accuracy they achieved after being applied to four feature vectors:Logistic Regression (69.47) Support Vector Machine (89.34) Naive Bayes (89.06) Recurrent Neural Network (74) Long Short-Term Memory (78) Recurrent Neural Network (74). Therefore, the SVM is the most effective model for identifying fake news.

The authors of [14] have come to the conclusion that the most significant challenge facing society today is social networking. On social platforms, anyone may sign up to be a news publisher, and those platforms are responsible for spreading the news. It quickly led society down the wrong path. Therefore, according to the authors, the platform for disseminating false information is social media. The author has suggested various features that can be used to identify bogus news. These features are features that have been eliminated from the news piece, the news source, and the environment. The detection of fake news also makes use of textual characteristics. The method of image processing is utilized in the process of removing text from films and photographs. There are 141 different aspects of the text that are taken into consideration by the author. There is one collection that has lexical characteristics, semantic features, linguistic features, and psycholinguistic features all gathered together. The author has made use of a classifier in order to evaluate the significance of the attributes. K-Nearest Neighbors, Naive Bayes,Random Forest, and Support Vector Machine are the algorithms that make up the classifier. Both the Area under the ROC Curve and the Marco F1 Score have been utilized by the Author in order to evaluate the performance of each classifier. While the Macro F1 score provides an overview of a classifier's general function, the Area under Curve

is more important for identifying instances of fake news. In 2021 Agrawal, et. al. proposed, structural features with the Modified Bi-directional Long Short Term Memory (MBi-LSTM) method is proposed to improve the efficiency of Fake news detection. The attention layer is introduced in the Bi-LSTM to update the weight value of the input features and Term Frequency – Inverse Document Frequency (TF-IDF), based on the scalar factor. This weight value is updated in the input gate weight value of the Bi-LSTM that helps to find the relevant feature to store in cell. The proper weight in the Bi-LSTM model stores the features related to reliable information in long-term that helps to improve the classification performance. The structural, user, content, and temporal features were extracted from the Twitter data and applied to the MBi-LSTM method. 33 features were extracted for structural, user, content, and temporal features for the classification. The PolitiFact dataset is collected and used for testing the efficiency of the proposed MBi-LSTM method. Additionally, the CREDBANK dataset is also applied to test the effectiveness of the proposed MBi-LSTM method in thecase of a large dataset. The experimental result shows that the proposed MBi-LSTM method has an accuracy of 91% and the Bi-LSTM method has an accuracy of 86.69% in PolitiFact dataset [15].

V. CHALLENGES AND RESEARCH DIRECTION

Despite the fact that numerous studies have been conducted on the identification of fake news, there is always space for future advancement and investigation. Regarding fake news recognition, we highlight challenges and several unique research areas for future research..Although DL-based methods provide higher accuracy compared to the other methods, there is scope to make it more acceptable.

• The feature and classifier selection greatly influences the efficiency of the model. Previousstudies did not place a high priority on the selection of features and classifiers. Researchers should focus on determining which classifier is most suitable for particular features. The long textual features require the use of sequence models (RNNs), but limited research works have taken this into account. We believe that research aimed at feature selection and classifiers can potentially improve performance

• The feature engineering concept is not common in deep learning-based studies. News content and headline features are the widely used features in fake news detection, but several other features such as user behavior [16], user profile, and social network behavior need to beexplored. Political or religious bias in profile features and lexical, syntactic, and statistical-based features can increase the detection rate. A fusion of deeply hidden text features with other statistical features may result in a better outcome.

• Propagation-based studies are scarce in this domain [17]. Network news modelsSpread is information that has not been fully exploited to detect fake news. [18]. Therefore, we suggest that news sharing be considered to identify fake news. Metadata and additional information can add credibility and reduce noise to a single textual statement, but they should be handled with care. Studies focused only on text data for fake news detection, whereas fake news is generated in sophisticated ways, with text or images that have been purposefully altered [19].

Only a few studies have used image features [20], [21]. Therefore, we recommend using visual data (videos and images). Search using videos and images will be an area of research to create a more robust and reliable system.

• Studies that use a fusion of features are scarce in this domain [22]. Combining information from multiple sources may be extremely beneficial in detecting whether Internet articles are fake [19]. We suggest utilizing multi-model-based approaches with later pre- trained word embeddings. Many other hidden features can have a big impact on fake news detection. Hence we encourage researchers to investigate hidden features.

• Fake news detection models that learn from newly emerging web articles in real-time could enhance detection results. Another promising future work is the use of a transfer-learning approach for training a neural network with online data streams.

• More data for a more significant number of fake news should be released since the lack ofdata is the major problem in fake news classification. We presume that more training data will improve model performance. Datasets focused on news content are publicly available. On the other hand, datasets based on different textual features are limited. Thus research utilizing additional textual features is scarce.

• Instead of a simple classifier, using an ensemble method produces better results [23]. By constructing an ensemble model with DL and ML algorithms, in which an LSTM can identify the original article while passing auxiliary features through a second model can yield better results [24]. A simpler GRU model performs better than an LSTM [25]. Therefore, we recommend combining GRU and CNNs to urge the leading result.

• Many researchers have achieved high accuracy by using CNN, LSTM, and ensemble models [26], [27]. SeqGAN and Deep Belief Network (DBN) were notreconnoitre in this domain. We encourage researchers to experiment with these models.

• Transformers have replaced RNN models such as LSTM as the model of choice for NLP tasks. BERT has been used in the identification of fake news, but Generative Pre-trained Transformer (GPT) has not been used in this domain. We suggest using GPT by fine-tuning fake news detection tasks.

• Existing algorithms make critical decisions without providing precise information about thereasoning that results in specific decisions, predictions, recommendations, or actions [28]. Explainable Artificial Intelligence (XAI) is a study field that tries to make the outcomes of AI systems more understandable to humans [29]. XAI can be a valuable approach to start making progress in this area.

VI. CONCLUSION

Fake news is escalating as social media is growing. Researchers are also trying their best to find solutions to keep society safe from fake news. This survey includes the complete

analysis of the classification of false notifications in base a discuss important studies. In-depth knowledge of recent approaches to false reporting risk is essential because the advanced framework is pioneering this field. Thus, we analyzed fake news identification methods based on various strategies. We presented gradation of fake news detection approaches. We have given a short description of the experimental findings of previous studies. In this field, we briefly outlined possible directions for future research. Fake news identification will remain an active research field for some time with the emergence of novel deep learning network architectures. There are fewer chances of inaccurate results using deep learning-based models. We strongly believe that this review will assist researchers in fake news detection to gain a better, concise perspective of existing problems, solutions, and future directions.

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Formulation of Antibacterial Herbal Soap
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Abstract
This study focuses on the formulation of an antibacterial soap using natural herbal ingredients. Due to growing concerns about the side effects of chemical-based soaps and the rise of antibiotic-resistant bacteria, there is increased interest in using plant-based alternatives. In this project, Neem (*Azadirachta indica*), Turmeric (*Curcuma longa*), and Tulsi (*Ocimum sanctum*) were selected for their well-known antibacterial properties. The soap was prepared using the cold process method, and different concentrations of the herbal extracts were tested. The antibacterial activity of the soaps was evaluated against common bacteria such as *Escherichia coli* and *Staphylococcus aureus*. The results showed that the soaps, especially those with higher amounts of Neem,Tulsi and curcumin, were effective in reducing bacterial growth. This suggests that herbal soaps can be a safe and effective alternative to commercial antibacterial soaps.

Keywords: Herbal soap, Neem, Tulsi, Curcumin, Antibacterial, *Staphylococcus aureus*, *E. coli*

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1. Introduction

Herbal products are becoming popular because they are natural, safe, and eco-friendly. Many people now prefer using herbal soaps instead of chemical-based ones. Plants like **Neem**, **Tulsi**, and **Turmeric** are known for helping treat infections, skin problems, and killing germs.

- **Neem** contains natural compounds like azadirachtin and nimbin that kill bacteria.

- **Tulsi** (also known as holy basil) has essential oils that fight bacteria and fungi.

- **Curcumin**, the main compound in turmeric, is known for its antibacterial and anti-inflammatory properties.

This research focuses on making soap using these three ingredients and testing its ability to kill harmful bacteria.

2. Materials and Methods

2.1 Materials Used

- Fresh neem leaves

- Fresh tulsi leaves

- Turmeric powder

- Coconut oil

- Castor oil

- Sodium hydroxide (NaOH – lye)

- Distilled water

- Ethanol (for extraction)

- Bacteria: *Staphylococcus aureus* and *E. coli*

2.2 Preparation of Plant Extracts

- **Neem and Tulsi:** Leaves were washed, dried in the shade, and ground into powder. About 50 g of each was soaked in 100 ml ethanol for 48 hours. The extract was filtered and dried.

- **Curcumin:** 50 g turmeric powder was soaked in ethanol and filtered in the same way.

2.3 Soap Making Procedure (Cold Process Method)

1. Mix coconut oil (70%) and castor oil (30%) and heat slightly.

2. Prepare a lye solution by carefully mixing sodium hydroxide with water.

3. When both mixtures cooled to about 40–45°C, mix them together.

4. Add Neem, Tulsi, and Curcumin extracts (5% each by weight).

5. Stir the mixture until it thickens (reaches trace).

6. Pour into moulds and leave it to set.

7. Cure the soap at room temperature for 4 weeks.

3. Antibacterial Activity Testing

The soap was tested using the **agar well diffusion method**:

- Bacteria (*S. aureus* and *E. coli*) were grown on nutrient agar plates.

- Wells were made in the agar and filled with the soap solution.

- One well had plain soap (without extracts) as a negative control.

- Another had a standard antibiotic as a positive control.

- Plates were incubated at 37°C for 24 hours.

- Zones of inhibition (clear areas where bacteria didn't grow) were measured.

4. Results

The herbal soap showed antibacterial effects, especially against *S. aureus*.

Sample	*S. aureus* (Zone in mm)	*E. coli* (Zone in mm)
Neem-Tulsi-Curcumin Soap	22 mm	17 mm
Normal Soap (no herbs)	0 mm	0 mm
Standard Antibiotic (Control)	25 mm	23 mm

5. Discussion

The results show that the soap made with neem, tulsi, and curcumin can kill bacteria, especially *Staphylococcus aureus*. This may be because:

- Neem destroys bacterial cell walls.

- Tulsi has oils that slow or stop bacterial growth.

- Curcumin damages bacterial membranes and prevents them from multiplying.

The soap works better on gram-positive bacteria (*S. aureus*) than gram-negative (*E. coli*) because gram-negative bacteria have an extra outer membrane that protects them.

6. Conclusion

This herbal soap made with neem, tulsi, and curcumin is effective against harmful bacteria. It can be a good, natural alternative to chemical antibacterial soaps. It may help prevent infections and improve skin health.

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Techno-Economic Evaluation of Hybrid Renewable Energy Systems for Sustainable Power Supply in Residential and Commercial Sectors

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Abstract
The increasing energy requirements in India, particularly in underserved and remote regions, highlight the urgent need for sustainable, affordable, and dependable energy solutions. This research investigates the techno-economic assessment of hybrid renewable energy systems that combine solar photovoltaic, wind, and small hydro sources along with backup and storage technologies. Utilizing HOMER Pro software, the study evaluates different hybrid configurations designed to satisfy the energy needs of both commercial and residential sectors. It analyzes metrics such as Net Present Cost (NPC), Levelized Cost of Energy (LCOE), and the reduction of CO_2 emissions for both standalone and hybrid systems.

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1. Introduction

India is currently witnessing rapid growth in both its population and industrial activities, which has resulted in an exponential rise in energy demand. However, despite notable progress in the energy sector, a significant portion of the population—especially those in rural and semi-urban areas still struggles to access reliable and affordable electricity. Conventional grid extension is often uneconomical in geographically dispersed or remote regions due to high transmission losses and infrastructure costs. Moreover, dependence on fossil fuel-based generation aggravates environmental degradation through greenhouse gas emissions, air pollution, and resource depletion.

To address these challenges, **Hybrid Energy Systems (HES)** have emerged as a promising solution. HES integrates multiple renewable energy resources such as solar photovoltaic (PV), wind turbines, and small-scale hydropower, often complemented by energy storage

systems like batteries. Such systems combine the strengths of different sources, thereby ensuring reliability and reducing intermittency issues commonly associated with renewables. Conducting a detailed **techno-economic analysis** is crucial to determine the feasibility, cost competitiveness, and environmental sustainability of these systems.

This paper evaluates the potential of HES in the Indian context by simulating various configurations using **HOMER Pro software**, focusing on both residential and commercial load profiles. The study aims to provide insights into the economic viability, environmental benefits, and future opportunities of decentralized renewable-based power generation.

2. Objectives of the Study

The main objectives of the study are as follows:

1. **Assess various hybrid energy configurations** using HOMER Pro software to determine optimal system design for different load requirements.
2. **Evaluate cost-effectiveness** by analyzing critical economic parameters such as **Net Present Cost (NPC)** and **Levelized Cost of Energy (LCOE)**.
3. **Contrast environmental impacts** of hybrid systems against conventional systems such as diesel-based or grid-reliant setups, focusing on greenhouse gas (GHG) reduction potential.
4. **Recommend sustainable decentralized energy solutions** that can be adopted in underserved regions of India to improve energy accessibility and security.

3. Methodology

The methodology followed in this research is structured into systematic steps to ensure both technical accuracy and practical relevance:

1. **Load Assessment**:
   - Residential and commercial energy demands were analyzed, considering variations in daily and seasonal consumption.
   - Peak load requirements and base load demand patterns were identified for accurate modeling.
2. **Resource Data Collection**:
   - Solar radiation data was obtained from the Indian Meteorological Department and NASA Surface Meteorology databases.
   - Wind speed data was collected from regional meteorological stations.
   - Hydro potential data for micro-hydro setups was assessed based on flow rates and head availability.
3. **System Modeling in HOMER Pro**:
   - Standalone systems (e.g., solar PV with battery storage) were first modeled to establish baseline performance.
   - Hybrid configurations combining **solar, wind, hydro, and storage** were designed to evaluate performance improvements.
4. **Simulation Runs**:

- o HOMER Pro simulations were executed for each configuration to estimate **energy generation, reliability, NPC, and LCOE**.
- o Different load profiles (residential vs. commercial) were tested.
5. **Sensitivity Analysis**:
    - o Critical parameters such as **fuel prices, resource variability, load growth, and battery cost trends** were varied to assess the robustness of each configuration.
    - o This ensured the results remain valid under changing economic and environmental conditions.

4.Environmental Impact

Hybrid energy systems demonstrate significant environmental advantages:

- **Reduction in Emissions**:
    - o Compared to diesel generator-based systems, hybrids reduce **CO_2 emissions by 60–75%**, depending on configuration.
    - o NOx and SO_2 emissions are almost negligible in renewable-dominant setups.
- **Sustainability Factor**:
    - o By utilizing indigenous renewable resources, dependency on imported fossil fuels decreases, contributing to energy security.
    - o The integration of multiple renewables reduces over-reliance on any single source, minimizing environmental vulnerabilities.
- **Case Example**:
    - o A solar-wind-battery hybrid supplying a 500-household village reduced emissions equivalent to **removing 400 cars from the road annually**.

5. Conclusion

The findings of this study emphasize that hybrid energy systems, when optimized through techno-economic modeling, offer a **sustainable, reliable, and cost-effective** solution to India's energy access challenges. Compared to conventional diesel and grid-reliant systems, hybrid models show superior performance in terms of **economic feasibility, emission reduction, and adaptability to local conditions**.

With India's growing emphasis on renewable energy adoption, decentralized hybrid systems hold immense potential to complement central grid infrastructure, reduce dependency on fossil fuels, and promote rural electrification. Furthermore, they present viable entrepreneurial opportunities for energy startups and cooperatives, aligning with the nation's sustainable development goals.

6. Future Scope

To further advance the role of hybrid energy systems in India, the following future directions are proposed:

- **Real-time Monitoring and IoT Integration**:
  Deployment of **IoT-enabled sensors and smart controllers** to enhance system efficiency, predictive maintenance, and demand-side management.
- **Integration with Smart Grids**:
  Hybrid systems can be integrated with **smart grids** to enable load balancing, demand response, and improved reliability during peak demand scenarios.
- **Advanced Energy Storage**:
  Research on **next-generation storage technologies** such as flow batteries and hydrogen storage can further improve performance.
- **Financial Modeling and Policy Support**:
  Development of innovative **business models** (e.g., pay-as-you-go, energy cooperatives) will encourage adoption in rural areas.
  Policy interventions such as subsidies, carbon credits, and green financing mechanisms can accelerate deployment.
- **Scalability Studies**:
  Further research should explore **scalability of hybrid microgrids** for integration into regional and national-level planning, especially under India's renewable energy mission targets.

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Design and Construction of Compact Hydro Generator:A Comprehensive Study

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Abstract

This paper presents the design and construction of compact hydro generators, which are small-scale hydroelectric systems that converts the potential energyof water to kinetic energy and finally into electrical power. The research investigates the key components, advantages and challenges. Special setion includes construction of compact hydro generator according to IEC standard with detailed example. Results indicate that compact hydro systems offer a sustainable and cost-effective solution forenergy generation, with minimal environmental disruption.

Keywords: Compact generator, hydro power, renewable energy, rotating electrical machine.

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Introduction

The mechanical design of large electric machines is often seen as one of the most traditional and conservative areas of innovation. A simple comparison of the design drawings of modern machines to those created several decades ago reveals striking similarities. Even an untrained eye can notice how little the designs have changed over time. This can be attributed to several factors. One of the most significant is the tendency to rely on proven designs, as these machines are very expensive, and a single failure in design can lead to major issues for the manufacturer. Additionally, operators are more comfortable with familiar designs, as they reduce operational risks.

While mechanical design innovations have been slow, there have been substantial advancements in electrical design. Modern insulation materials, for instance, have led to significant improvements in efficiency at a relatively low cost. For example, according to IEC 60085, the permissible temperature for stator windings, a key element in the electrical design of generators, has increased from class B in the 1950s to class F today. This change alone has led to a 20-40% increase in power output by simply using better insulation materials. Despite these improvements, in recent years, the mechanical design field has seen increased innovation. This is due to rising material and energy costs, as well as shorter design

and production timelines, which have prompted more attention to be given to mechanical design optimization.

Mechanical components of a hydropower system

Turbine: The type of turbine chosen depends on the water flow and head available. Common types include:

- Pelton Wheel: Suitable for high head and low flow.
- Francis Turbine: Good for medium head and flow.
- Kaplan Turbine: Low head & high flow applications.

The potential energy of the water is converted into kinetic energy and then into rotational energy by means of the turbine, which causes rotation of the turbine shaft. This rotation is used to drive a generator to produce electrical energy. To achieve optimum efficiency, the turbine must be adapted to the specific demands of the hydropower plant such as different heads and flow rates
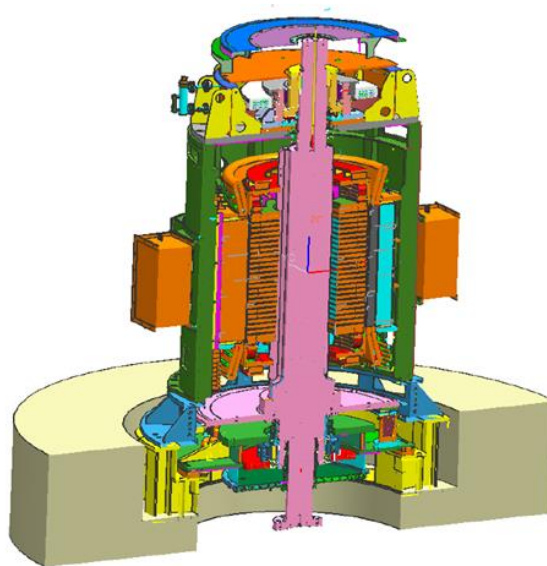
SectionalviewofVerticalHydroGenerator(Source: https://www.scribd.com/document/391562888/Andritz-Hydro-Upgrade-Modermnization-pdf)

Generator: The generator is responsible for converting the rotational energy from the turbine into electrical energy. It is based on Faraday's law of electromagnetic induction which quantifies that if an electric conductor is moved through a magnetic field, electric current will

be induced in the conductor.Depending on the hydropower plant characteristics, the turbine used and the required speed, the following generators are available:

- Vertical shaft generators
- Motor-generators
- PIT type generators
- Bulb generators
- Special machines
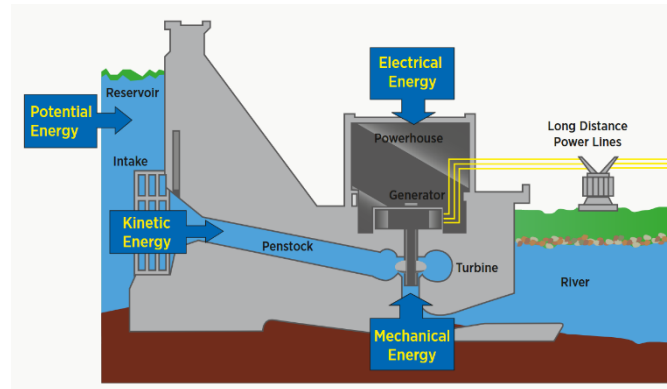
Energy conversion in a Hydropower Plant

Vertical shaft generators are coupled to vertical shaft hydro turbines of any size with outputs up to 840 MVA.

- Mini hydropower plants (from 101 kW to 2MW)
- Compact hydropower plants (units up to 25 MW) according to Central Electricity Authority in India.

A Compact Hydro (CH) Project is the development of hydroelectric power which harnesses energy from flowing or falling water from rivers, artificially created storage dams or canal drops for generation of electricity. Compact Hydro systems are typically designed for areas with limited space and are intended to provideenergy generation for rural areas.

There is no international consensus on the definition of small-scale hydropower, the upper limit varying from 10 - 30 MW. Small-scale hydropower remains a constant, offering cheap, clean, and reliable energy. It is one of the most environment friendly power generation methods available today. Additionally, compact hydro has vast untapped potential in many regions of the world, making it a promising solution for future energy needs. While the technology is largely well-established, there is still significant opportunity for further optimization.

Compact Hydro stands for "water to wire" solutions and offers a single source of supply for the entire electromechanical equipment, as well as factory acceptance test performed units, reduced dimensions for transportation and short installation times.

Advantages of Compact Hydro Generators

- Eco-Friendly: Unlike generators powered by fossil fuels, compact hydro systems use renewable energy sourced from water.

- Sustainable and Dependable: Hydroelectric energy is very reliable, particularly in regions with a steady water flow.

- Affordable Maintenance and Operating Costs: After installation, the costs for maintenance and operation are typically low.

- Environmentally Clean – it does not emit heat or harmful gases.

- Reliable and long service life.

- Quick response to changes in load demand.

- Over 90 % efficiency is achieved

Challenges

- Initial Investment: While the setup and installation of a compact hydro system can be costly, the long-term advantages typically justify the expense.

- Site Constraints: The efficiency of the system is largely influenced by the available water flow and head, which restricts its use to specific locations.

- Environmental Considerations: Although the impact is less significant than that of large dams, even small-scale systems can impact local ecosystems if not carefully designed.

- Project clearance is time consuming process

Components of Compact Hydro Generator

1. Stator complete
   a. Stator frame
   b. Upper bracket
   c. Lower bracket
   d. Stator core (stator sheet)
   e. Stator winding (stator coil/bar)
   f. Core fixing
   g. Stator terminals

2. Rotor complete
   a. Shaft
   b. Laminated rim assembly
   c. Fan DE and NDE with fixing
   d. Thrust collar
   e. Poles (pole sheet, endplate, winding, damper)
   f. Rotor winding connection

      g. Rotor leads

      h. Balancing weights

      i. Cover for rotor DEand NDE

      j. Exciter shaft with adapter flange

      k. Flywheel

3. Covers

      a. Air shield DE and NDE

      b. Cooling air duct

      c. Generator top cover

      d. Terminal cover line & neutral

4. Bearings and supports

      a. Upper combined thrust and guide bearing

      b. Lower guide bearing (depends on construction)

5. Exciter

      a. Exciter stator includes frame and core wound

      b. Exciter rotor includes wound, diode wheel, fan, slipring etc.

      c. Exciter slipring housing

      d. Exciter brush holder bracket

6. Auxiliary system

      a. Bearings oil system

      b. Cooling water plant including piping

      c. Brake system with brake piping

7. Erection & transportation devices

Construction of Compact Hydro Generator

IEC 60034-7 Rotating electrical machines - Part 7: Classification of types of construction, mounting arrangements and terminal box position (IM Code) standard is followed for construction of Hydro Generator.

Taking an example of one IM 4015 (V10) - Combined Bearing (thrust & guide) on top and Guide Bearing on bottom type machine.

Code I (alpha-numeric designation)

IM V10

IM – International Mounting

V – Vertical

10– 2 end shield bearings, with flange, Special flange at D-end, Mounted on D-end side of flange, D-end down

(An optional letter for terminal box location)

Code II (all-numeric designation)
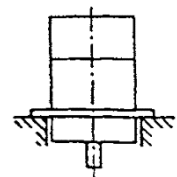
The first, second and third numerals designate aspects of construction.The significance of the second and third numerals is specified depending on the first numeral with which they are associated.

The fourth numeral designates the type of shaft extension.

When used, a letter following the four numerals shall designate the terminal box position.

IM 4015

IM – International Mounting

4 – Flange-mounted machines with endshield bearing(s) only, with a flange not part of an endshield but an integral part of the frame or other component

0– number of bearings - 2, flange position - D-end, access to back of flange - yes, face of flange faces towards - D-end

1 – D-end down

5 – One flanged shaft extension
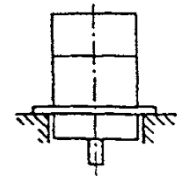
This type of construction used in these Hydro Projects:

Nam Kong 3, Lao PDR

Total output: 54 MW
Scope: 3 × 18 MW
Head: 96.4 m
Voltage: 11 kV
 Speed: 500 rpm
Runner diameter: 1,534 mm

Nam Kong 3 Generator Complete
(Source:https://hobomaps.com/NamKong3Dam.html)

Tolga, Norway

Scope:	3×15.41 MW
Head:	88 m
Voltage:	13.2 kV
Speed:	428.6 rpm
Runner diameter:	1,500 mm

Powerhouse of Tolga
(Source:https://www.andritz.com/hydro-en/hydronews/hn36/tolga-norway)

Conclusion:

The mechanical design of large electric machines, particularly within hydropower systems, has undergone notable advancements, although more slowly than electrical innovations. Historically conservative in nature due to the reliance on proven designs, mechanical engineering for these systems has faced pressures from rising material costs, energy demands, and tighter production timelines, which have necessitated more design optimizations. While the turbines and generators of hydropower plants remain largely traditional in design, modern compact hydro systems present a promising evolution, especially for decentralized energy generation in rural and constrained environments.

The development of compact hydro power plants has emerged as a sustainable and eco-friendly solution for clean, reliable energy. Their ability to harness water efficiently, with over 90% operational efficiency, highlights the potential for widespread use, particularly in regions with steady water flow. Though challenges such as high initial investment, site-

specific limitations, and environmental impacts remain, the long-term benefits—low operating costs, minimal environmental footprint, and rapid response to load changes—make compact hydro systems an increasingly attractive option for the future.

As the industry continues to evolve, further optimization in both mechanical and electrical designs will be crucial to enhancing efficiency and overcoming existing challenges. The continued integration of advanced materials, as demonstrated in electrical design, combined with innovative mechanical systems, could unlock even greater potential for hydropower plants, particularly in compact configurations. With the growing global demand for clean energy and the ongoing push for innovation in mechanical designs, compact hydro offers a promising solution to meet future energy needs while reducing environmental impact.

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Seismic Retrofitting of Existing Structures in High-Risk Zones: A Comprehensive Review

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Abstract

Seismic retrofitting has emerged as a crucial intervention strategy for existing building stock, particularly in regions classified under high seismic hazard zones such as Zone V in India. Many of these structures were designed and built under outdated codes or without due consideration of seismic forces, rendering them vulnerable to collapse during strong earthquakes. This review synthesizes the state of knowledge on retrofitting techniques, performance evaluation, and sustainability considerations for existing reinforced concrete (RC) and masonry structures. Traditional approaches such as jacketing, shear wall insertion, and foundation strengthening are compared with modern solutions including energy-dissipating devices, tuned mass dampers, self-centering braces, and externally attached sub-structures. In addition, the review highlights integrated approaches that combine seismic and energy retrofitting, enabling sustainable, cost-effective, and resilient interventions. A critical analysis of challenges, research gaps, and future directions is also presented, emphasizing optimization, advanced simulation tools, and policy frameworks. The findings underline the need for holistic and performance-based design approaches to retrofit existing structures in high-risk seismic zones, ensuring safety, compliance with evolving codes, and long-term resilience.

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1. Introduction

Earthquakes are among the most devastating natural hazards, causing widespread loss of life, property damage, and socio-economic disruption. The Indian Seismic Zoning Map (IS 1893:2016) identifies **Zone V** as the highest risk zone, where expected ground shaking is intense and catastrophic structural failure is possible without adequate seismic design. Many buildings in this zone, especially those constructed before the enforcement of modern seismic codes, lack essential ductility and detailing measures, making them highly vulnerable.

Globally, similar challenges are observed in earthquake-prone regions such as Japan, Italy, Turkey, Chile, and the U.S. west coast. Retrofitting existing structures, rather than demolishing and rebuilding, is increasingly recognized as a technically viable and economically favorable solution. This review consolidates global and regional knowledge, highlighting critical retrofitting strategies that improve safety, extend the lifespan of structures, and reduce the socio-economic burden of post-earthquake recovery.

2. Seismic Vulnerability of Existing Structures

2.1 Outdated Design Codes

Older buildings often adhere to outdated seismic provisions that underestimate ground accelerations and ignore ductility requirements. For example, pre-2002 Indian codes lacked adequate specifications for detailing, leaving many RC and masonry buildings deficient.

2.2 Aging and Material Deterioration

Structural performance degrades due to material aging—steel corrosion, concrete cracking, and bond failure. Combined with poor construction practices, these deficiencies amplify seismic vulnerability.

2.3 Change in Occupancy and Load Demands

Buildings originally designed as residential may later be converted to commercial or institutional use, introducing higher live loads and increased importance factors. Without structural upgrading, these changes compromise safety.

2.4 Poor Construction Practices

Widespread reliance on unskilled labor, lack of quality control, and non-engineered construction has produced weak structures that cannot withstand seismic demands.

2.5 Socio-Economic and Regulatory Pressures

Authorities increasingly mandate upgrades for critical facilities such as hospitals, schools, and heritage buildings in high seismic zones. The objective is to safeguard human lives while preserving economic stability.

3. Retrofitting Approaches

3.1 Conventional Strengthening Methods

- **Column Jacketing**: Adding reinforced concrete (RC), steel, or fiber-reinforced polymer (FRP) jackets around deficient columns enhances axial and flexural capacity.
- **Beam Strengthening**: FRP wrapping or steel plating improves flexural and shear strength.

- **Shear Wall Addition**: Introducing RC shear walls increases lateral stiffness and load resistance.
- **Foundation Strengthening**: Encompasses underpinning, micropiles, and enlargements to enhance soil–structure interaction capacity.

These approaches are reliable but often invasive and labor-intensive, making them less suitable for fully occupied or heritage structures.

3.2 Energy Dissipation Devices

Passive dampers dissipate seismic energy, reducing structural demands:

- *Viscous Dampers*: Modeled by Aydin et al. (2019), optimized for distribution and cost-effectiveness.
- *Friction Dampers*: Demonstrated by Moon et al. (2017) to enhance seismic resilience of low- to mid-rise RC buildings.
- *Steel Slit Dampers*: Lee & Kim (2017) introduced compact, high-performance designs that absorb seismic energy efficiently.
- *Hybrid Devices*: Kim (2019) proposed slit–friction hybrid dampers and self-centering systems with preloaded tendons.

These devices are attractive due to adaptability, energy efficiency, and minimal disruption during retrofitting.

3.3 Self-Centering and Dissipative Systems

Recent innovations address the limitation of residual drifts post-earthquake:

- *Self-Centering Post-Tensioned Frames with Friction Dampers (SC-PC-FD)*: Nour et al. (2020) validated these using cyclic tests, showing improved collapse resistance.
- *Self-Centering Dissipative Braces (SCDBs)*: De et al. (2024) proposed displacement-based design strategies, demonstrating superior resilience compared to conventional dissipative braces.

3.4 Tuned Mass Dampers (TMDs)

Traditionally applied in high-rise buildings, **non-conventional TMDs** with higher mass ratios are now proposed for retrofitting. Marrazzo et al. (2024) showed reductions of 30–40% in displacements and accelerations, making TMDs an effective retrofit for older buildings.

3.5 Externally Attached Sub-Structures

Cao et al. (2022) reviewed **external sub-structure retrofitting**, where new frames, braces, or wall systems are externally attached to existing buildings. These improve overall seismic behavior without significantly disturbing interior functionality. Applications are promising for hospitals, offices, and critical infrastructure.

3.6 Integrated Seismic and Energy Retrofitting

Recent studies (Bergami et al., 2024; Clemett et al., 2023) demonstrate the cost-effectiveness of combined retrofitting, addressing both seismic safety and energy performance. Approaches using life cycle assessment (LCA) frameworks evaluate economic costs, environmental impacts, and energy savings, aligning with sustainability goals.

4. Comparative Analysis of Retrofitting Techniques

Table 1 summarizes key features, advantages, and limitations of various retrofit methods.

Method	Advantages	Limitations
Column/Beam Jacketing	Proven, code-compliant, increases strength	Labor-intensive, disrupts occupancy
Shear Walls	Significant stiffness, effective for tall buildings	Alters architecture, heavy loads on foundation
Viscous/Friction Dampers	Energy dissipation, adaptable	Needs careful tuning, added costs
Slit/Hybrid Dampers	Compact, efficient energy absorption	Requires advanced design
Self-Centering Braces	Eliminates residual drifts	Limited standardization
TMDs	Significant reduction in displacements	Requires space, cost considerations
External Sub-Structures	Non-intrusive, system-level improvement	Complex connections, high cost
Integrated Seismic + Energy Retrofit	Sustainability benefits, cost-effective in long run	High initial investment

5. Recent Advances and Future Trends

1. **Optimization Techniques** – Use of genetic algorithms, adjoint methods, and multi-objective optimization for damper placement and brace sizing.

2. **Advanced Simulation Tools** – Nonlinear time-history analysis, fragility analysis, and incremental dynamic analysis for realistic performance assessment.
3. **Multi-Hazard Considerations** – Designing retrofits not just for earthquakes but also for wind, fire, and climate hazards.
4. **Sustainability Focus** – Integration of renewable energy systems and energy efficiency in retrofitting projects.
5. **Policy and Code Evolution** – Increasing incorporation of performance-based design frameworks in codes (e.g., FEMA P-58, ATC-40, Eurocode 8, IS 1893).

6. Challenges and Research Gaps

- Lack of **standardized retrofit guidelines** for diverse building types in India and other developing nations.
- Limited **cost-benefit analyses** considering social, environmental, and long-term resilience factors.
- Need for **large-scale experimental validation** (shake table tests, field demonstrations).
- Barriers in **implementation**, including funding constraints, public awareness, and disruption to occupants.
- Integration of **digital tools** (e.g., BIM, digital twins) for real-time monitoring of retrofit performance remains underexplored.

7. Conclusion

Seismic retrofitting is an indispensable strategy to safeguard existing structures in high-risk seismic zones like Zone V. This review highlights the breadth of available methods, from conventional strengthening to advanced energy-dissipating and self-centering devices. Integrated seismic-energy retrofitting emerges as a sustainable pathway, aligning safety with environmental and economic objectives. While significant advances have been made, challenges persist in standardization, optimization, and widespread implementation. Future research should emphasize performance-based design, sustainability integration, and digital innovation to ensure safer, resilient, and sustainable built environments.

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AN ENERGY EFFICIENT APPROACH IN WIRELESS SENSOR NETWORK

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ABSTRACT:-Wireless sensor networks (WSNs) consist of a large amount of tiny sensor nodes. Oneof the important issues in wireless sensor network is the inherent limited batterypower within the sensor nodes. Therefore, battery power is crucial parameter in thealgorithm design in maximizing the lifespan of sensor nodes. It is also preferable todistribute the energy dissipated throughout the wireless sensor network in order tomaximize overall network performance. Hence a hierarchical cluster-based structurecan be used to deal the self-organization issues of large networks. This cluster-basedorganization can prolong network lifetime and reduce the broadcast overhead. Wepropose a new type of energy-efficient approach which maximizes the distancebetween cluster head and gateway by a neighbor node discovery mechanism.Furthermore, a parent/child cluster head scheme is introduced as a useful means of further improving the energy-efficiency. In this approach, energy efficiency isdistributed and network performance is improved by selecting parent/child clusterheads on the basis of the residual energy of existing cluster heads. In this work wecompare the energy efficiency of single-hop and multi-hop taking into account circuitenergy consumption as well as transmission energy. This work explore when multihoprouting is more energy efficient than direct transmission to the sink and theconditions for which the two-hop strategy is optimal. It is not enough to reduceoverall energy consumption, it is also important to maximize the lifetime of the entirenetwork, that is, maintain full network connectivity for as long as possible. This paperconsiders different multi-hop scenarios to compute the energy per bit, efficiency andenergy consumed by individual nodes and the network as a whole.Keywords: Helical coil heat exchanger, Baffles, Nusselt number

1.Introduction

1.1 INTRODUCTION

A Wireless Sensor Network (WSN) is an engaged remote system that includes varioussensor hubs orchestrate in a predetermined territory for checking environment conditions,for example, temperature, pneumatic force, mugginess, light, movement or vibration, etc.The sensor hubs are normally customized to gather data from encompassing environmentand transfer to the base station for remote client access through distinguishcorrespondence advances. Figure 1.1 shows general wireless sensor system structuralengineering. Ordinarily, a sensor hub is a little gadget or bit that comprises of four

fundamental segments as appeared in Figure 1.2:

1) Processing subsystem for information preparing and information putting away.

2) Sensing subsystem for information gathering from its surroundings environments.

3) Energy supply subsystem which is a force hotspot for the sensor node.

4) Wireless correspondence subsystem for information transmission.

Be that as it may, sensor hubs have little memory, moderate handling speed, and

restricted vitality supply. These confinements are run of the mill attributes of sensor hubsin wireless sensor networks.
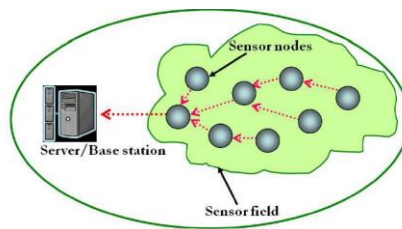
Figure 1.1: Wireless Sensor Network
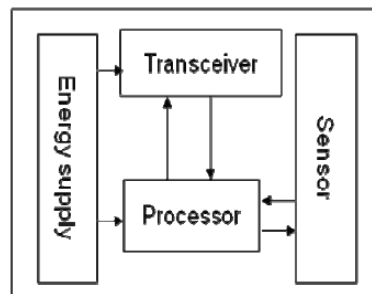
Figure 1.2: Overview of sensor node components

A wireless sensor networks as a rule has vitality limitation because of every sensor hubneeds battery with a restricted vitality supply to work. Likewise, reviving or supplanting

sensor battery may be less than ideal and unfeasible in a few situations. On the other side,the Wireless sensor system ought to work sufficiently long to consideration fulfill theapplication prerequisites. Along these lines, vitality protection is a fundamental matter inthe arrangement of Wireless sensor systems. There are disparate ways to deal with protectvitality tradition and drag out the system lifetime or prolong in WSN. The key way todeal with improve vitality use in WSN is the development of vitality mindful systemconventions. In this dissertation display an audit of directing and bunching calculationsfor force protection in Wireless sensor systems. This additionally show a force mindfulbunching strategy for improving the system lifetime and also growing the quantity ofeffectively conveyed bundles and diminishing the system delay time.

2. LITERATURE REVIEW

DongfengXieet. al[65] suggests that game theory has emerged as a new approach tostructured and generalized several issues of wireless sensor networks, such as routing,

knowledge collection, and topology control. Now days, a novel clustering mechanismcalled clustered routing for egocentric sensors a.k.a CROSS has been invented based onconcept of game theory. The sensor nodes, which are modeled as players; join in aclustering game to campaign for cluster heads with an equilibrium probability. However,

the CROSS algorithm requires the global information (GI) of how copiousness of sensornodes give in the game at every encircling. Thinking about that this global wayintroduces much more packets swap and energy consumption [18], they present aLocalized game theoretical clustering algorithm also abbreviated by LGCA. In ourprotocol, each node inconsiderately plays a limited clustering game only with itsneighbors within a communication radius RC. Moreover, precisely node can productivelyoffer for a location of the cluster head in region, thus achieving a most favorable induce.Simulation results show that our system achieves a better result compared with CROSSand LEACH in terms of network lifetime.

ParisaBazmiet. al. [66] recommended that proposes that fundamental favorableposition of any bunch based convention ought to be vivacity talented or draw out the

system life time. Exhaust is prominent surrounded by the most respected steeringconventions which created in 2000 for this motive. In this paper another system for grouphead strength of mind is proposed to enhance the LEACH convention. K meancalculation together with diagram suggestion is used to diminish the division in themiddle of hubs and Cluster Heads in addition the idea of aberration in diagram hypothesisis utilized to locate the central position of every group for new CH gathering. It minimizesthe vitality devoured by every sensor for the illustrate of their information to CH. The proposed calculation is contrasted and LEACH in parameters counting residual vitality of each round and arrange lifetime. PC renovation uncovers unrivaled execution of the proposed calculation in these parameters than LEACH.

Femi A. Aderohunmuet. al [20] examined that in wireless sensor networks (WSN)there are so many cluster based protocol that works with the cluster head to enhance thelife time of network. But there is also little protocol which are based on less powerconsumption in homogeneous & heterogeneous based network. Implementation &experiment setup has been conducted to calculate the new clustering approach, and foundthe best results based on the hetero energy setting. Multilevel clustering based protocolshows the result that in case of multilevel cluster formation gives less energyconsumption. This protocol is also maintaining the load balancing of the different clustersin network and nodes under the cluster relatively same in all cluster formation.

Masood Ahmad et. al [21] suggests that main advantage of any cluster based protocolshould be energy efficient or prolong the network life time. So here, a new approachEnergy Aware Uniform Cluster Head distribution which elects a node as a representativenode that will collect the data from all under the nodes from each part of the network. Inthis approach network divided into multiple parts. Each parts having a representativenode. Multiple simulation & experiments setup for each part of network withrepresentative node. With comparison of LEACH, this new approach increase thenetwork life time.

Md. Golam Rashedet. al [22] suggests that a new clustering weighted protocol named WEP (Weighted Election Protocol) to improve network life time. WEP is used for the balanced energy consumption. WEP elects the cluster head based on weight from rest of the nodes. Under the cluster there will be normal nodes. In simulation found that WEP is more efficient than other clustering routing protocol like as SEP, HEARP & LEACH.

3. PROBLEM IDENTIFICATION & METHODOLOGY

3.1 PROBLEM IDENTIFICATION

A WSN creates with large number of sensor nodes can be used tools to find outthe data in different situation. A senor node with the advances in micro-electromechanical

system.WSN is highly equipped to handle more typical functions. Soproposed a new approach or technique that has been made impact in case of clusteringtechnique. In this dissertation, a new single level clustering to form sub cluster head(SCH) under cluster to improve the life time of network. In case of single level clusteringenergy consumption has been improved than other clustering approach. Hence ahierarchical cluster based structure can be used to deal the self-organization issues oflarge networks. This cluster based organization can prolong network lifetime and reducethe broadcast overhead. This dissertation proposes a new type of energy efficientapproach which maximizes the network life time. Furthermore, a parent/child orouter/inner cluster head or parent/child clustering or outer/inner clustering scheme is

introduced as a useful means of further improving the energy efficiency. This single levelclustering is also known as nested clustering. In this approach, energy efficiency is sharedand network performance is improved by selecting parent/child or outer/inner clusterheads on the basis of the residual energy of existing cluster heads. In this

dissertation,compare the energy efficiency of single hop and multi hop taking into considerationcircuit energy consumption as well as transmission energy. This dissertation exploreswhen multi hop routing is more energy efficient than direct transmission to the sink orbase-station and the conditions for which the two-hop strategy is best possible. In thisapproach SCH is firstly communicate with CH, and then CH is further communicatedwith base station. It is not enough to diminish total energy consumption, it is alsoimportant to maximize prolong of the complete network, that is, preserve full networkconnectivity for as long as probable. This dissertation considers different multi hopscenarios to calculate the sending energy per bit, efficiency and energy consumed byindividual nodes and the network as a whole.

If cluster heads [29] is near to the base station, then die earlier due to overhead,because they will be in heavier data traffic, which are relatively far from the base station.

3.1.1 Clustering in Wireless Sensor Network

In Figure 3.1, a cluster based network, sensor node formation under the clusters.Using cluster head selection approach or protocol, firstly select the CH. CH is responsibleto fetch the data from own under sensor or cluster member (CM). CH broadcast amessage to own cluster member that ready for the giving the data whatever clustermember fetch from environment. There may be direct communication to base station orsink node or can CHs also communicate to each other. Now the cluster member are readyfor giving the data to the correspond CH. CH is broadcasting a message that sends thedata to correspond CH. CH collects the data from different CM. Now the task perform byCH is very important i.e. data aggregation. Because CMs are very close to each otherthere may be replication of data, so CH is performing data aggregation at own side. Thecalculated data or final data has been prepared and sends to BS or nearest CH also. This

the multi hop transmission performs by network. In case of multi hop, energyconsumption is very less than single hop communication. Moreover, data aggregation ismost important or can be performed at cluster heads to reduce the amount of datatransmitted to the sink and improve the energy efficiency of the network [30][31] .Theclustering is suitable considering the amount of duplicity found in WSNs; directtransmissions the base station will consume large amount of transmit power from eachnode.
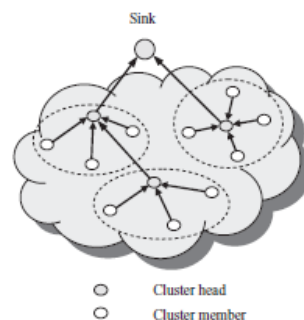
Figure 3.1: Single - hop clustering architecture

The amount of redundancy found in WSNs; direct transmissions the base stationwill consume large amount of transmit power of each node. In cluster based WSN each

sensor node sends the data to respective cluster head. In a cluster, there are so manysensors nodes, so each & every node needs to transfer the data to respective CH, in this

condition some nodes may be near to CH so they consume less energy than those nodesfar from CH. Far nodes consume more energy to transfer the data to respective CH. Herethis dissertation discuss problem regarding farthest nodes of CH.

4. PROPOSED SOLUTION

A WSN is usually randomly deployed in inaccessible terrains, catastrophe areas,or polluted environments, where battery replacement or recharge is difficult or even

impossible to be performed. For this reason, network lifetime is of crucial importance to aWSN.To prolong network lifetime, there is a necessity for efficient power controlmechanisms to reduce power consumption in sensor nodes & energy – efficienttechniques ought to be employed at all layers of the network, which ought to take in toconsideration the following unique characteristics &application requirements of WSNs

The topology of a WSN changes frequently.

• Sensor nodes are densely deployed in sensed areas.

• Sensor nodes mainly use broadcast communication, whereas most wireless Adhoc

networks are based on point to point communications.

• Sensor nodes may not have global identification due to the large amount of overhead

introduced and their large number.

• Sensor nodes are limited in power, computational capacity, and memory.

In a WSN, sensor nodes are typically operated by batteries, which are limited inenergy capacity, and difficult or even impossible to be replaced or recharged. For thisreason, power control is needed to efficiently make use of the limited energy resources inorder to minimize the energy consumed by the sensor nodes and thus prolong networklifetime. For this purpose, energy efficiency must be considered in every aspect ofnetwork design and operation, not only for individual sensor nodes, but also for thecommunication of the entire network. Energy efficiency and power control are the basicguarantee of the network performance, for example, throughput and delay.

4.1 PROPOSED WORK

The amount of redundancy found in WSNs; direct transmissions the base stationwill consume large amount of transmit power from each node. In single level clusteringapproach, instead of

sensor nodes sending the data to the cluster-heads directly, eachnode sends it to its sub cluster. This dissertation wants to save power consumption ofcluster heads by this architecture because cluster head will communicate with all the subcluster head nodes directly. The proposed algorithm is successfully implemented in

MATLAB R2009b.

4.1.1 Cluster head selection using K-means Clustering Algorithm

Initially this work has collection of nodes, so with help of K-means algorithm (asdiscussed in chapter 3) creates clusters of nodes in Figure 4.1, by which nodes comeunder in different clusters. Each node belongs to one cluster. Next level of working findthe center of cluster & also find the nearest node of center that node work as cluster head.Selected CH work for each node of respective cluster to collect data from nodes and sendto the base station.

4.1.2 Single level clustering or Sub Cluster (SC)

Figure 4.1 shows, firstly draw a outer circle , each node of cluster come under this

circle and CH coordinates work center point of circle, now find out average distancebetween nodes & CH, and draw an inner circle , with radius as average distance withcenter point is CH coordinates. To mark CH node coordinates draw dimension of x-axis& y-axis. This work has four partitions & quadrants, each partition having some nodeswhich are lies in between outer & inner circle. So by which found four sub clusters. Thisprocess is knows as single level clustering.Next phase of our work to select Sub Cluster Head (SCH) of each SC. Afterformation of SC, this dissertation need to find out that node of SC, which is havingminimum distance from CH, so that node of SC will work as SCH of that SC. So finallyeach SC having own SCH. Now the flow of data is moving from SC node to own SCHand then finally sends to CH with aggregation operation.
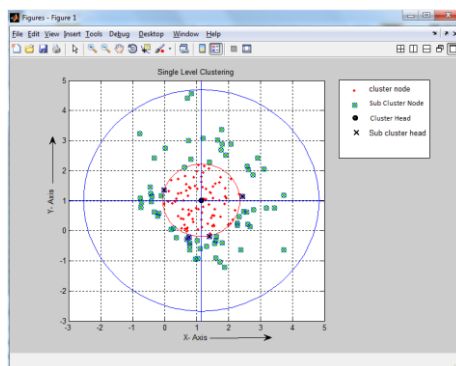
Figure 4.1: Single level Clustering

Many greedy algorithms have been proposed to choose cluster heads in ad hocnetworks, and wireless sensor networks. They are based on the criteria of highest degree,

lowest- ID, highest-ID, and node-weight, residual energy, probability, and anycombination of these. The clustering techniques can also be classified based on clustersize, namely Single

hop, and Multi hop. LEACH [40] (Low Energy Adaptive ClusteringHierarchy) elects cluster heads based on randomly generated value between 0 and 1. Ifthis randomly generated value is less than threshold value then the node becomes clusterhead for the current round. LEACH [40] is the first tree based cluster-based routingprotocol for wireless sensor network which divides the nodes into clusters, in each clustera node with extra privileges called Cluster Head (CH) is responsible for creating andmanipulating a TDMA (Time Division Multiple Access) schedule and sendingaggregated data from nodes to the BS where these data is needed using CDMA (CodeDivision Multiple Access). Remaining nodes are cluster nodes. PEGASIS (PowerEfficient Gathering in Sensor Information Systems) [42] is an improvement over LEACHby making only one node transmit data to the base station in this protocol every node

transmits it's data only to its nearest/neighbor node in the data fusion phase. PEGASISstarts with the farthest node from the base station. HEED (Hybrid Energy EfficientApproach) [41] periodically selects cluster heads according to a combination of theirResidual Energy (RE), and communication cost of nodes. Distributed Weight Based

Energy-Efficient Hierarchical Clustering (DWEHC) [45] is an extension or modified

version of the HEED. It claims to provide more balanced cluster size. HEED uses two

clustering parameter to select CH: one is residual energy, and the other is communication

cost.

Numerical simulation of helical coil tube in tube heat exchanger has been done with Ansys fluent and the variation of Nusselt number with different baffle thickness and for various D/d ratio and different flow rate of hot fluid has been plotted.
The conclusion drawn are as follows

➢ With increase in D/d ratio the Nusselt number is decreasing, the Nusselt number is maximum for D/d=10 for a particular value of Re this is due to the effect of centrifugal force which is more for small D/d ratios and for high D/d ratio the behavior of helical coil tends to that of straight tube.

➢For laminar case with baffle thickness of t=3.5 mm and t=4 mm the Nusselt number is increasing compared to case without baffle and thickness of t=4.5 mm.

➢For Laminar flow for different D/d ratios the Nu variation with Re follow the same pattern.

➢ For turbulent case with baffle thickness of t=3.5 mm and 4mm the Nusselt number is slightly increasing and for thickness of t=4.5mm for low Reynolds number the value of Nu is decreasing and for high Reynolds number Nu value is increasing.
HEED each node must be mapped to exactly one cluster, and each nodebelongs to its only CH within one hop. After a clustering process, each node can eitherelect to become a CH due to a probability or join a cluster according to CH messages.

6. RESULTS ANALYSIS
6.1 COMPARISON BETWEEN CLUSTERING & SINGLE LEVEL

CLUSTERING

Figure 6.1 depicts comparison of sending energy between single level clusteringalgorithm & clustering by using **K-Means cluster formation**. This graph drawn based onnumber of nodes in cluster & energy consumption in both clustering & single levelclustering. Figure 6.1 depicts that energy consumption in clustering is more incomparison of single level clustering.This graph having two parameters first is number of nodes (x axis) & second isenergy in nano-joule (y axis). Blue line is representing the clustering & red linerepresenting the single level clustering. As increment in nodes then the energyconsumption is also relative to increase. So can see that if, use single level clustering then

can save the energy in comparison of previous method. So need to focus to improve thelife time of network because energy if valuable resources need to save it.
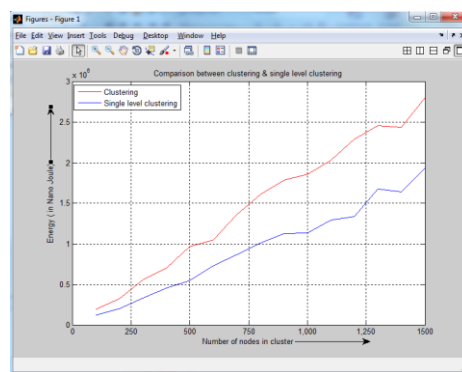
Figure 6.1: Graph between clustering & single level clustering

As in Table 6.1 represents three columns:

1. Number of nodes

2. Energy Usage in Clustering (nj)

3. Energy Usage in Single Level Clustering nj)

4. Saving Energy by Single level Clustering (nj)

1. **Number of nodes: -** In this Table number of nodes represents the how many nodes in

clustering by using K-mean under a single cluster.

2. **Energy Usage in Clustering (nj):-** This represents the sending energy consumption

in case of clustering. A node sends the data to the correspond cluster head, and then it

consume the energy.

3. **Energy Usage in Single Level Clustering (nj):-** This represents the sending energy

consumption in case of single level clustering. A node sends the data to the

corresponding sub cluster head, and sub cluster heads to the correspond cluster head.

4. **Saving Energy by Single level Clustering (nj):-** This represents the saved energy by

the using single level clustering in comparison of clustering.

TABLE 6.1

Number of Nodes	Energy Usage in Clustering (In nj)	Energy Usage in Single Level Clustering (In nj)	Saving Energy by using Single level Clustering (nj)
50	22515.97101	22464.03758	51.93343
100	39339.13822	39293.75822	45.38
150	62661.18551	62534.80382	126.38169
200	81067.55358	80935.08111	132.47247
250	100335.6963	100159.2454	176.4509
300	120000.8884	119801.9817	198.9067
350	139260.2053	139049.3044	210.9009
400	164595.5473	164344.8574	250.6899
450	180308.3102	179988.6439	319.6663
500	201552.1931	201234.5559	317.6372
550	220881.2376	220500.8234	380.4142
600	251707.2251	251205.9576	501.2675
650	254104.6642	253665.1394	439.5248
700	283032.7378	282498.8032	533.9346
750	303528.8188	303078.0281	450.7907
800	329481.0581	328949.0441	532.014
850	344862.3422	344275.3337	587.0085
900	370241.2394	369595.5253	645.7141
950	380263.3529	379595.8909	667.462
1000	400246.5263	399598.251	648.2753
1050	428017.734	427374.1703	643.5637
1100	435975.7433	435274.8969	700.8464
1150	443227.4296	442436.7427	790.6869
1200	489360.818	488535.7304	825.0876
1250	510231.4737	509251.1052	980.3685
1300	516930.3452	516184.3252	746.02
1350	539206.2688	538212.0202	994.2486
1400	566071.2292	564944.9066	1126.3226
1450	580946.7357	579897.0883	1049.6474
1500	608254.5076	607261.4639	993.0437

SENDING ENERGY WASTAGE OF NODES IN CLUSTERING & SINGLE LEVEL CLUSTERING

7. CONCLUSION & FUTURE WORK

WSN, by nature, is extremely energy constrained thereby forcing the routingprotocol designers to go for energy efficient design. In this work have reviewed the mainapproaches to energy saving methods in Wireless Sensor Network, and a comprehensivelist of the EER protocols for WSN has been studied. These energy saving methods arebasically used to increase the life time of sensor nodes in wireless sensor networks. Socan emphasize on developing convenient techniques to reduce the energy consumption of

the sensors by this approach.In clustering, the cluster head decision is a major challenge. If network is taken asa whole, then the energy consumption can be optimized by the rotation of this clusterhead & SCH (Sub Cluster Head) inside the individual clusters & sub cluster. This workmainly focused on clustering & single level clustering for energy consumption ofWireless Sensor Network. The approach involves the concept which represents thedifferent steps that are performed to conserve the energy of CH & SCH in wireless sensornetworks. In this work, a new technique is proposed to select sub cluster head amongsome of the wireless sensor nodes based on distance from CH. The proposed single levelclustering used to increase & improve the lifetime of the network.In Future can be enhance the single level clustering in to multi level clusteringand increase the life time of network & can also be work on single hop & multi hopenergy consumption.

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PERFORMANCE ANALYSIS OF Z-SOURCE INVERTER FED SINGLE PHASE INDUCTION MOTOR DRIVE

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ABSTRACT:-Many research works are focusing in the development of the efficient controlalgorithms for high performance variable speed induction motor drives.Traditionally, three phase inverters with six switches have been commonlyutilized for variable speed induction motor drives. This involves the losses ofthe six switches as well as the complexity of the system. Thus the main issueof this work is to develop a cost effective, simple and efficient highperformance induction motor drive.In this research work a split phase single phase induction motor is used inwhich splitting is done by means of linear and high frequency transformer. Inthis Z-source inverter technique is used to boost the voltage which makesmotor drive more efficient. The advantage of this method is that the singleconversion from dc to ac takes place.Simulations have been done in MATLAB/ SIMULINK environment toexplore the system response. The response obtained for the rotor speed (whichshows soft starting of motor), main winding current, auxiliary winding currentand electromagnetic torque. Result comparison has done which shows thebetter performance of the system.

Keywords-SPIM,IM,VSI,ZSI,DC/AC, VSC.

Introduction

Many analysis works are focusing within the development of the economicalmanagement algorithms for top performance variable speed induction motor (IM)drives. Induction motor has been operated as a work horse in the industry because ofits simple build, high robustness and customarily satisfactory potency. Recentdevelopment of high speed power semi conductor devices, 3 phase invertersparticipate in the key role for variable speed AC motor drives. Historically, 3 phaseinverters with six switches (SSTP) are ordinarily utilized for variable speed IM drives;this involves the losses of the six switches still because the complexness of themanagement algorithmsand interface circuits to get six PWM logic signals. Up tonowresearchersprimarilyfocusedonthedevelopmentof new managementalgorithms. However, the cost, simplicity and adaptability of the general drive systemthat are a number of the foremost necessary factors didn't get that abundant attentionfrom the researchers. That's why,despite tremendous analysis during this area, mostof the developedsystemdidn'tattracttheindustry.Thus,the most issue of this work isto develop a value effective, easy and economical high performance IM drive.The basic inverter topologies are Voltage source inverter (VSI) and Current sourceinverter (CSI), which incorporates diode rectifier face, DC link and Inverter Bridge.So as to boost power issue, either an AC inductor

or DC inductor is generally used.TheDClinkvoltageisroughlyadequateto1.35times the road voltage and thereforethe Voltage source inverter could be a buck converter that may solely turn out an ACvoltage restricted by the dc link voltage. Due to this nature, the Voltage sourceinverter primarily based PWM VSI and CSI are characterized by comparatively lowpotency due to switching losses and wide electromagnetic Interference (EMI) generation.

The drives industry provides choices using fly back convertor or boost convertor with energy storage or diode rectifier to attainride-through.But these choices includepenalties of value, size, weight and complexness. Influx and harmonic current fromthe diode rectifier will contaminate the road. Low power issue is another issue of thenormal drives. Performance and responsibility are compromised by the voltage sourceinverter structure, as a result of misgating from EMI will cause shoot- through thatresults in destruction of the inverter, the dead time that's required to avoidshootthrough creates distortion and unstable operation at lowspeeds,andcommonmodevoltage(CMV)causesshaft current and premature failures of the motor. During atraditional voltage sourceinverter, the two switchesofthe identical section leg willnever be gated on, at the same time, because, such activity would cause a short circuit(shoot-through) and would destroy the inverter. Additionally, the maximum outputvoltage available will never exceed the dc bus voltage.

Operation Blocks of Z-source FullBridge DC/DC Converter

Z-source full bridge dc/dc converter is designed for boosting the input voltage tohigher output voltage level. The main circuit diagram of the full-bridge Z-sourcedc/dc converter is shown in Fig.1.
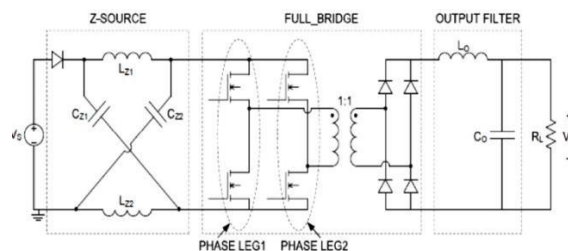
Figure1: Circuit diagram of the Z-sourcefullbridge dc/dc converter

The Z-source part of the converter, shown with dashedpart, is used to boost thevoltage across the full bridge MOSFETs. Boosting of input voltage is achieved byswitching the MOSFETs, in the same line, at the same time. By this way, shootthroughoperation is used to energize the Z-source inductors, LZ1and LZ 2. The full bridge part of the circuit is used for isolation and rectification. This partgenerates ac voltage across the transformer primary side and rectifies the transformersecondary side ac voltage. Simplifying the full bridge part ease the analysis of Zsourcedc/dc converter. As mentioned before, in normal operation of Z-source dc/dcconverter, one the phase leg shown in Fig.4.1 is shorted to energize the Z-sourceinductors (Lz1and Lz2) through the Z-source capacitors (Cz1and Cz2).
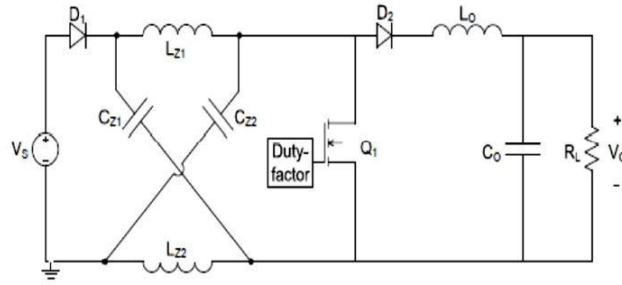
Figure 2: Simplified circuit diagram of the Z-source full bridge dc/dc converter

- **Simulation & Result**

Single phase impedance source inverter fed split phase induction motor drive is simulated in this proposed work. For simulation of the proposed system here MATLAB software is used. The whole simulation is modeled in SimpowerSimtools. Figure 3 shows the Simulink model of the proposed system.
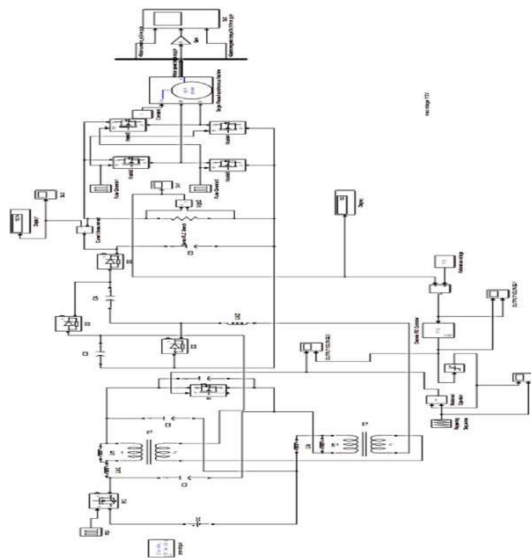
Figure 3:SIMULINK model of proposed Single Phase NPC-MLI

Parameter	Value
DC source Value	24 V
Z-Source converter Parameter	
Linear High Frequency Transformer	5000VA, 50kHz 24/100 V
$L_1=L_2$	1 µH
$C_1=C_2$	300µF
C_o	5mF
R	700Ω
DC link Capacitor C_5	100nF
Coupling Capacitor $C_3=C_4$	1 µF
Carrier Frequency	5kHz
SPIM Parameter	
Motor Rating	¼ HP, 170 V, 50 Hz
Main Winding Stator	Rs=2.02Ω, L= 7.4mH
Main Winding Rotor	R_r'=4.12 Ω, L_t'= 5.6 mH
Auxiliary Winding Stator	R_{sa}=7.14 Ω, L_{sa}= 8.5 mH
Number of Pole	2
Disconnection Speed	75%

Table5.1: Parameter used in the SIMULATION

Result &Discussion

The proposed system is simulated in MATLAB/SIMULINKsoftwareforchecking performance of the proposed system. In this section the application of proposed system in split phase induction motor drive. Figure 5.2 shows the speed of the proposed systemapplied on the single phase split phase induction motor. The result shows the soft starting of the drive. Here it is clearly seen that the motor start to runs smoothly from zero to 1500rpm from zero to 2 sec. then it keep constant till end of simulation.
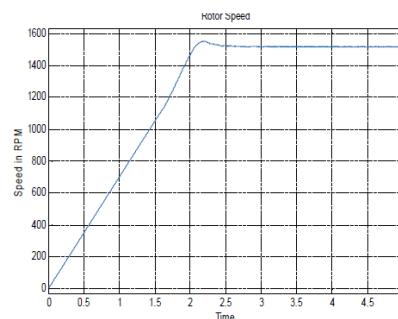
Figure 4: Rotor Speed of the Single phase Split Phase Induction Motor with proposed System
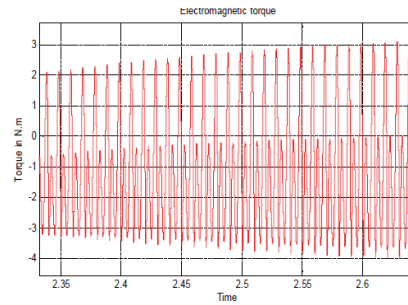
Figure 5 shows the electromagnetic torque response of the proposed inverter fed SPIM.
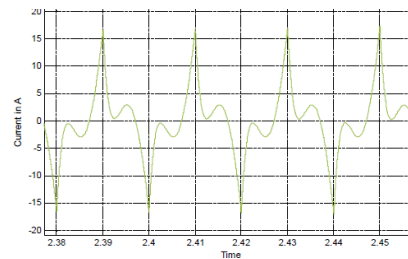
Figure 5. Main winding Current response of Proposed ZSI based SPIM
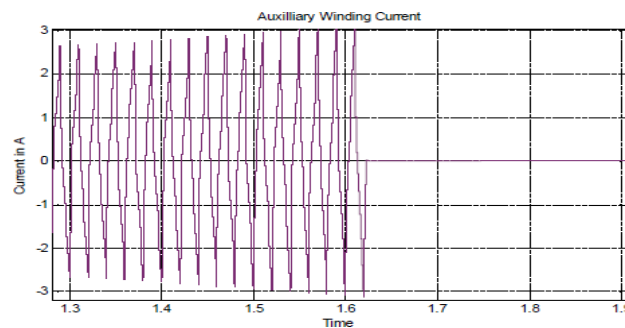
Figure 6: Auxiliary Winding Response of the proposed ZSI based SPIM

From the figure the cutoff of the auxiliary is taken whenthespeedreached75%ofthe maximumspeed.Thistimeis at 1.625 s. at this time auxiliary winding is cutout. The operation of the split phase is produce by the using the transformer T1 and T2. These transformers are used for phase shifting of the output voltage of the proposed ZSI inverter. The main function of the auxiliary winding is produce the phase difference for startup the induction motor.Figure 6 shows the FFT analysis of the main winding of thesplitphaseinductionmotor.Hereitisseenthatthetotal harmonicsdistortionofthe main windingis19.65%found.
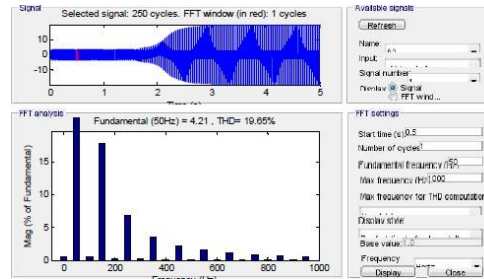
Figure 6:FFT analysis

In this section here discuss with the previous work with proposed work. Table 5.3 shows the comparison between previous work and present work.

Table5.3: Comparison between previous work and present work

Parameter	Previous work	Present work
Inverter used	Half Bridge	Full Bridge is more efficient then half bridge
Phase splitting Technique	Capacitor produce 90° phase split for main and auxiliary winding	Linear Transformer is used for splitting phase
Methos involved for conversion	Voltage source conversion	Impedance source Conversion which is more efficient than voltage source conversion
Motor Running Status	Fluctuated start due to this jerk on the rotor present	Soft start due to this jerk on the rotor is very small
For low voltage operation	No	Yes due to ZSI

- **CONCLUSION**

Induction motors are among the most widely used motors in industrial applications, and various methods have been developed for their control. In recent years, single-phase induction motors have found increasing use not only in domestic appliances but also in certain industrial applications. However, due to the presence of a single winding, these motors cannot self-start as they fail to produce the required rotational torque, and therefore, starting capacitors are generally employed. With the growing utilization of non-conventional energy sources, the application of single-phase induction motors has expanded further. Since the output from renewable energy systems is relatively low, inverters are essential for converting DC power into AC power to drive the motor. To achieve this, a two-stage converter system is typically required: the first stage boosts the voltage, and the second stage converts DC to AC. This necessity, however, increases the overall complexity of the converter system.

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Improved Power Quality Using Three-Phase Pulse Width Modulated Rectifire and MPPT

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ABSTRACT :-The compensation of area load harmonic current utilizing one weight unit interfacing convertorcould create the increase of supply voltage harmonics delicate burdens, particularly when theelemental grid voltage is incredibly mutilated. Pulse width-modulated (PWM) rectifier technologyis increasingly used in industrial applications like variable-speed motor drives, since it offers manydesired options like curved input currents, manageable power issue, bidirectional power flow andprime quality DC output voltage. To achieve these features, however, an effective control systemwith quick and correct current and DC voltage responses is required. Unlike the task of broughttogether Unified power quality conditioners (UPQC) with game plan gadget, another consonantcurrent give voltage and framework current symphonious pay approach is arranged using quickenadministration of two shunt interfacing converters. Using the proposed technique, the present TotalHarmonic Distortion (THD) of the lattice is decreased underneath as far as possible and in this waythe general power nature of the framework is moved forward. The proposed show configurationdependent on three segment beat measurement balance.

Keywords: Pulse Width Modulation Rectifier, THD, PV Cell, Wind Power, MPPT , Voltage Source Inverter, LCL Filter.

1. INTRODUCTION

An intensive research in the neighborhood of variable-speed AC drives has been carried out overthe last four decades. For an extended time the stress of the analysis has been placed on themotor electrical converter and its management, whereas the AC to DC rectification has been accomplished by associated degree uncontrollable diode rectifier or a linecommutated section controlled Thyristor Bridge. Though each these converters supply ahigh dependability and easy structure they even have major inherent drawbacks. The outputvoltage of the diode rectifier can't be controlled and also the power flow is simplex also, theinformation current of the diode rectifier incorporates a nearly high bending. By overwhelmingthe terminating edge, the DC voltage of the Thyristor Bridge is frequently directed. Additionallycontrol be expected the DC feature to the AC aspect is doable, anyway because of the extremityof the DC voltage ought to be switched for this to happen, a thruster connect isn't a properrectifier for applications wherever a snappy unique reaction is required. Truth be told, the DCvoltage extremity revision isn't permitted in light of the electrolytic capacitors for the most partutilized in the DC connection of a voltage supply gadget. By interfacing two thyristor spans antparallel, bidirectional power stream is likely without DC voltage extremity

inversion, be that as itmay, thus, the quantity of the power switches is multiplied. Furthermore, the power factor of thethyristor connect rectifier diminishes when the terminating edge increments and the line currenttwisting can be a much more terrible issue than that of the diode rectifier.

Accompanied by the previous twenty years the enthusiasm for amending units has been rapidly developing in the principle the expanding worry of the electrical utilities and complete clients concerning the adapted Contamination in the power framework. As a result, pulse widthmodulated (PWM) rectifiers are of explicit interest and that they became engaging particularly in industrial variable-speed drive applications within the power vary from one or two of kilowatts up to many megawatts. This is partly due to the reduced costs and improved performance of both the power and control electronics components but most of all due to the numerous benefits the using of the PWM rectifiers offers.

There has been a requirement to regulate disturbances to the provision network virtually since it had been initial made within the late nineteenth century the primary of these was British Lighting Clauses Act of 1899 that kept uncontrolled curve lights from causing flash on radiant lights.

With the development of gear at interims the 1970's, it ended up important to deal with the unsettling influences caused by this expanding instrumentation. The development of customer physical science has implied that the normal home contains an excess of mains driven electronic gadgets and not just televisions. Continually these electronic gadgets have mains correction circuits that is existing purpose for mains consonant twisting. most up to date electrical and electronic hardware utilize some sort of air conditioning to dc control supply among their plan and it's these provisions that draw beats of current from the air conditioner organize all through each 0.5cycle give waveform.
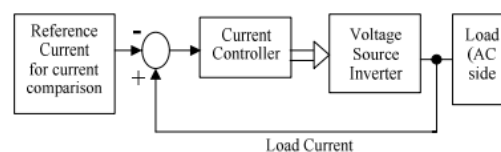
Fig.1.1 Basic block diagram of current controller for VSI

1.2 Overview of voltage source PWM rectifier

A typical voltage source PWM rectifier configuration is shown schematically in Fig. 1.2. It consists of three parts: line filter, Rectifier Bridge and DC voltage link. Series inductors, which are so-called L-filters, are the most commonly used line filters. Also the LCL-topology, illustrated in Fig. 1.3, has lately become popular due to its higher attenuation above the resonance frequency and better line voltage disturbance rejection capability compared to the L filter. The purpose of the line filter is to attenuate the current ripple produced by PWM switching and, at the same time, to act as energy storage for voltage boost operation. The inductance of the line filter inductor is denoted with 1.The bridge circuit, which is identical to

a conventional inverter bridge, is constructed of six controllable power switches and anti parallel diodes. In lowvoltage applications the power switches are typically IGBTs with switching frequency from a few kilohertz to a few tens of kilohertz. At medium-voltage levels GTOs or IGCTs are often used. The switching frequency of these devices is typically a few hundred hertz.
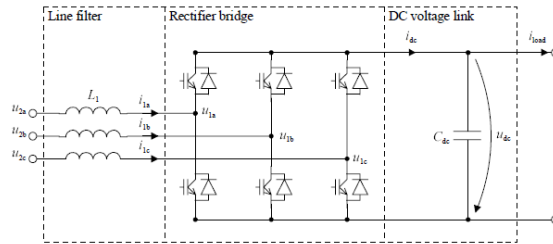

Fig. 1.2: Main circuit of a voltage source PWM rectifier with L-filter

There phase of the magnitudes and phases of the fundamental components of the converter phasevoltages to the line phase voltages U2a, U2b and U2c together with the impedance of the line filterdetermine the fundamental component of the line currents i1a, i1b and i1c. There occur also currentharmonics produced by the corresponding harmonic voltage of the PWM rectifier, but theirmagnitude is essentially reduced because the impedance of the line filter increases as thefrequency increases.
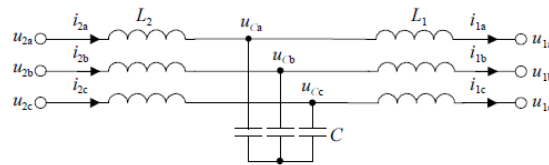
Fig. 1.3: Circuit diagram of an LCL line filter.

It is additionally conceivable to orchestrate the channel capacitors in delta association. L1 andL2 indicate the inductance of the converter side and line side inductors, individually. i2a, i2b andi2c are the line side stage streams and UCa, UCb and UCc are the voltages of the channelcapacitors C.

1.3. History of PV (Photovoltaic)

The main ordinary photovoltaic cells were created in the late 1950s, and all through the 1960swere essentially used to give electrical capacity to earth-circling satellites the 1970s, upgrades indelivering, execution and nature of PV modules diminished costs and showed assortment ofchances for fueling remote earthbound applications, together with battery charging for bearingguides, signals, broadcast communications instrumentation and diverse basic, low-control needs.Inside the 1980s, photovoltaic's turned into a favored power supply for customer electronicgadgets, together with adding machines, watches, radios, lights and diverse little batterychargingapplications. Following the vitality emergencies of the 1970s, essential endeavorsmoreover started to create PV control frameworks for private and business utilizes, each forfinish, remote power likewise concerning utility-associated applications.

Following the energycrises of the 1970s, important efforts additionally began to develop PV power systems forresidential and business uses, each for complete, remote power also as for utility-connectedapplications. Throughout identical amount, international applications for PV systems to powerrural health clinics, refrigeration, water pumping, telecommunications, and off-grid householdsincreased dramatically, and stay a serious portion of the current world marketplace for PVproduct. Today, the industry's production of PV modules is growing at some 25 % annually, and major programs within the U.S., Japan and Europe square measure speedily fast the implementation of PV systems on buildings and interconnection to utility networks.
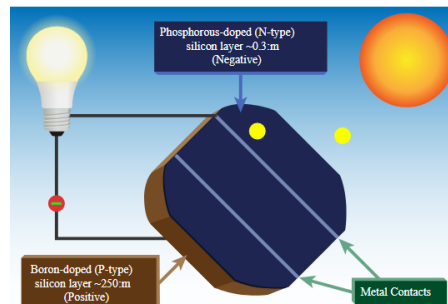
Fig.1.4 Diagram of a photovoltaic cell

2. LITERATURE REVIEW

George C. Konstantopoulos et al. [1] —Nonlinear Control of Single-Phase PWM RectifiersWith Inherent Current-Limiting Capability‖, in this paper, a nonlinear controller with an innatecurrent constraining capacity was proposed for single-stage rectifiers. The created methodologyensures nonlinear asymptotic solidness and combination to a novel arrangement consistently,while accomplishing the principle errands of the rectifier activity, i.e., precise yield voltagecontrol and solidarity control factor task. A diagnostic depiction of the controller parameterschoice was given to ensure that the info current will be constrained underneath a given anincentive amid drifters regardless of whether the network voltage fluctuates. Contradicted to thecurrent control strategies, the proposed current-restricting controller is completely free from theframework parameters and does not require a PLL or the quick estimation of the networkvoltage, prompting a rearranged usage. Expansive test outcomes were given to help thespeculative establishment of the proposed approach and check its practical movement.

George C. Konstantopoulos et al. [2] —Current-Limiting Non-linear Controller for Single-phaseAC/DC PWM Power Converters‖, a current-constraining non-direct controller was proposed toaccomplish PFC and yield voltage direction for single-stage air conditioning/dc controlconverters. The proposed CLNC acts autonomously from the framework parameters and canensure shut circle framework solidness and a given limit for the information current. Since theCLNC has a straightforward structure and does not require the prompt estimation of theframework voltage or a PLL, its execution turns out to be exceptionally basic.

Reenactmentresults utilizing Matlab/Simulink and a constant computerized test system appropriately checkedthe hypothetical examination for a few changes of the yield voltage reference.

Omar stihi et al.[3] ─A Single-phase Current Controlled PWM rectifier, it is shown that by incorporating a butterworth filter in its voltage feedback loop, the single phase controlled current PWM rectifier can be made into a fast response stand alonee system drawing near sinusoidal current waveform at unity power factor with bidirectional power flow capability. The possibility of feedback instability is identified and an experimentally verified approximate theoretical analysis is presented of feedback instability is identified and an experimentally verified approximate theoretical analysis is presented.

Wensheng Song et al. [4] ─A Simple Model Predictive Power Control Strategy for Single-phase PWM Converters with Modulation Function Optimization ‖ , show prescient direct power control (MP-DPC) with the balance work enhancement for the prompt power control of single-stage

PWM rectifiers is proposed in this paper. Based on SOGI, the momentary dynamic and responsive forces arrangement of single-stage converters is talked about in two-stage stationary organize outline. The streamlined regulation capacity of the received rectifier is gotten from the cost work minimization in MP-DPC. The proposed MP-DPC conspires joined with the PWM arrange comprises the general control arrangement of the embraced rectifier. What's more, the affectability of the MP-DPC conspire is researched, because of the air conditioner side inductor parameter confound. Based on this, the inductance parameter on-line estimation plot is proposed to wipe out its impact on the responsive power. The execution of the proposed MP-DPC plot is assessed dependent on a solitary stage PWM rectifier downsize test. Besides, it was contrasted and that of ordinary PI-based prompt current control (ICC) approach broadly embraced in the railroad footing application, and the limited control-set (FCS) MP-DPC plot. Also, Table IV demonstrates an execution correlation of these three control plots based on test results and hypothetical examination.

Yongchang Zhang et al. [5] ─Performance Improvement of Two-Vectors-Based Model Predictive Control of PWM Rectifier ‖ , this paper proposes an improved two-vectors-based MPC (MPC2) for PWM rectifier. Different from prior MPC with duty cycle control (MPC1), which applies a nonzero vector and a zero vector during one control period. The proposed methodrelaxed the restriction on the second voltage vector, which is possibly a nonzero vector. In other words, in the proposed MPC2, it is possible to apply two nonzero vectors during one control period to achieve better steady-state performance. The principle of the selection of the firstvector and the second optimal vector is explained in detail and the theoretical study confirms that the optimal second vector is not necessarily a zero vector. By using the negative conjugate of complex power as the control variable, both the first and second voltage vector in the proposed MPC2can be obtained in a very efficient way, which is favorable for the practical implementation. The vector duration is such derived that the power

error is minimized at the end of one control period. The proposed MPC2 is compared with MPC1, DB-SVM, and andDB- 3VV.

3. PROBLEM FORMULATION

The existing method describes AC/DC converters are inherently nonlinear systems because oftheir change operative perform. Among these devices, the single-phase full-bridge or H-bridgerectifier represents a typical greenhouse emission device operative in pulse-width modulating(PWM) mode and its model is generalized within the three-phase device case.The three-phase hysteresis current control has an extremely simple and robust structure andexcellent dynamic performance. Nevertheless, this control scheme has also disadvantages suchas varying and load-dependent switching frequency, wide line current spectrum, poor utilizationof the converter zero voltage vectors and interaction between the phases in three-phase threewiresystems. A number of proposals have been put forward to overcome these problems. Anadaptive tolerance band can be applied to achieve nearly constant switching frequency (Bose,1990). To decrease the switching frequency and to compensate the phase interaction effect, thehysteresis current control based on space-vector approach, three- level comparator and lookuptable can be used.

4. PROPOSED METHODOLOGY

The planned methodology describes a nonlinear controller with a current-limiting propertyis planned to ensure correct dc output voltage regulation and unity power issue operation forthree-phase pulse-width modulating rectifiers while not the requirement of a phase-locked-loop(PLL). To possess harmonic current alleviation of the provision voltage and also the grid currentharmonics, a compensation technique utilizing expedited management of 2 parallel interfacingconverters is planned during this section. To boost the ability quality and system performanceand reduces the overall harmonic distortion mistreatment the 3 section pulse breadth modulatingrectifier and MPPT ways.
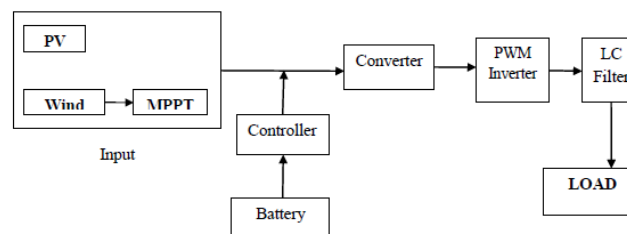
Fig.4.1 Block Diagram of Proposed System

4.1 Phase controlled rectifiers

The electric energy conversion created by semi conductive converters is getting used additionaland additional. This had diode to the expansion of negative development that appearednegligible, once solely a couple of converters square measure used. But the event ofsemiconductor structures has enabled higher power to be transmitted and has additionally

diode to wide unfold of converters. During this method, converters have a negative impact on the provision network. The regressive effects of overloads with harmonics and reactive power consumption have become major disadvantages of section controlled (mostly thyristor) rectifiers. These facet effects have to be compelled to be remunerated by extra filtering circuits with capacitors or inductances. However, such circuits raise the prices and additionally increase material and house necessities for the device.

Phase management and commutation of semi conductive devices impact the part displacement between 1st|the primary} harmonics of the consumed current and also the first harmonics of the provision voltage. This displacement ends up in power issue degradation and to reactive power consumption. The consumed current harmonics because non-sinusoidal voltage drops on provide the availability the provision} network impedances and cause supply voltage deformation. This could cause malfunctions of alternative devices that area unit wise to the curving form of the provision voltage (e.g. mensuration apparatuses, communication and management systems). The reactive power raises with longer management angle delays that the rectifier acts as time variable ohmic resistance that's nonlinear and causes ill-shapen current consumption.
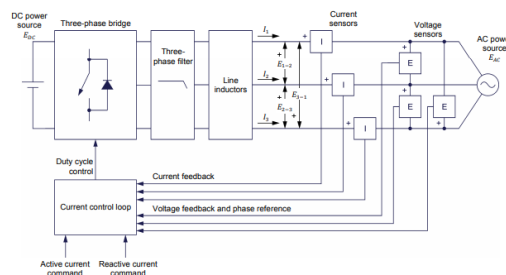
Fig.4.2 Block diagram of a three-phase PWM rectifier/inverter connected to a dc power sourceand an ac power source

The higher the worth of the three-phase ac voltage EAC across the ac aspect of the three-phasePWM rectifier/inverter, the upper the voltage EDC that the dc power supply should manufacture.identical suggests that accustomed eliminate or scale back this limitation in single-phase gridtiedinverters are employed in three-phase PWM rectifiers/inverters (e.g., connecting batteriesasynchronous to extend the dc power supply voltage, adding a three-phase transformer todecrease the voltage at the ac aspect of the rectifier/inverter).

5. SIMULATION RESULTS

Simulink contains all-inclusive library of sink, source, linear and nonlinear, and connectingblocks. If the blocks cannot meet your needs, however, you may create your own blocks. Theintuitive condition improves the displaying procedure, taking out the need to detail differentialand distinction conditions in a dialect or program. Simulink is a chunk outline environment formulti territory renovation. It generally bolsters confirmation of inserted frameworks,reproduction, and programmed code age. Constant test and Simulink gives a graphical editorial manager, adaptable square libraries, and solvers for demonstrating and mimicking dynamicframeworks. It is coordinated with MATLAB, empowering you to

consolidate MATLABcalculations into models and fare recreation results to MATLAB for further investigation.
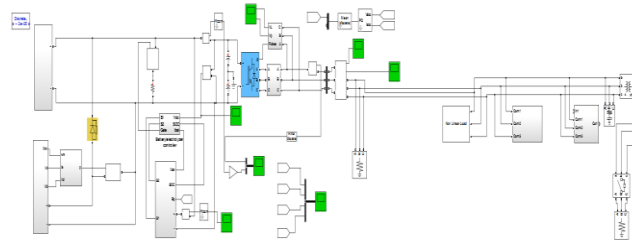

Fig. 5.1 Proposed Model

Figure 5.1 shows the proposed model, to have concurrent relief of the supply voltage and thematrix current music, a pay strategy utilizing composed control of two parallel interfacingconverters is proposed in this area. The hardware and control outlines of the proposed frameworkare appear din Fig.
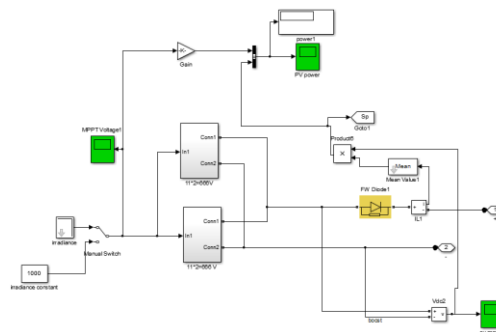

Fig. 5.2:- Subsystem of PV Systems

Proposed model has three sections. Section1 is wind, second is PV cell (Photovoltaic Cell) andlast section is battery block. In wind section basic focus is on pitch angle and wind speed. Thiswind model contains wind turbine that is related to static magnet synchronous generator that isdirectly driven by turbine while not exploitation case varity of PV panels connected in serialand/or in parallel giving a DC output out of the incident irradiance. Orientation and tilt of thosepanels are square measure vital style design parameters, furthermore as shading from close obstructions.
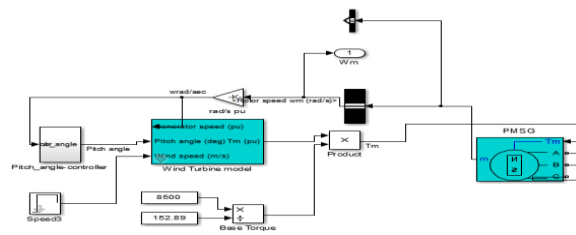
Fig. 5.3: Scheme of Wind Energy System Part 1

The output voltage of the PV and Wind power generation area unit quite low as compared withthe required in operating level. Wind turbine that is put in on high of a tall tower, collectsmechanical energy from the wind and converts it to electricity that's compatible with a home'selectrical system. Figure 5.3 shows the wind turbine model half part & Figure 5.4 shows the halfof wind Turbine section.
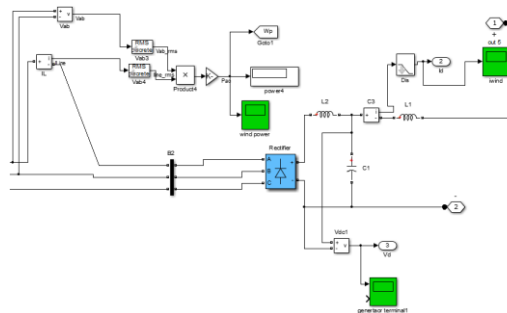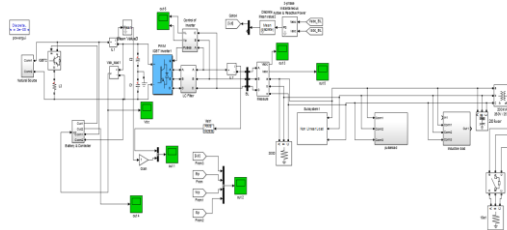

Fig. 5.4: Subsystem of Turbine Energy System Part 2

Fig. 5.5: Subsystem of merge PV and Wind, Battery and Controller
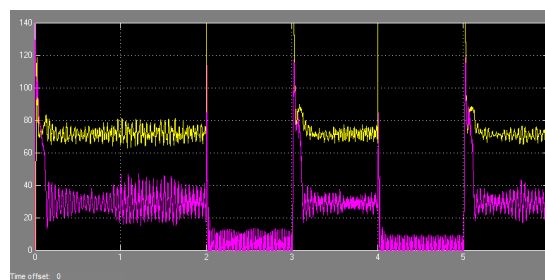
Fig.5.6 Output Voltage levels of load and PV Cell

Above Figure 5.6 shows the PV cell and load voltage output in which labels shows power andapplied voltage level diagram. In this three color wave form blue color shows battery power,pink color shows wind power, and yellow color show PV power. The MPPT section describesthe maximum power point tracking algorithm used to extract the maximum power available towind hybrid – battery system for load requirement and charging the battery.
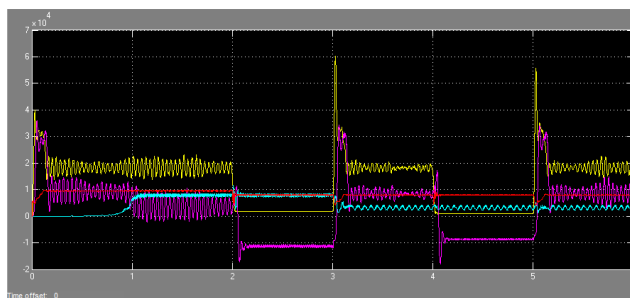
Fig.5.7 Simulation result of the power management when PV and Wind supplies load

In Figure 5.7, the power produced by PV and wind is high; the load demand is also high. In thiscase the PV alone is sufficient to run the load; the excess power from the wind is used to chargethe battery through. In this four color wave form cyan color shows battery power, pink colorshows wind power, yellow color show PV power, and red color shows load power.

6. CONCLUSION

Proposed work reduces the total harmonic distortion and the system power quality is improvedusing maximum power point tracking, wind power, PV cell and three phase pulse widthmodulated. In the meantime, the harmonic current brought on by the nonlinear load and theprincipal converter is repaid by the second converter. Consequently, the nature of the networkcurrent and the supply voltage are both essentially progressed. To lessen the computational heapof DG interfacing converter, the organized voltage and current control without utilizing loadcurrent/supply voltage harmonic extractions or stage bolt loops is produced to acknowledgecomposing control of parallel converters. At the point when a single multi-useful interfacingconverter is received to compensating generation the harmonic current from nearby nonlinearburdens, the nature of supply voltage to neighborhood load can barely be enhanced in the meantime, specific once the basic network voltage is blended.

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Sustainable Talent Management: The Role of Training and Development in Employee Retention in Private Universities

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Abstract

In the increasingly competitive and dynamic landscape of higher education in India, private universities are under growing pressure to attract, nurture, and retain high-quality faculty and staff. These institutions, which play a crucial role in expanding educational opportunities, often struggle with high employee turnover, which negatively affects academic quality, student satisfaction, and institutional continuity. In this context, sustainable talent management (STM) has emerged as a strategic imperative that emphasizes not only recruitment and retention but also long-term employee development aligned with institutional sustainability goals.

This research investigates the critical role of training and development (T&D) as a cornerstone of STM in enhancing employee retention within private universities. The study adopts a mixed-methods approach, combining quantitative surveys and qualitative interviews with academic and administrative staff across a diverse selection of private institutions in India. It aims to uncover prevailing trends, existing gaps, and effective practices in the design and implementation of T&D programs.

The findings reveal a strong and statistically significant correlation between well-structured, continuous T&D initiatives and key indicators such as employee satisfaction, organizational commitment, and retention rates. Institutions that invest strategically in faculty and staff development are more likely to foster a culture of engagement, loyalty, and professional growth. Furthermore, the study highlights a significant gap in the integration of sustainability principles within HR and talent development strategies. While some universities are beginning to align their T&D initiatives with broader goals of sustainable development, this practice is far from widespread.

By situating T&D within the framework of sustainable human resource management (SHRM), this study contributes to a deeper understanding of how Indian private universities can build resilient, future-ready institutions. The research offers actionable insights for policymakers, university administrators, and HR professionals seeking to enhance

Keywords: Sustainable Talent Management, Training and Development, Employee Retention, Private Universities, Human Resource Management, India, Higher Educationinstitutional effectiveness through sustainable talent practices.

Introduction

The landscape of higher education in India has undergone a transformative expansion over the past few decades, driven in large part by the proliferation of private universities. These institutions have significantly contributed to improving access to tertiary education, particularly in underserved and rapidly urbanizing regions. However, alongside this growth, private universities face pressing challenges related to maintaining academic quality, institutional credibility, and long-term sustainability. One of the most persistent and impactful issues is high employee turnover—especially among faculty and administrative staff—which undermines the continuity of institutional knowledge, adversely affects student learning experiences, and escalates recruitment and onboarding costs.

In response to these challenges, the concept of Sustainable Talent Management (STM) has gained traction as a forward-looking strategic framework. STM emphasizes the long-term development, engagement, and retention of human capital while aligning with broader organizational goals and values, including social and environmental responsibility. Rather than viewing talent acquisition and retention as isolated HR functions, STM advocates for an

integrated approach that embeds employee development into the fabric of institutional planning.

A key pillar of STM is Training and Development (T&D), which encompasses formal and informal learning initiatives designed to improve employee skills, competencies, and professional outlook. T&D programs are instrumental not only in enhancing individual performance and career progression but also in cultivating a culture of continuous improvement, innovation, and institutional loyalty. In academic settings, these initiatives often include pedagogical training, research capacity building, leadership development, and digital literacy programs.

Despite growing recognition of the value of T&D in organizational success, there remains a noticeable gap in empirical research—particularly in the context of private universities in India. Much of the existing literature has either focused on public sector institutions or generalized human resource management practices without deeply exploring the intersection of T&D, employee retention, and sustainability. This research aims to address that gap by examining how structured and strategic T&D initiatives contribute to sustainable talent management and employee retention within private Indian universities. By doing so, the study seeks to offer actionable insights that can help institutions not only attract and retain skilled professionals but also build resilient, future-ready organizations in the evolving higher education landscape.

Literature Review

Sustainable Talent Management (STM)- Sustainable Talent Management (STM) is an emerging paradigm within human resource management that emphasizes the alignment of talent strategies with the long-term goals of organizational sustainability. Rather than focusing solely on immediate staffing needs, STM takes a holistic view of human capital by incorporating economic viability, social equity, and environmental consciousness into HR practices. According to Ehnert et al. (2016), STM requires balancing these three dimensions to foster an organizational culture that supports innovation, adaptability, and resilience. In the context of higher education, STM becomes particularly significant, as universities operate in knowledge-intensive environments that demand continuous learning and intellectual engagement. Sustainable practices in talent management—such as ethical recruitment,

inclusive development programs, and long-term career planning—are crucial for institutions seeking to thrive in the face of evolving academic demands and societal expectations.

Training and Development (T&D)- Training and Development (T&D) represent a core function of effective human resource management, aimed at enhancing the capabilities of employees through structured learning and experiential activities. T&D initiatives are designed to bridge skill gaps, boost morale, and align individual performance with organizational goals. As highlighted by Noe (2017), comprehensive T&D programs have a direct influence on employee engagement, job satisfaction, and organizational performance. In academic institutions, T&D can include a range of activities such as pedagogical workshops, research mentorship programs, digital literacy sessions, administrative leadership training, and interdisciplinary collaboration opportunities. When strategically implemented, these initiatives not only improve faculty competence but also instill a sense of purpose and belonging, which are critical for long-term retention. Furthermore, regular professional development can enable faculty and staff to keep pace with global trends in education, thus enhancing the institution's competitive edge.

Employee Retention in Academia-Retaining talented employees, particularly in academic settings, is a multifaceted challenge influenced by both intrinsic and extrinsic factors. Employee retention goes beyond compensation; it includes aspects such as a supportive work environment, recognition, work-life balance, academic freedom, and opportunities for career progression. Research by Johnsrud and Rosser (2002) emphasizes the role of professional development in mitigating faculty turnover, suggesting that when academic staff perceive genuine opportunities for growth and learning, they are more likely to remain committed to their institutions. In universities, where intellectual and emotional investment in work is high, providing a stimulating and nurturing environment becomes key to sustaining faculty engagement. High turnover, on the other hand, leads to discontinuity in academic programs, increased administrative burdens, and a weakening of institutional culture.

The Indian Context-In India, the rapid expansion of private universities has created both opportunities and challenges in the higher education ecosystem. While these institutions are vital for addressing the demand-supply gap in tertiary education, they often operate under constraints such as limited funding, regulatory complexities, and high competition for talent. Many private universities attempt to counter these limitations through investments in training and development programs. However, as noted by Agarwal (2009), these efforts frequently

lack a strategic orientation toward sustainable talent management. The absence of clear policies, insufficient funding for long-term staff development, and a transactional approach to HR practices hinder the full potential of T&D initiatives. Moreover, faculty members in private universities often face job insecurity, limited academic freedom, and heavy workloads, further exacerbating attrition rates. Addressing these issues through a sustainable, well-integrated talent management framework is essential for improving retention and fostering academic excellence.

Research Gap-Although a substantial body of international literature has addressed the concepts of Sustainable Talent Management (STM) and Training and Development (T&D) independently, research examining the intersection of these two domains—particularly within the context of private higher education institutions in India—is notably limited. Much of the existing research on STM has been concentrated in corporate settings or in public sector organizations, with relatively less attention given to how sustainability principles are applied in academic talent management. Similarly, while numerous studies highlight the benefits of T&D on employee performance and engagement, there is a lack of focused investigation into how these developmental efforts translate into long-term employee retention in Indian private universities.

The Indian higher education sector, especially its private segment, operates under unique structural and organizational constraints, including resource limitations, high competition for skilled faculty, and evolving regulatory frameworks. These factors create a context that differs significantly from that of Western universities or even public institutions within India. Consequently, findings from international or public sector research may not be directly applicable or sufficient for understanding the challenges and opportunities faced by private universities in India.

Furthermore, there is a limited understanding of how these institutions interpret and operationalize sustainability within their human resource practices. While sustainability is often discussed in broad institutional terms—focusing on environmental or financial aspects—its application to employee development, engagement, and retention remains under-researched. There is a pressing need to explore whether and how sustainability principles are being embedded into talent development strategies, and what impact such alignment may have on faculty and staff retention.

This gap in the literature underscores the need for empirical studies that specifically investigate the role of structured, strategic, and sustainable T&D initiatives in shaping retention outcomes within private Indian universities. Addressing this gap can provide valuable insights for policymakers, academic leaders, and HR professionals aiming to strengthen institutional sustainability through people-centric strategies.

Research Questions

- How are T&D programs structured and implemented in private universities in India?
- What is the impact of T&D on employee retention in these institutions?
- How do private universities integrate sustainability into their talent management strategies?

Research Objectives

- To analyze the structure and effectiveness of T&D programs in private Indian universities.
- To assess the relationship between T&D initiatives and employee retention.
- To examine the integration of sustainable practices in HR management.

Research Methodology

This study employed a mixed-methods research design to comprehensively investigate the role of Training and Development (T&D) in Sustainable Talent Management (STM) and its impact on employee retention in private universities in India. The mixed-methods approach integrates both quantitative and qualitative techniques, enabling the researcher to capture numerical data for generalizability while also exploring in-depth perspectives for nuanced understanding. The quantitative component involved the use of structured questionnaires to collect data on employee perceptions, satisfaction levels, and retention intentions. Complementing this, the qualitative component utilized semi-structured interviews to delve deeper into the lived experiences of faculty and administrative staff, allowing for the identification of themes related to sustainability, organizational culture, and talent development practices.

Sampling

The target population for this study consisted of faculty members and administrative

personnel employed at ten private universities situated in diverse geographical regions across India. To ensure comprehensive and equitable representation, a stratified random sampling technique was adopted. This method allowed for the categorization of participants based on variables such as academic discipline, professional role, years of experience, and organizational hierarchy. By applying stratified random sampling, the study minimized selection bias and ensured that the views of both teaching and non-teaching staff were adequately represented, thereby enhancing the validity and reliability of the findings.

Data Collection Tools- To gather data, the study utilized two primary instruments:

- **Questionnaire**: A structured questionnaire was developed comprising both closed-ended and Likert-scale items. The questions were designed to assess employees' perceptions regarding the effectiveness of T&D programs, their levels of job satisfaction, perceived organizational support, and intentions to remain with their current employer. The questionnaire also included demographic items to allow for sub-group analyses.
- **Interview Guide**: A semi-structured interview guide was formulated to facilitate qualitative data collection. The guide included open-ended questions that explored participants' experiences with training programs, their views on how T&D contributes to personal and professional growth, their understanding of sustainability in the workplace, and their perceptions of the organization's HR strategies. The semi-structured nature of the interviews provided flexibility for probing deeper into relevant issues while maintaining consistency across interviews.

Data Analysis-Data analysis was conducted through a dual-method approach aligned with the mixed-methods design.

- **Quantitative Analysis**: The numerical data collected from the questionnaires were analyzed using Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics were computed to summarize participant responses, followed by correlation analysis to examine relationships between key variables such as T&D effectiveness, job satisfaction, and retention intentions. Additionally, regression analysis was conducted to explore the predictive value of T&D on employee retention outcomes.

- **Qualitative Analysis**: The qualitative data from the interviews were transcribed and analyzed using NVivo software. A thematic analysis approach was adopted, involving the coding of data into emerging themes and subthemes. This process facilitated the identification of patterns related to the integration of sustainability principles into HR practices, the perceived value of training programs, and factors influencing employee loyalty and engagement.

Findings

Structure and Implementation of T&D-The analysis revealed that most of the surveyed private universities conducted regular training and development (T&D) programs as part of their professional development efforts. These programs typically focused on core academic competencies such as pedagogical techniques, the use of digital instructional tools, research methodologies, and soft skills development, including communication and teamwork. Despite the presence of these initiatives, it was evident that only a minority of institutions had formalized T&D strategies supported by dedicated budgets or long-term planning. In many cases, training programs were implemented on an ad-hoc basis, often depending on immediate institutional needs or available funding. There was also significant variation in the frequency, depth, and quality of these programs, with some institutions offering periodic workshops while others lacked consistency in delivery. Furthermore, few universities conducted needs assessments or evaluations to tailor training to specific employee requirements, which often limited the overall effectiveness and relevance of these initiatives.

Impact on Retention-Quantitative data analysis demonstrated a strong positive correlation ($r = 0.68$) between employees' participation in T&D programs and their intention to remain with their current institution. Respondents who reported higher levels of satisfaction with the quality, frequency, and relevance of training programs were significantly less likely to express interest in leaving their roles. Interviews further supported this finding, revealing that staff perceived meaningful T&D opportunities as indicators of organizational support and long-term investment in their careers. Employees noted that well-structured training enhanced their sense of professional competence, job satisfaction, and loyalty to the institution. Conversely, the absence of developmental opportunities contributed to feelings of stagnation and demotivation, which were identified as key drivers of turnover intentions. This suggests that T&D initiatives not only improve skills but also serve as critical tools for enhancing employee engagement and institutional retention.

Sustainability in HR Practices-The integration of sustainability principles within human resource (HR) practices was found to be limited across the surveyed institutions. Only a small number of universities reported having a strategic framework that explicitly linked HR policies with broader sustainability goals, such as long-term workforce planning, employee well-being, or environmental responsibility. In institutions where such alignment existed, participants described a more holistic and inclusive work environment, characterized by transparent career progression pathways, participative decision-making, and attention to work-life balance. These universities reported higher levels of organizational commitment, motivation, and employee engagement. Moreover, sustainability-oriented HR practices appeared to promote a culture of continuous improvement and mutual accountability, which further reinforced retention by creating a stable and supportive professional ecosystem. The findings indicate that integrating sustainability into talent management strategies can yield not only ecological or social benefits but also tangible improvements in employee satisfaction and organizational resilience.

Conclusion

This research set out to examine the critical role of Training and Development (T&D) in promoting Sustainable Talent Management (STM) and enhancing employee retention in private universities across India. In the face of increasing competition and evolving expectations in the higher education sector, private institutions are under pressure to not only attract top talent but also retain skilled faculty and administrative staff who contribute to long-term institutional success. The findings of this study underscore the strategic importance of T&D as a foundational element of STM.

The evidence gathered through surveys and interviews suggests that well-structured, consistent, and goal-oriented T&D programs significantly influence employees' sense of professional fulfillment, job satisfaction, and commitment to their organizations. Institutions that prioritize developmental opportunities for their staff are more likely to foster an environment of trust, engagement, and long-term loyalty. Furthermore, the study confirms a robust positive correlation between participation in effective training initiatives and an employee's intention to remain with their institution, highlighting T&D as a practical tool for reducing turnover rates.

However, the research also reveals several challenges that impede the full potential of T&D in supporting STM. These include a lack of dedicated financial resources, short-term planning, limited customization of training modules, and insufficient evaluation mechanisms. Additionally, the study identifies a gap in the integration of sustainability principles into HR strategies, with only a handful of universities aligning their talent development efforts with broader sustainability objectives such as equity, inclusiveness, and long-term workforce resilience.

To fully leverage the benefits of T&D in fostering STM, private universities in India must adopt a more strategic and sustainable approach. This involves aligning training programs with institutional goals, ensuring equitable access to development opportunities, and embedding sustainability into the core of HR practices. Doing so not only enhances employee retention but also contributes to the creation of a resilient, future-ready academic workforce.

In summary, T&D is not merely a functional HR activity—it is a strategic lever for sustainable institutional development. By investing in continuous learning and aligning such investments with sustainability goals, private universities can position themselves as forward-thinking employers capable of navigating the dynamic landscape of higher education in India.

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Performance Analysis of 5 Level Diode Clamp Multilevel Inverter

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ABSTRACT- Many research efforts have focused on the development of efficient multilevel inverters to achieve high-performance power conversion. Traditionally, switched-capacitor multilevel inverters with six switches have been widely used for DC-to-AC power conversion. However, these configurations suffer from switching losses and increased circuit complexity.The primary objective of this work is to design a cost-effective, simple, and efficient single-phase multilevel inverter. In this research, a single-phase five-level diode-clamped inverter is implemented. The inverter employs multicarrier pulse width modulation (PWM) using a sinusoidal reference signal and triangular carrier signals. This modulation strategy effectively reduces Total Harmonic Distortion (THD)**,** achieving values of less than 5%, thereby improving the overall efficiency of the system. Simulations were carried out in the MATLAB/Simulink environment to evaluate system performance. The obtained results demonstrate improved line current and line voltage profiles with minimal harmonic distortion. A comparative analysis confirms that the proposed inverter exhibits superior performance compared to conventional approaches.

KEYWORDS-NPC,MLI,THD,MOSFET,VSC,EMC,PV,FC,DCI,MLC.

1. Introduction

In recent years, global electricity consumption has risen sharply due to the continuous growth in energy demand. This has led to extensive use of fossil fuels and other conventional energy resources, which are major contributors to greenhouse gas emissions and global warming. To address these environmental challenges, significant research efforts have been directed toward finding alternative and renewable energy sources. Over the past three decades, renewable energy (RE) has emerged as a key area of focus, offering sustainable, naturally abundant, and environmentally friendly solutions.

Most renewable energy resources, such as solar, wind, tidal, and biomass, inherently generate power in the form of direct current (DC). However, modern electrical transmission systems are primarily based on alternating current (AC), and most household and industrial appliances

require AC for operation. This creates a critical need for inverters, which convert DC energy into usable AC energy.

An inverter is an electrical device that converts direct current (DC) into alternating current (AC). Early inverters were limited to two-level configurations, utilizing only a few semiconductor switches. With the rapid growth of high-power applications, often reaching the megawatt scale, conventional two-level inverters proved inadequate. To overcome these limitations, multilevel inverters (MLIs) were developed. MLIs not only enhance the efficiency of high-power applications but also provide better power quality, lower switching losses, and higher voltage handling capability.

Within power electronics, DC/AC converters form a vital branch of technology. These devices perform the conversion and control of electrical power from DC sources to AC outputs, adjusting voltage magnitude, frequency, and the number of output phases to suit user requirements. Advances in semiconductor devices—such as Bipolar Junction Transistors (BJTs), Metal-Oxide Semiconductor Field Effect Transistors (MOSFETs), and Insulated Gate Bipolar Transistors (IGBTs)—have greatly improved the performance of such converters.

Power electronics today plays a pivotal role in energy systems, enabling the conversion and control of electrical energy across a wide power range, from milliwatts to hundreds of megawatts. Power electronic converters are used wherever there is a need to modify electrical parameters such as current, voltage, or frequency, and they are classified based on their input and output types.

The fundamental function of a converter is to transform electrical energy from one form— DC or AC—into either the same or another form, such as DC–DC, AC–AC, or DC–AC. Modern converters are also capable of operating bidirectionally, reducing the number of required system components in applications like starter–generator drives. By integrating advanced semiconductor switches with filtering components such as inductors and capacitors, converters achieve highly efficient energy transformation, forming the backbone of modern power systems.

2. Multilevel Inverter Concept

A multilevel inverter employs an arrangement of power semiconductor switches along with several lower-voltage DC sources to generate a staircase-like output voltage waveform. This waveform can be controlled in terms of frequency, phase, and amplitude, making the inverter suitable for high-performance applications. Typical DC sources used in such systems include batteries, capacitors, and renewable energy resources like photovoltaic (PV) panels.

Multilevel inverters are recognized for their characteristic stepped output waveforms. In a single-phase N-level inverter, the generalized waveform consists of identical positive and negative halves, each comprising $(N-1)/2(N-1)/2(N-1)/2$ voltage levels. This staircase approximation of a sinusoidal waveform significantly improves harmonic performance, as illustrated in **Figure 3.1**.

An important observation is that the number of levels (*N*) in the output is generally chosen to be odd rather than even. This is due to the inclusion of a zero-voltage level, which allows for a more symmetrical waveform and enhances its harmonic profile.

Classification of Multilevel Inverters

Multilevel inverters are classified into three major topologies:

1. **Diode-Clamped Multilevel Inverter (DCMLI)**
   o Uses diodes to clamp voltage levels across switches.
   o Widely adopted for medium- and high-voltage applications.
2. **Flying Capacitor Multilevel Inverter (FCMLI)**
   o Employs capacitors as voltage balancing components.
   o Offers flexibility but requires a large number of capacitors.
3. **Cascaded H-Bridge Multilevel Inverter (CHBMLI)**
   o Consists of multiple H-bridge cells connected in series, each powered by a separate DC source.
   o Commonly used in renewable energy integration due to modularity.

These topologies, often termed as **classical structures**, serve as the foundation for numerous modern variations of multilevel inverter designs.
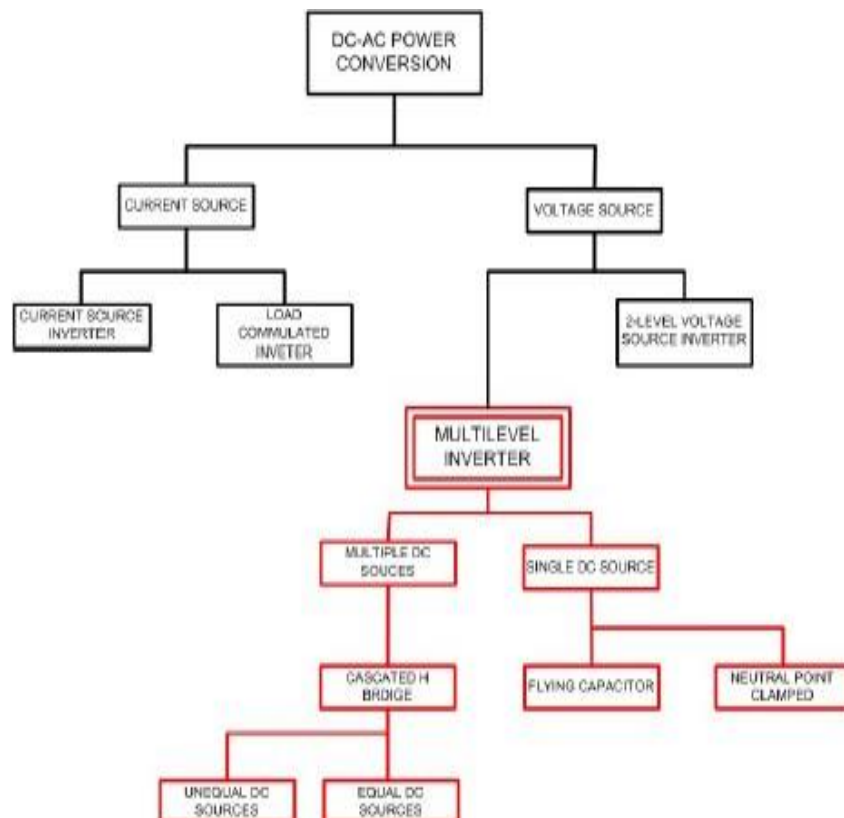
Figure3.1: Multilevel inverter classifications

4. Proposed Inverter

Neutral Point Clamped (NPC) five-level inverter schemes, as discussed in the literature, face inherent **capacitor voltage balancing issues**. Unequal voltage distribution across the DC-link capacitors can lead to device stress, semiconductor damage, and unwanted harmonics in the output waveform. Traditional modulation techniques cannot fully exploit the larger number of levels, redundant voltage vectors, and zero common-mode voltage vectors that are available in five-level diode-clamped inverters (DCIs). As a result, challenges such as switching frequency limitations, common-mode voltage elimination, and capacitor voltage imbalance persist, reducing the efficiency and reliability of these systems. The objective of this chapter is to propose a **multicarrier-based voltage balancing strategy** for a novel five-level single-phase NPC-MLI topology. This design employs a reduced number of clamping diodes compared to conventional five-level DCIs, making it simpler and more cost-effective. A switching function model of the topology is also derived to predict DC-link capacitor currents by monitoring load currents for each switching state, while effectively using redundant switching vectors.Among the available multilevel inverter topologies, the **diode-clamped inverter** is the most widely used. In this topology, diodes are employed as clamping devices to divide and limit the DC bus voltage, thereby creating multiple steps in the output voltage waveform.

The key principle is that each switch and capacitor in the structure is subjected only to a fraction of the total DC bus voltage (V_{dc}), reducing voltage stress on individual devices. For an *n*-level inverter:

- The design requires $(n-1)$ voltage sources,
- $2(n-1)$ switching devices, and
- $(n-1)(n-2)$ clamping diodes.

By increasing the number of voltage levels, the quality of the output waveform improves, and it becomes closer to a pure sinusoidal waveform, thereby reducing harmonic distortion.
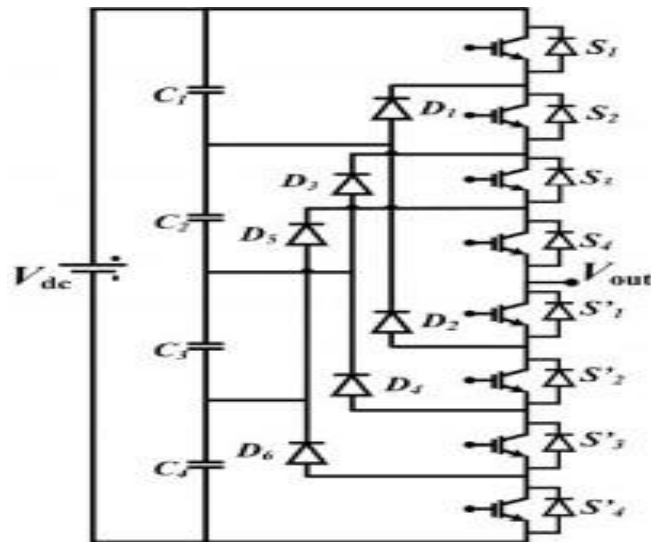
Figure 4.1:Single Phase 5 Level NPC-MLI with equal diode voltage

5. Result & Discussion

In this Section discuss about the simulation of the proposed system which discussed in previous section MATLAB is the software which is used for simulation of the proposed system. The main objective of simulation is to check the performance of the proposed neutral phase clamped multilevel inverter (NPC-MLI) with the application of various load in domestic application. For simulation of the proposed work here simpower system tool box of MATLAB is used. Figure 6.1 shows the Simulink model of the proposed system.
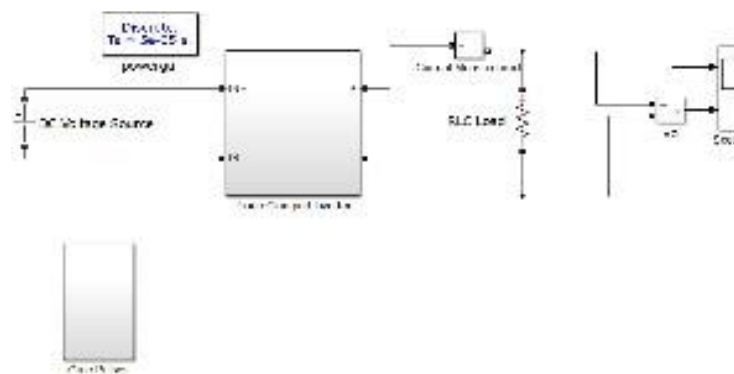

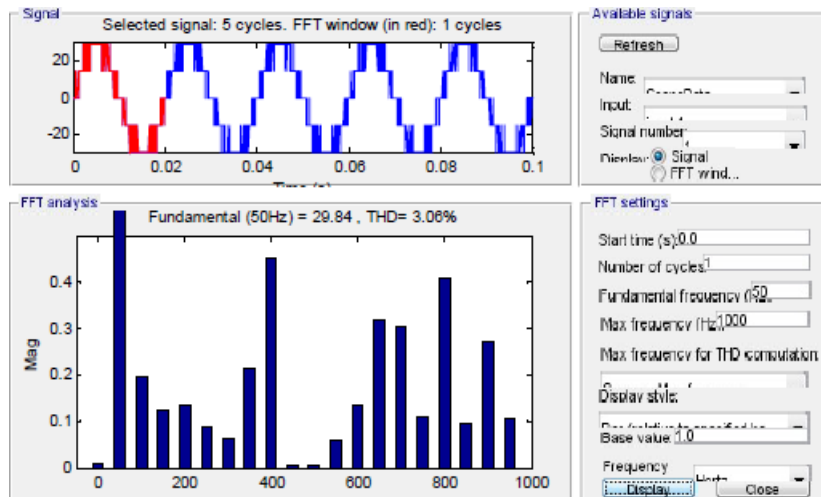Figure 5.1: SIMULINK model of proposed NPC-MLI
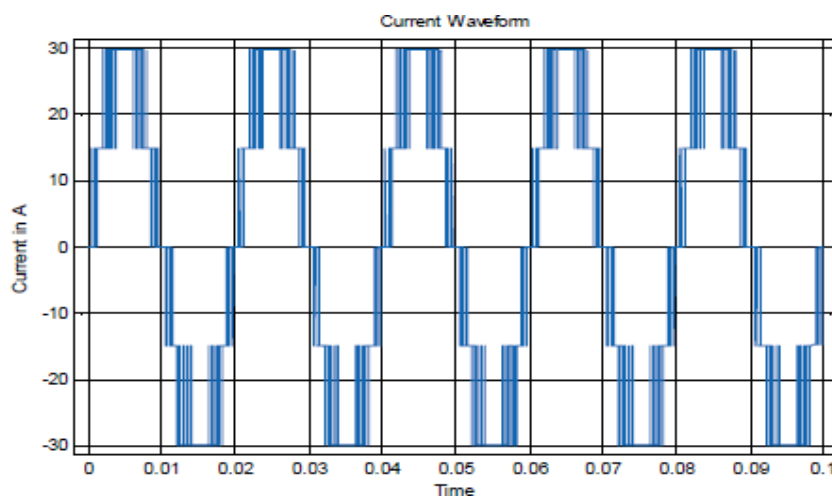
Figure 5.2: THD analysis of voltage waveform

Figure 5.3: Voltage of 5 level proposed inverter

6. Conclusion

Power inverters play a major role in the conversion of DC power into AC power. In recent years, with the growing application of non-conventional energy sources, the demand for efficient inverters has increased significantly. Conventional power inverters, however, often introduce harmonics into electrical appliances, which can reduce their efficiency and shorten their lifespan. Traditionally, DC–AC conversion has been achieved using a two-stage process, which makes the circuitry more complex and costly. Therefore, there is a need for a new type of power inverter that features a simpler design while minimizing harmonic distortion, thereby improving overall system performance and reliability.

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