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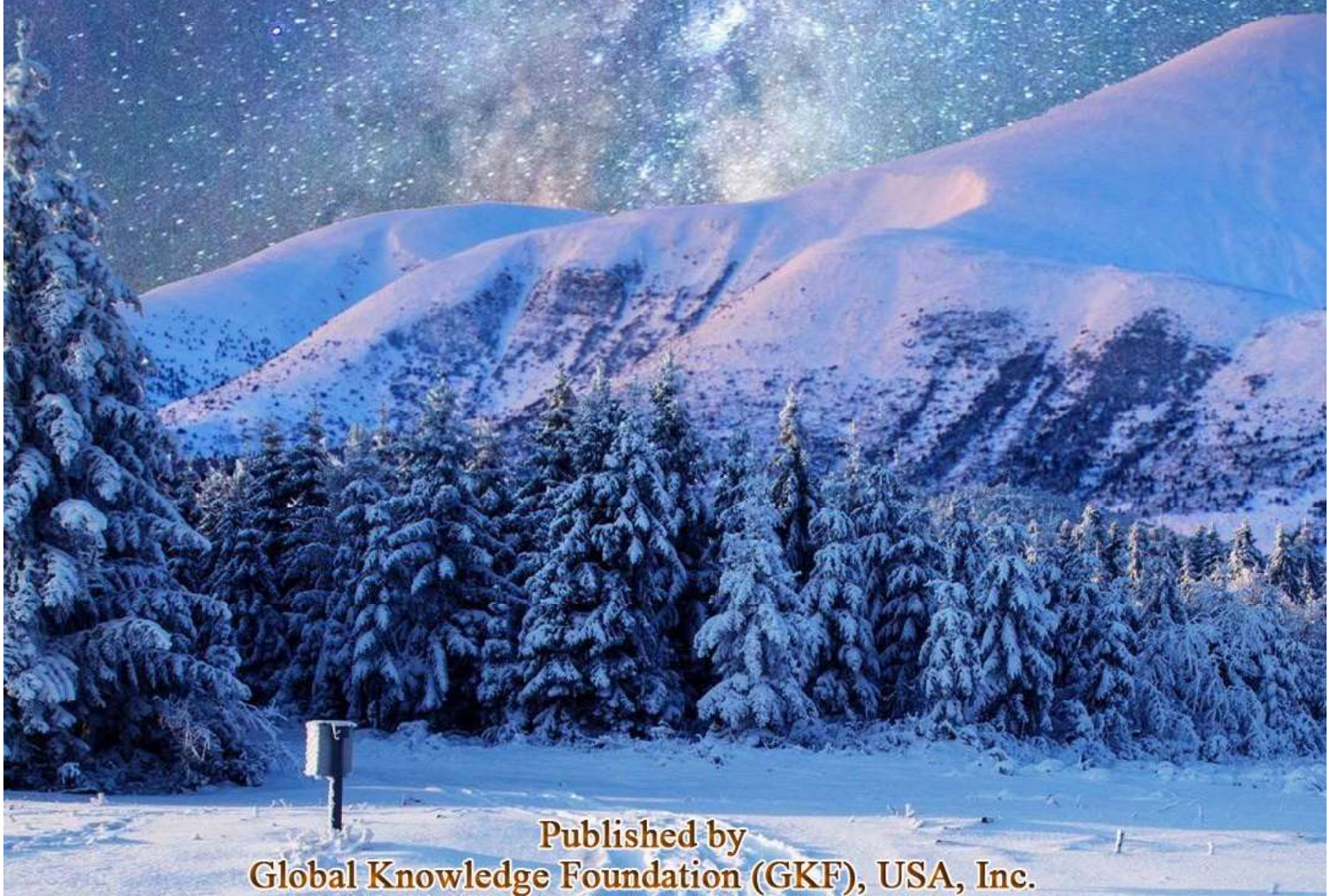

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# CHHATTISGARH AI: A WEB PORTAL FOR AI SENSITISATION IN THE STATE

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Chhattisgarh AI is an artificial intelligence teaching platform Inspired by India AI and Odisha AI. This project provides two types of courses fast is basic AI and second is advance AI. The website under development is targeted at the people of Chhattisgarh and is expected to provide basic information about Artificial Intelligence in the simplest way possible. Everyone, including the children and students, farmers, housewives, and even the senior citizens should be able to understand AI in Chhattisgarhi language. This Project is Hosted by ABVV under the government of Chhattisgarh. This is because we want to ensure that everyone has an equal opportunity of accessing education on AI and being well equipped to face the future. There are two courses which include a Basic Course which gives an overview of the concepts of AI and an Advanced Course which goes a step further to explain the various applications of AI. Both the courses are developed in a way that the learners can enjoy while going through the lessons. In the first phase of each course, the learners watch videos with avatars that explain the concepts in a simple way. In the second phase, the participants solve quizzes based on the videos to know how much they have learnt and to test their understanding. Once a course is completed the learners are awarded with a digital badge as recognition to their time and effort invested. This badge can be a proof of their accomplishment and can be displayed or accessed at any time in the future. Our platform is based on India AI and the main idea is to make sure that every person in Chhattisgarh has access to basic information about AI. Thus, with the help of an interesting and simple interface, we want people to get ready for the increasing use of AI in the world, to be aware of the possibilities and challenges of the technological progress.

**Keywords:** Chhattisgarh, Artificial Intelligence, Education, Odisha AI, Basic AI, Quiz, I-Mita, ABVV.

# QUANTUM-INSPIRED APPROACHES IN MEDICAL IMAGING: A REVIEW OF MACHINE LEARNING TECHNIQUES FOR EARLY DISEASE DETECTION

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**Background:** Medical image analysis using quantum-inspired machine learning (QIML) offers a revolutionary approach to improving early disease identification and detection. Scalability, accuracy, and computing efficiency are issues that traditional machine learning approaches must deal with as the need for accuracy and efficiency in the analysis of complex medical imaging data keeps increasing. QIML overcomes these constraints and improves diagnostic capabilities by utilizing quantum computing-derived concepts including superposition, entanglement, and quantum-inspired optimization.

**Objective:** A thorough examination of the state of QIML applications in medical image analysis is given in this review study. With an emphasis on its function in early disease identification and diagnosis, this review paper attempts to investigate the revolutionary potential of QIML in medical image analysis. By offering a thorough analysis of their theoretical underpinnings, real-world benefits, and developing trends, it aims to close the gap between quantum-inspired methods and useful healthcare applications.

**Methods:** This is accomplished by the paper's methodical assessment of developments in QIML algorithms and their use in vital medical imaging tasks such organ segmentation, tumor detection, and anomaly identification. The efficiency of quantum-inspired optimization techniques in resolving computational issues and enhancing diagnostic results is also assessed. The benefits, drawbacks, and potential applications of QIML in healthcare are determined by analyzing important literature and case studies.

**Result:** Key accomplishments, restrictions, and difficulties in using QIML for medical applications are highlighted in this critical assessment of the body of extant work. The review also covers QIML's potential to speed up clinical workflows, lower computational complexity, and increase diagnostic accuracy. In order to overcome practical and technical obstacles, it also examines potential avenues for future study, highlighting the necessity of interdisciplinary cooperation.

**Conclusion:** This research attempts to highlight the revolutionary potential of QIML in transforming medical image analysis for early disease identification by combining ideas from several investigations. It offers a road map for scientists and professionals to use quantum-inspired technology to make major strides in precision medicine and healthcare.

**Keywords:** Quantum Machine Learning (QML), Medical Image Analysis, Organ Segmentation

# A HOLISTIC AI-INTEGRATED APPROACH TO PRECISION AGRICULTURE: FOR OPTIMIZING CROP HEALTH AND FARM PRODUCTIVITYUSING MACHINE LEARNING TECHNIQUES

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Agriculture is fundamental to global food security and economic stability, yet it faces major challenges such as crop diseases, soil degradation, inefficient fertilizer use, and climate change. Precision agriculture (PA), driven by machine learning (ML) and deep learning (DL), offers data-driven solutions to enhance crop health, optimize resource utilization, and maximize yields. This research synthesizes findings from authentic research articles, focusing on crop disease identification, fertilizer recommendation, yield prediction, and soil management. Advances in computer vision, particularly Convolutional Neural Networks (CNNs), have improved disease detection accuracy through image-based analysis, while ML algorithms like Extreme Gradient Boosting (XGBoost) have enhanced fertilizer recommendations by analyzing soil and environmental factors. Yield prediction models leveraging historical data, satellite imagery, and weather conditions provide valuable insights for farmers, while ML-integrated soil management systems monitor and improve soil health. However, existing models face challenges such as limited generalization across diverse agricultural environments, inadequate early disease detection, and inefficient fertilizer recommendations that fail to consider specific soil and crop conditions. To address these gaps, this study proposes a hybrid approach integrating CNN for disease detection and XGBoost for fertilizer recommendation. This model combines the strengths of ML and DL, ensuring improved accuracy, scalability, cost-effectiveness, and sustainability. Future research should focus on expanding datasets, enhancing real-world adaptability, and integrating multi-modal data sources. AI-driven PA solutions, coupled with IoT and cloud computing, have the potential to revolutionize modern farming, ensuring sustainable practices, reducing resource wastage, and enhancing food security globally. This study bridges critical gaps in existing research and contributes to the advancement of AI-driven precision agriculture for improved efficiency and sustainability.

**Keywords:** Precision Agriculture, Machine Learning, Deep Learning, Crop Disease Detection, Fertilizer Recommendation, Yield Prediction, Soil Management, CNN, XGBoost, AI in Agriculture.

# MACHINE LEARNING BASED HYBRID MODEL FOR CROP RECOMMENDATION AND YIELD PREDICTION

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As global food demands increase, agricultural techniques must adapt to overcome inefficiencies, unpredictable yields, and the need for sustainable practices. Traditional farming methods often lack the precision required for optimal resource use and accurate crop forecasts. This research work presents an innovative machine learning-based hybrid model for crop recommendation and yield prediction, essential for planning agricultural commodities, import-export strategies, and improving farmers' income. The model comprises two components: the Crop Recommendation System, which uses extensive datasets on soil and weather conditions trained with various machine learning algorithms, achieving accuracies such as 99.54% for Naïve Bayes and 98.86% for both Decision Tree and Random Forest. The second component i.e. Yield Prediction System forecasts annual crop production (in tons) using data from 101 countries, considering factors like average rainfall and temperature, where Decision tree, Random forests, Lasso regression, and Support vector machine are applied giving combined accuracy of 98%. This robust model provides actionable insights, significantly improving prediction accuracy over traditional methods. By addressing data heterogeneity and computational scalability, this technology enhances efficient and sustainable farming practices. Ultimately, it empowers farmers and stakeholders to transform food production and ensure a sustainable agricultural future.

**Keywords:** Crop Recommendation, Yield Prediction, RNN, Decision Trees, Random Forests, Support Vector Regression.

# AUTOMATED MULTIPLE CHOICE QUESTION GENERATION FROM TRANSFORMER MODELS

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This research paper explores the application of transformer models in the domain of automated multiple-choice question (MCQ) generation. With the increasing demand for efficient and scalable methods to create assessments, the utilization of natural language processing (NLP) techniques, particularly transformers, has gained prominence. This paper presents a comprehensive study of the architecture, implementation, and evaluation of an automated MCQ generator based on transformer models. The proposed system aims to streamline the process of question creation, providing educators and content creators with a powerful tool for generating diverse and contextually relevant multiple-choice questions.

**Keywords**: Natural language processing, Automated model, Transformer model, Text-to-question generation.

# TOMATO PLANT DISEASE DETECTION USING MACHINE LEARNING TECHNIQUES

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Tomato is the most important and used crop in everyone's house in this world and is produced in high quantity with high commercial value. After wheat, rice, and potato, it is the most widely cultivated crop in the world. But the quality and quantity of the crop are decreasing day by day, affected by various kinds of diseases. Due to this, farmers are worried that their plants are getting infected and their crops are getting ruined, and they do not have any immediate solution available. So, to detect and classify the various tomato plant diseases we have come up with a solution in this paper, a deep learning based Convolutional Neural Network (CNN) model is used. In this model, there are 6 convolutional and 6 max pooling layers followed by 2 fully connected layer. The experimental results show the efficiency of the proposed model over the pre-trained model, i.e., VGG16. The classification accuracy varies from 85% to 100% with respect to classes and average accuracy of the proposed model is 94.4% for the Tomato Leaf Disease dataset, which contains nine diseases and one healthy class, each class contains 1000 images of tomato leaves.

**Keywords:** Tomato Plant Disease, Machine Learning, Convolution Neural Network (CNN), Deep Learning, Supervised Learning, VGG16, Classification.

# ENERGY-EFFICIENT CLUSTER-BASED COMMUNICATION IN MOBILE WIRELESS SENSOR NETWORKS USING MULTIPLE MOBILE SINK A BASELINE MODEL

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Ensuring energy efficiency and reliable communication in Mobile Wireless Sensor Networks (MWSNs) becomes increasingly challenging when multiple mobile sinks are involved, particularly in grid-based mobility scenarios. This paper presents an energy-efficient cluster-based communication model designed for MWSNs with two mobile sinks following a predefined grid structure. The objective is to optimize data packet transfer from sensor nodes to their respective cluster heads (CHs) and ultimately to the sinks while improving key performance metrics, like Throughput, Packet Delivery Ratio (PDR), End-to-End (E2E) delay, latency and reliability. The proposed model incorporates a dynamic clustering mechanism, where Cluster Heads are going to select based on mobility patterns, residual energy as well as spatial proximity to sensor nodes. This strategy assures balanced energy consumption across the MWSN, reducing the risk of energy depletion in critical nodes. A mobility-aware routing protocol leverages the predictable grid-based movement of the sinks to minimize communication overhead and delays. Furthermore, adaptive data aggregation techniques are employed to eliminate redundant transmissions, enhancing overall network efficiency. Simulation results shows that the model noteworthy outperforms as compare to existing approaches in following metrics of reduced latency, PDR, minimized E2E delay and improved reliability. By efficiently managing the dual mobile sinks and their grid-based movement, the proposed solution provides a scalable and robust framework for real-time applications such as environmental monitoring, disaster response, and smart city systems. This work offers a baseline for future advancements in energy-efficient and mobility-aware communication in MWSNs with multiple sinks.

**Keywords:** MWSN, Multiple Mobile Sink, Packet Delivery Ratio, Latency.

# TRANSFORMER-BASED SENTIMENT ANALYSIS OF AMAZON FINE FOOD REVIEWS

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Digital resources such as smart application reviews and online feedback, are essential for collecting client insights and understanding consumer sentiment. These reviews provide significant information regarding products and services, assisting individuals in making informed purchasing choices. The importance of these factors has increased within the eCommerce sector, as they play a crucial role in making consumer trust and influencing decision-making processes. In this article, we introduce a model that utilizes the Transformer architecture, applying Natural Language Processing (NLP) methods to estimate overall review scores derived from textual descriptions. The study employs the "Amazon Fine Food Reviews" dataset, sourced from Kaggle. Prior to model training, the dataset goes through preprocessing, which involved removing rows with null values, eliminating duplicate entries based on the "Text" column, and applying a clean text function to strip unnecessary elements like mentions, URLs, hashtags, email addresses, and extra spaces. The data was further refined by balancing sentiment categories through downsampling the "Positive" class to equal the size of the "Negative" class, ensuring unbiased representation. The proposed model achieved a predictive accuracy of 74.1% and a loss value of 0.613 on the test dataset. The application of this model could be used in the hospitality sector to analyse customer feedback and generate overall ratings for hotels, restaurants and travel services based on text reviews collected from various sources.

**Keywords:** Sentiment analysis, Transformer, Preprocessing, Natural language processing, Amazon fine food reviews.

# HIGHLIGHTING A CLEAR PERSPECTIVE ON INDIAN LAWS USING AI

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The main goal of the paper is to create a conversational environment driven by AI (Artificial Intelligence) that can offer reliable and accurate legal advice based on new laws implemented in India. It considers all the bare acts published on the official government site, "Ministry of Home Affairs," in English. Utilizing natural language processing tools such as Meta's Llama-2-7B chat model, the system is designed to provide contextually informed responses.The research combines the FAISS library with sophisticated embeddings for effective retrieval from a vector database, allowing the assistant to respond to user inquiries based on the supplied context. The combination of generative AI and retrieval-based models ensures accurate responses for users. The project uses a pipeline for embedded storage, model loading, and query resolution, and it is designed for proper deployment.By providing a user-friendly and scalable solution, the project aims to be highly useful for advocates, law students, legal scholars, and the general public. While upholding ethical AI principles, the ultimate objective is to democratize access to legal information.

**Keywords:** Conversational System, Legal Advice, Natural Language Processing.

# SMART IOT-BASED IV BAG MONITORING AND ALERT SYSTEM FOR ENHANCED HEALTHCARE AUTOMATION

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The day-to-day monitoring of patients in a hospital is a challenging task under our existing medical care system. During Health Hazard times like Covid 19 physicians or nurses are too busy to keep track of every patient. This leads to numerous issues. Work relating to health should be completed correctly and accurately. Saline or intravenous fluid injections into patient veins are an example of this kind of activity in our hospitals. IV therapy is an essential medical procedure, yet manual monitoring of IV bags can lead to delays, human error, and compromised patient safety. This research introduces an IoT-based IV Bag Monitoring and Alert System that automates the supervision of IV fluid levels and flow status. The system integrates a Load Cell Sensor with the HX711 module, an IR Sensor, and the ESP8266 NodeMCU Wi-Fi Module to provide accurate, real-time data.The load cell sensor precisely measures the IV bag's weight to determine the remaining fluid, while the IR sensor monitors the presence of air bubbles or blockages in the IV line, a critical safety parameter. The ESP8266 NodeMCU processes the sensor data and transmits it wirelessly to the Blynk app, offering a user-friendly interface for healthcare providers. Alerts are triggered in the app when fluid levels fall below a predefined threshold or when irregularities in flow are detected, ensuring timely action. This system is cost-effective, scalable, and efficient, reducing the dependency on manual checks and enhancing patient care quality. By enabling remote monitoring and real-time alerts, it minimizes the risks associated with IV therapy, improving hospital workflow and patient outcomes.

**Keywords:** Internet of Things (IoT), Intravenous (IV) Monitoring, ESP8266 NodeMCU, Load Cell Sensor, HX711 Module, IR Sensor, Healthcare Automation, Blynk App, Real-Time Alerts.

# CRACKS IN CONCRETE STRUCTURES AND THEIR PREDICTION THROUGH MACHINE LEARNING

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Cracks in concrete structures are critical indicators of structural health and durability, often resulting from complex interactions between material properties, environmental conditions, and applied loads. Concrete, being a quasi-brittle material, exhibits non-linear stress-strain behavior, shrinkage, and creep, which contribute to crack initiation and propagation over time. Traditional methods of crack detection and prediction rely heavily on manual inspections and basic analytical models, which can be time-consuming, subjective, and prone to human error. Recent advancements in machine learning (ML) provide innovative solutions for addressing these challenges by offering robust tools for analyzing the behavior of concrete under various conditions. This study explores the application of ML techniques to predict and analyse cracks in concrete structures, taking into account material heterogeneity, load distribution, and environmental stressors such as temperature variations and moisture diffusion. Leveraging datasets from non-destructive testing (NDT), digital imaging, and structural monitoring, ML algorithms such as convolutional neural networks (CNNs) for crack image analysis, and predictive models like decision trees and support vector machines, are used to model crack formation and propagation. These models account for key aspects of concrete behavior, including strain localization, tensile strength, and the influence of reinforcement on crack patterns. Furthermore, integrating ML models with real-time monitoring systems enables the identification of micro-cracks before they evolve into larger, structurally significant defects. The predictive capability of ML models facilitates proactive maintenance strategies, reducing repair costs and enhancing the lifespan of structures. The findings underscore the importance of data-driven approaches in civil engineering, providing new insights into the behavior of concrete and paving the way for smarter, more resilient infrastructure.

**Keywords:** Concrete, Cracks, Machine Learning, Structural Health Monitoring.

# AUTONOMUS ROBO-CAR WITH INTEGRATED SPY CAMERA (SPY-ROBO)

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Autonomous Robo-Car with an integrated spy camera system, designed to enhance security and surveillance capabilities in various environments. The Robo-Car employs advanced sensors, machine learning algorithms, and an embedded camera system to autonomously navigate urban and rural landscapes while capturing high-resolution video footage. Equipped with real-time image recognition, the system can identify and track specific objects or individuals of interest, making it an effective tool for security, law enforcement, and private surveillance applications. The integration of the spy camera with autonomous driving technology allows the Robo-Car to operate without human intervention, navigating through challenging terrains while maintaining a constant surveillance presence. With cloud connectivity, users can access the camera feed remotely through a secure mobile app, allowing real-time monitoring and decision-making. This setup ensures that critical footage is captured and transmitted securely, enabling prompt responses to potential threats or security breaches. This system is designed to be cost-effective and adaptable, suitable for various applications ranging from urban surveillance to rural security. The autonomous movement of the Robo-Car reduces human oversight requirements, while the integrated spy camera provides continuous, real-time surveillance, enhancing security and situational awareness.

**Keywords**: Autonomous Robo-Car, Spy Camera, Autonomous Navigation, Machine Learning, Real-Time Surveillance, Remote Monitoring, Object Tracking, Security, Cloud Connectivity, Internet of Things (IoT), Video Streaming, Surveillance Technology.

# HEALTH SPROUT PERSONALIZED WEB- BASED DIET RECOMMENDATION SYSTEM

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Health sprout is a web-based application designed to provide personalized diets for customers or users based on their health data, and it also includes allergies. This system is available to calculate Basal Metabolic Rate (BMR) for all age groups. It includes factors like age, weight, height, gender, activity level, and food allergies that help to generate a healthy diet plan. By using the Random Forest model, it provides suitable food items and also helps in filtering allergies to reduce the health risk of users. The main reason for creating Healthsprout is to promote a healthy lifestyle for people and provide a perfect diet plan according to their personal needs. This application will help in reducing the habits of unhealthy eating, which causes health issues likeobesity and diabetes.An important part of the Healthsprout is that it can generate an allergy-free diet plan for one day as well as one week. It provides food according to user needs and taste and also provides information on seasonal fruits and vegetables for users. AI-driven recommendation is used in Healthsprout to provide customizabledietplansthat are based on data of health, level of activity, and changes in diet.

**Keywords:** Personalized diet recommendations, Random Forest model, Allergy filtering.

# COVERAGE AND CONNECTIVITY OPTIMIZATION IN WIRELESS SENSOR NETWORKS WITH CONTIKI COOJA

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For wireless sensor networks (WSNs) to be effective, coverage and connectivity are crucial, especially for applications that need dependable data collection and transfer. The Cooja simulator and the Contiki operating system are used in this study to maximize coverage and connection in WSNs. optimizes coverage while maintaining consistent network connectivity by combining energy-efficient routing algorithms with flexible node placement strategies. By incorporating dynamic modifications based on communication range and node energy levels, the protocol ensures optimal resource usage and prolongs network lifetime. The protocol is tested under a range of network conditions, such as varying node densities, topologies, and energy limitations, using Cooja's simulation capabilities and Contiki's energy modeling. To evaluate the effectiveness of the protocol, performance parameters such packet delivery ratio, network lifetime, coverage ratio, and connectivity maintenance are examined. According to simulation results, the suggested method performs noticeably better than conventional protocols in terms of coverage area, energy efficiency, and connectivity dependability. The study also emphasizes the trade-offs between energy usage and coverage, providing guidance for creating scalable and balanced WSNs. By tackling the dual problems of coverage and connectivity, this study advances WSN technology and offers a workable framework for sustainable and energy-efficient network operations. The results are especially pertinent to applications where resource-constrained network optimization is crucial, such as smart cities, industrial automation, and environmental monitoring.

**Keywords:** WSN, Adaptive Clustering, Contiki Cooja, Energy Saving, Sink Mobility.

# CREDIT CARD FRAUD DETECTION: A MACHINE LEARNING APPROACH

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Credit card fraud is a significant problem which refers to the physical loss of a credit card or the loss of sensitive credit card information, with billions of dollars lost each year. Machine learning can be used to detect this fraud by identifying patterns that are indicative of fraudulent transactions. E-commerce and many other online sites have increased the online payment modes, increasing the risk for online frauds. Increase in fraud rates, researchers started using different machine learning methods to detect and analyse frauds in online transaction. The main aim of this paper is to design and develop a novel fraud detection method for streaming transaction data, with an objective to analyse the past transaction details of the customers and extract the behavioral patterns. We have used many machine learning algorithms to detect credit card fraud so that cardholders can avoid the losses. The aim of this paper is to identify fraudulent transactions and prevent them, while also reducing the risk of blocking legitimate customers.

**Keyword**: Random Forest, kNN, Logistics Regression, Support Vector Machine etc.

# INTEGRATING DEEP LEARNING AND EXPLAINABLE AI FOR ACCURATE FLOOD MAPPING

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Flood mapping and segmentation are essential activities in disaster management and mitigation, requiring great accuracy and dependability. This study assesses the efficacy of many advanced deep learning models, including OCRNet, Swin Transformer, FPN, PSPNet, and TransUnet, with a flood dataset. The models are evaluated using essential measures including recall, precision, F1-score, Dice coefficient, mean intersection over union (mIoU), and overall accuracy. TransUnet attained the superior performance with a recall of 91.47%, precision of 91.66%, F1-score of 91.60%, Dice coefficient of 90.7%, mIoU of 83.2%, and accuracy of 91.8%. To improve the interpretability and dependability of the model, we applied Explainable AI (XAI) techniques, primarily LIME (Local Interpretable Model-Agnostic Explanations), on the TransUnet model.The use of XAI explained the model's decision-making process, identifying essential areas that affect predictions and so enhancing transparency.This study demonstrates the efficacy of TransUnet in flood segmentation and highlights the necessity of integrating explainability for reliable AI applications in disaster management.

**Keywords**: Flood Mapping, Flood Segmentation, Deep Learning, TransUnet, OCRNet, Swin Transformer, FPN, PSPNet, Explainable AI (XAI), LIME, Model Interpretability, Disaster Management, Semantic Segmentation, mIoU, Dice Coefficient.

# IOT BASED SMART LUGGAGE SYSTEM FOR ENHANCED SAFETY AND TRACKING

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This research focuses on designing and developing an IoT-based smart luggage system that ensures enhanced security and convenience for travelers. The proposed smart luggage integrates advanced features like real-time location tracking, safety mechanisms, and IoT-enabled sensors to address common travel challenges such as lost or stolen luggage. The system employs GPS technology for precise location tracking, allowing users to monitor their luggage's position via a dedicated mobile application, thereby reducing the risk of misplacement during transit. A microcontroller serves as the central processing unit, interfacing with various sensors and communication modules. The proposed smart luggage also includes a dedicated women's safety mechanism. In emergencies, the user can trigger an SOS alert through the luggage, instantly sharing their real time location with pre-registered emergency contacts. Additionally, the system incorporates a panic alarm feature to deter potential threats. The smart luggage is designed for scalability, enabling seamless integration of future technologies. By leveraging microcontrollers and IoT based sensors, this system ensures enhanced security, efficiency, and user convenience, making it an ideal travel companion for modern users.

**Keywords:** IOT, Smart Luggage System, GPS (Global Positioning System), Women Safety.

# IMAGE BASED FOOD CALORIE ESTIMATOR USING AI AND DEEP LEARNING (NutriVision-G)

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Image based Food Calorie Estimator (NutriVision-G) Using InceptionV3 deep learning model and Flask is an AI-powered Web based application designed to predict the calorie content of food items from image inputs. Predicting the calories and nutritional content of food is a very critical challenge in nutrition and health monitoring. Traditional ways for manual calorie tracking are very inefficient, error-prone, and extra time-consuming, which limits their usefulness in maintaining and promoting healthier eating habits. Understanding to this problem, there is an increasing demand for an efficient, automated, and user-friendly technology that can properly recognize food products and estimate their calorie content from photographs and images. (NutriVision-G) uses InceptionV3 deep learning model using various image and calorie datasets such as Food-101, Fruits and Vegetables Dataset, and Indian Food Dataset. This method provides accurate results by detecting food items and analyzing their visual properties like color, texture and patterns. Calorie values are calculated from a structured CSV-based calorie mapping dataset, ensuring precise estimates of the food. Developed model is supported by a Flask backend that handles image preprocessing, API connectivity, and model predictions. Providing easy approach in the system, users can either upload images or take them in real time using a camera. This paper bridges the gap between current technology and nutrition understanding, supporting better and healthy lifestyles. Users can easily upload or capture photographs of food, receive correct calorie estimates, and know about their nutritional intake. It also sets the framework for future enhancements such as portion size analysis, multi-food detection, complete nutritional value detection and integration with health-tracking systems, and more comprehensivedietary managementsolutions.

**Keywords**: Calorie Estimation, Artificial Intelligence, InceptionV3, Flask, Image Recognition, Machine Vision, Dietary Monitoring.

# RECIPE RECOMMENDATION SYSTEM: A MACHINE LEARNING APPROACH

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This research is all about the preparation of cuisines which can be from any of the region it takes ingredients from the users and recommend similar recipes. As nowadays it is the era of internet, we can make recipes using internet but user often struggle to find most relevant recipes based on ingredients they have because there are millions of recipes on internet. To solve this problem, this model has been developed which will recommend related recipes on the basis of ingredients and will also give instruction to cook that food. This will decrease time of thinking about what to make from specific ingredients it is very good for us knowing that the science has grown this much that it is helping us even in this way. In this, we have presented machine learning based approach by system utilizes fine-tuning SBERT model with cosine similarity for identifying similar recipes from dataset and integrating Spoonacular API for additional details. The model achieves an accuracy 90%, demonstrating its effectiveness in improving recipe recommendation compared to traditional recipe search technique.

**Keywords**: Fine-Tuned SBERT Model, Spoonacular API, Deep Learning, Natural Language Processing (NLP).

# DEVELOPMENT OF A WEB APPLICATION FOR SMART BICYCLE RENTAL SYSTEM

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Sometimes when we are moving to other cities for our higher studies for our work and other related works it becomes difficult to carry our means of transportation to other cities due to which we often end up facing many problems related to mobility. To overcome this problem, we have come up with our project The Cycle Sync. Cycle Sync is a web application-based project where we are basically designing a user-friendly website, through this website the users can book the bicycles on an hourly, weekly or monthly basis. To create our website, we have used modern technologies, for the front end we have used Html, CSS, Js and Bootstrap framework and for the backend we have used NodeJS, EJS framework and MongoDB database. Our vision is to make use of these latest technologies and create an interactive website which is very user friendly so that everyone can easily book bicycles through our website. This helps them to move freely around and according to their own schedules.

**Keywords**: Sustainable Transportation, Mobility, Bicycle Rental, Web Application, User Authentication.

# ARDUINO BASED SMART VACUUMC LEANER ROBOT WITH BLUETOOTH CONTROL

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In today's fast-paced world, balancing work and house hold choreshas become a significant challenge. People are becoming more career-oriented in recent years, making it challenging to manage both home and office responsibilities due to erratic work schedules. Hiring cleaners is a common solution, but many individuals lack trust in them. To address this issue, the Smart Vacuum Cleaner Robot employs advanced technology to automate the cleaning process, offering an efficient and reliable alternative. This project presents a compact, self-operating vacuum cleaner robot powered by an Arduino Nano microcontroller. It integrates an HC-05 Bluetooth module for remote control, BO motors paired with an L298 motor driver for navigation, and a high-speed motor for efficient suction. The system is powered bya rechargeable Li-ion battery, ensuring portability and continuous operation. The robot autonomously navigates and cleans confined spaces without human intervention. Using Bluetooth connectivity, users can control the robot remotely via a smartphone, dding convenience. The main goal is to make clean in geasier by reducing the need for people to help. Most vacuum cleaners today need someone to operate them, which shows we need ones that can work on their own. This project is about creating a vacuum cleaner that can clean without any human help. This self-working vacuumcan safely clean dangerous areas, keeping people safe. By using smart parts and a simple design, this projects how show Arduino technology can be used in robots and home automation, providing a helpful way to make every day cleaning tasks simpler.

**Keywords:** Arduino Nano, HC-05 Bluetooth module, BO motor, L298 driver, high-speed motor, Li-ion battery, Self-cleaning.

# AN EFFICIENT INTEGRATED CLOUD BASED SMART ELECTRIC SWITCHING SYSTEM FOR HOME AUTOMATION

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Managing electrical appliances at home can be challenging, especially when it comes to ensuring convenience, energy efficiency, and ease of control. This research introduces the Smart Electric Board system, which integrates a 4-channel relay module with Amazon Alexa, Google Assistant, and the ESP Rain Maker app to offer smarter appliance management. The 4-channel relay enables users to control multiple appliances simultaneously, such as lights, fans, and other devices, all through a single platform along with voice commands via Amazon Alexa and Google Assistant, users can turn appliances on or off without the need to physically interact with switches. Additionally, the ESP Rain Maker app provides a cloud-based interface, allowing users to remotely monitor and control their appliances from anywhere. Proposed system is user-friendly, affordable, cost-effective, scalable, and efficient, reducing the need for manual control and helps save time and energy by automating the management of home appliances. Proposed system will improve overall home automation and enhances appliance management, increases security, and minimizes energy consumption, ultimately improving the entire home automation experience.

**Keywords**: Smart Electric Switch, Amazon Alexa, Google Assistant, Remote Monitoring, Real-Time Control.

# IOT BASED FIRE FIGHTING ROBOT WITH GSM TECHNOLOGY

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Fires are disasters that leave victims severely affected, such that they can cause loss of life, destruction of property, and permanent disability. Every year, thousands of people die from fire, which consumes homes and kills humans and animals. This project aims at controlling fire with the help of a robotic vehicle for firefighting to boost the chances of effective fighting. In our daily life, fire accidents are very common and sometimes it becomes very difficult for firefighters to save human life. In such a case, firefighting robot comes into the picture. The Fire Fighting Robot is an IoT-based project that uses GSM technology to send message and call after detecting and extinguishing fires independently, with minimal human involvement in dangerous situations. It has a Arduino Nano, a flame sensor for detection, a DC pump for extinguishing flames, and motors controlled by an L298 motor driver for mobility. The robot is powered by a battery and equipped with wheels for movement, making it deployable in various environments. Traditional firefighting methods often put firefighters in harm's way, leading to injuries and fatalities, and in many cases, fires can spread rapidly before firefighters arrive. Robots can help to mitigate this risk and can be deployed immediately, potentially controlling the fire before it escalates. The primary goal to develop Fire Fighting Robot is to enhance fire safety through automation, providing a practical tool for responding to emergencies efficiently where human fire fighters cannot reach directly. Its compact design and advanced functionality ensure a swift response to fire hazards, reducing risks to human lives and proving beneficial in residential, industrial, and remote places.

**Keywords:** Firefighting Robot, IoT, Arduino Nano, Flame Sensor, L298 Motor Driver, GSM Technology, Human Risk Reduction.

# EVALUATING CNN ARCHITECTURES AND EXPLAINABLE AI FOR BUILDING SEGMENTATION IN SATELLITE IMAGERY

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This study evaluates various Convolutional Neural Networks (CNNs) architectures to enhance the segmentation of buildings in satellite imagery. We assess five CNN models: U-Net, FCN, Deep Lab V3+, U-Net++, and Gated-SCNN, using a satellite imagery dataset from Kaggle. The U-Net model achieved remarkable results, with an accuracy of 96.01%, an Intersection over Union (IoU) of 82.79%, and a Dice coefficient of 90.35%. These results highlight significant performance variations across different architectures for segmentation tasks. Additionally, we employ Explainable AI (XAI) techniques, specifically Grad-CAM++, to interpret model predictions and provide insights into the decision-making process of the segmentation models. This study underscores the importance of selecting appropriate CNN architectures for satellite image segmentation and offers valuable insights for applications in urban planning, disaster management, and environmental monitoring.

**Keywords:** Satellite Image Segmentation, Convolutional Neural Networks (CNNs), U-Net, Explainable AI (XAI), Grad-CAM++, Urban Planning, Disaster Management.

# FUZZY USED INNOVATIONS IN ENERGY SYSTEMS: BRIDGING COMPLEXITY AND SUSTAINABILITY

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Fuzzy logic has emerged as a key innovation in energy systems, offering effective solutions to the growing complexity of power grids, renewable energy integration, and energy management. Traditional control systems often encounter difficulties in managing dynamic and variable conditions, while fuzzy logic excels in handling imprecise data. This paper investigates the use of fuzzy logic theory in energy system with a focus on complexity and sustainability of renewable energy.

**Keywords**: Fuzzy Logic, Energy Systems, Renewable Energy Integration, Power Grid Optimization, Energy Management.

# AN APPLICATION OF MACHINE LEARNING TECHNIQUES FOR PATTERN RECOGNITION

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Pattern recognition, a critical aspect of artificial intelligence, has been revolutionized by the advent of machine learning techniques. This paper explores the application of machine learning algorithms in identifying, analyzing, and predicting patterns across diverse domains, including image processing, speech recognition, and data analytics. By leveraging supervised, unsupervised, and reinforcement learning models, we address challenges associated with feature extraction, noise reduct.

**Keywords:** Machine Learning, Pattern Recognition, Feature Extraction, Noise Reduction, Image Processing, Speech Recognition, Data Analytics, Predictive Modeling, Classification, Big Data.

# A REVIEW ON MACHINE LEARNING APPROACH FOR HEART DISEASE PREDICTION

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This study concentrates on the significant need for advanced predictive paradigms in the detection of cardiovascular disease (CVD), as it is the main cause of global death. Our objective was to evaluate several machine learning (ML) techniques using a comprehensive dataset combining clinical and biochemical factors. To ensure data accuracy and dependability early phase of processing data was performed. To build extrapolative models we have applied various ML algorithms, including random forest (RF), support vector machines (SVM), logistic regression and deep learning neural networks, to build extrapolative models. The key performance metrics, such as sensitivity, accuracy, and the area under the receiver operating characteristic curve (AUC-ROC) measured the efficiency of the models. Our findings indicate that in categorizing potential CVD cases complex models like deep learning offer improved abilities in traditional models, such as regression, also provide valuable projecting perceptions. This research provides innovative role of machine learning (ML) in recognizing CVD risk and also highlights the prominence of mixing different set of data sources to obtain accurate assessment of cardiovascular health. We also checked the role of feature selection techniques in improving model execution and its interpretability. By providing visions into the development of more accurate and effective tools for heart health management. At last, our results contribute to the development of personalized medicine.

**Keywords:** Cardiovascular Disease, Machine Learning, Deep Learning.

# A COMPARATIVE STUDY FOR CRYPTOGRAPHIC ALGORITHM IN ZIGBEE NETWORK

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The speedy expansion of Zigbee network in numerous applications like smart homes, healthcare and industries has raised up significant concerns and issues regarding their privacy and security. This paper sees the sights various cryptographic techniques that can be implemented to secure Zigbee network whose main focus is to address the unique encounters posed by low-power, low-throughput situations. The paper reviews include symmetric encryption, asymmetric encryption that converts both traditional lightweight solutions and cryptographic algorithms; even hashing algorithms estimating their performances over Zigbee. This paper investigates the security vulnerabilities integral in Zigbee networks, which highlights the need for improving authentication, data integrity and confidentiality mechanisms. The main purposes are to make available a comprehensive overview of cryptographic implementations that can strengthen the security and hence offering hands-on applications for securing the Internet of Things (IoT) setup.

**Keywords:** Zigbee Network, IoT Infrastructure, Cryptography, Zigbee Securities.

# A REVIEW PAPER ON NEURO FUZZY SYSTEMS FOR PATTERN RECOGNITION

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Pattern recognition is a fundamental task in artificial intelligence (AI), where the goal is to classify data into predefined categories based on learned patterns. Traditional methods often face challenges when working with uncertain, imprecise, or incomplete data. To address these challenges, neuro-fuzzy systems, which combine the learning capabilities of neural networks with the interpretability of fuzzy logic, have emerged as an effective solution. This paper explores the use of neuro-fuzzy systems for pattern recognition, highlighting their ability to handle uncertainty and complexity in various data types. By combining fuzzy logic's ability to deal with imprecision and neural networks' ability to learn from data, neuro-fuzzy systems offer enhanced performance in tasks like image recognition, speech processing, medical diagnostics, and financial forecasting. This research reviews the architecture of neuro-fuzzy systems, various training methods, and their applications across different domains. The advantages, such as improved accuracy, robustness, and flexibility, are discussed, along with the challenges in training efficiency and scalability. The paper concludes by outlining potential future directions for research in this hybrid approach to pattern recognition, emphasizing its growing relevance in AI applications.

**Keywords:** Neuro-Fuzzy Systems, Pattern Recognition, Artificial Intelligence, Fuzzy Logic, Neural Networks, Machine Learning, Medical Diagnosis, Image Recognition, Speech Recognition.

# IMAGE INPAINTING-BASED ON MACHINE LEARNING &DEEP LEARNING A SURVEY

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Image inpainting is the process of reconstructing missing, damaged, scratched, sketched, and noisy or corrupted parts of an image, has become a crucial application of machine learning and deep learning in various fields such as computer vision, medical images, object removal, digital restoration, photo restoration & video restoration. Traditional methods relied on patch-based techniques and hand-crafted features, which frequently had trouble grasping complicated textures or semantic understanding. However, Machine Learning and Deep Learning approaches have greatly improved inpainting capabilities by leveraging convolutional neural networks (CNNs), generative adversarial networks (GANs), and transformer architecture. These techniques are particularly capturing spatial context, generative semantically consistent content, and handle large missing regions. This paper reviews key advancements in image inpainting using machine learning and deep learning exploring fundamental techniques, models, articles, datasets, and evolution metrics. Furthermore, it also highlights challenges, such as maintaining high-quality texture synthesis, reducing computational cost, and addressing practical deployment issues. The potential applications, future directions, and creativity of these cutting-edge technologies are also discussed to inspire further research and innovation in the field.

**Keywords:** Image Inpainting, Deep Learning, Convolutional Neural Networks (CNNs), Generative Adversarial Networks (GANs).

# A REVIEW ON THE DEVELOPMENT AND RECENT TRENDS IN HESITANT FUZZY LOGIC

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Hesitant Fuzzy Logic (HFL) has evolved as a significant extension of classical fuzzy logic, addressing the limitations in representing uncertainty and imprecision by allowing multiple possible values for each fuzzy element. This review paper provides a comprehensive exploration of HFL's theoretical development, key contributions, and its growing applications across various domains. We trace the origins of HFL, starting from its early conceptualization to the development of advanced aggregation operators, distance measures, and decision-making frameworks tailored to hesitant data. Recent research has focused on integrating HFL with cutting-edge technologies such as machine learning, artificial intelligence, and deep learning, enhancing decision-making in uncertain, dynamic environments. In this paper we have study on the diverse applications of HFL in fields like healthcare, finance, supply chain management, smart cities, and robotics, demonstrating its versatility in solving complex, multi-criteria decision problems. Despite the promising advances, challenges such as computational complexity, scalability, and interpretability remain. In this paper also we have more efficient algorithms, hybrid models combining HFL with soft computing techniques, and the application of HFL to emerging fields like autonomous systems and big data analytics.

**Keywords:** Hesitant Fuzzy Logic, Fuzzy Systems, Decision Making, Machine Learning, Multi-Criteria Analysis, Applications.

# COMPARATIVE ANALYSIS OF MACHINE LEARNING TECHNIQUES USING HYPER-PARAMETER FOR PREDICTION OF BREAST CANCER

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This study creates a predictive model utilizing hyper-parameter machine learning algorithm technique to reduce the risk of breast cancer. In order to predict breast cancer in patients at an early stage we employed the Weka and Python programming tools on the Wisconsin Breast Cancer Dataset. Furthermore, we applied the machine learning methods of Random Forest, Logistic Regression, and Decision Trees to the datasets in order to diagnose breast cancer. Analyses performance metrics of the created model, such as ROC curve, precision, recall rate, and f1-score, and compare the accuracy of predictive models. These proposed models have high accuracy of up to 93%, 96%, and 92% for Random Forest (RF), Logistic Regression (LR), and Decision Tree, respectively. Therefore, we conclude that the Logistic Regression algorithm leads to the maximum accuracy up to 96% by using the hyper-parameter techniques.

**Keywords**: Breast Cancer, Machine Learning, Prediction Techniques, Logistic Regression.

# PHISHING WEB SITES DETECTION USING MACHINE LEARNING

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Phishing is a fraudulent technique that uses social and technological tricks to steal customer identification and financial credentials. Social media systems use spoofed e-mails from legitimate companies and agencies to enable users to use fake websites to divulge financial details like usernames and passwords. It is a prevalent cyber threat that deceives users into revealing sensitive information.Phishers use multiple methods, including email, Uniform Resource Locators (URL), instant messages, forum postings, telephone calls, and text messages to steal user information. Detecting phishing websites is crucial to safeguarding online security and protecting users from financial and personal harm. There is a significant chance of exploitation of user information. For these reasons, phishing in modern society is highly urgent, challenging, and overly critical. Users are struggle to identify newly created phishing sites in real time. The lack of an adaptive and scalable solution exacerbates the risk, leading to financial losses and compromised user privacy. To address this issue, this research proposes a machine learning-based approach to detect phishing websites. By analyzing key features of websites, such as URL characteristics, domain properties, SSL certificates, and HTML content, machine learning models can identify patterns and anomalies indicative of phishing. This study aims to provide a robust, efficient, and scalable tool to enhance online security and protect users from the growing threat of phishing attacks.

**Keywords:** Feature Engineering, URL, Model training, SVM, Classification Algorithms.

# STUDY AND ANALYSIS OF CONGESTION CONTROL TECHNIQUES IN IOT NETWORK

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The Internet of Things (IoT) is a global network platform that connects various devices over the internet, enabling interconnection and data transmission. This has led to an exponential increase in connected devices, increasing congestion over the internet. Transmission Control Protocol (TCP) is a reliable transport layer protocol used for wired and wireless networks, controlling transmission rates according to network congestion. However, TCP's congestion control algorithms can lead to low power and lossy networks (LLNs), which may have high error rates and packet loss. IoT networks prefer using user datagram protocols, such as message queuing telemetry transport, constrained application protocol (CoAP), and data distribution services. The IoT vision envisions a future Internet where physical things, like banknotes and bicycles, can actively participate in the internet, exchanging information about themselves and their surroundings. This will lead to innovative services, increased efficiency, and productivity. Congestion occurs when network resources are overloaded, resulting in implementations for network users. Congestion control techniques aim to avoid data overload in nodes and packet loss, reducing overall network quality and packet loss. In this work we have study and analyse the better throughputs various IoT networks.

**Keywords:** Internet of Things (IoT), Transmission Control Protocol (TCP), Constrained Application Protocol (CoAP), Congestion Control Techniques.

# GREEN CLOUD: MOVING TOWARD SUSTAINABLE IT METHODOLOGIES

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Over the past few years, Cloud Computing has become increasingly popular and a prevalent subject of conversation. A subset of cloud computing known as "green cloud computing" focuses on improving the energy efficiency, sustainability, and environmental friendliness of cloud computing services. The process of developing, implementing, and overseeing systems that uses cloud computing in an environmentally sustainable manner is known as "Green cloud computing." Green cloud is beneficial for energy efficiency, Cost reduction, Virtualization and resource efficiency, sustainability of IT infrastructure, Sustainability reporting and compliance and integration of Green IT Practices in Software Development. This paper discusses about the achievements and importance of green cloud computing in the IT sector. By emphasizing energy efficiency, resource optimization, and limiting carbon footprints over the whole lifecycle of cloud infrastructure and services, it seeks reducing the environmental impact of cloud services. The accomplishments of green computing in the past, current green computing ideas now, and upcoming research difficulties are all explored in this paper.

**Keywords:** Cloud Computing, Green Cloud Computing, Resource allocation, Virtualization, Energy Efficiency, Carbon Footprints, Environmental Sustainability**.**

# ENERGY-EFFICIENT VISION TRANSFORMERS: ADAPTIVE COMPUTATION FOR RESOURCE-CONSTRAINED EDGE DEVICES

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Vision Transformers exhibit excellent results on computer vision tasks, this is still restricted since most edge devices demand high computations and energy usage. This paper introduces discussion around a new adaptive computation framework of Vision Transformers: their model complexity changing according to the dynamically varying complexities of the inputs and resources available. The research introduces three key innovations: an attention-guided token pruning mechanism that dynamically reduces redundant visual tokens, a hardware-aware adaptive computation scheduler, and a hierarchical token clustering strategy. The token pruning mechanism achieved a 60% computation reduction with minimal accuracy loss, while the adaptive scheduler optimized model execution based on device-specific constraints. The hierarchical clustering strategy progressively reduced spatial resolution while preserving semantic information. Experimental results on standard vision benchmarks showed a 45% reduction in energy consumption and 35% decrease in inference time compared to baseline ViT models, while maintaining 98% of the original accuracy. On resource-constrained devices, the method achieved real-time performance (30 FPS) for 1080p video processing while consuming only 2.5W of power. The study establishes new benchmarks for energy-efficient vision transformers and demonstrates practical deployment potential for transformer-based vision models on edge devices, particularly for applications in mobile robotics, autonomous systems, and IoT devices.

**Keywords**: Vision Transformers, Edge Computing, Energy Efficiency, Adaptive Computation, Token Pruning, Computer Vision, Deep Learning, Hardware Optimization, Real-Time Processing, Resource Constraints.

# IMPROVINGPRENATALCAREWITHDEEPLEARNING –BASEDFETAL GROWTH PREDICTIONS

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Pregnancy-related complications, such as infections, obstructed labor, and excessive bleeding, are major contributors to maternal and neonatal morbidity and mortality. Effective prevention of these complications requires robust delivery processes and advanced monitoring systems that support timely and informed decision-making. This research focuses on improving prenatal care by assessing fetal health during pregnancy, particularly in predicting fetal growth retardation (FGR). Most pregnancy complications, if undetected, can lead to adverse outcomes, including fetal demise. Ensuring a safe pregnancy by predicting risk levels before complications arise is essential for promoting healthy fetal development. This study aims to predict FGR by integrating textual and imaging data from ultrasonography. Convolutional Neural Networks (CNNs), a state-of-the-art deep learning approach, are employed to extract critical features from ultrasonography images. These image-derived features are then combined with textual featuresto create a comprehensive dataset. Machine learning algorithms, including Decision Trees, Logistic Regression (LR), Random Forest (RF), and Support Vector Machines (SVM), are utilized to analyze the fused features and predict the likelihood of FGR. The proposed approach provides a novel and efficient framework for early detection of fetal growth abnormalities, ultimately enhancing prenatal care and reducing the risk of adverse pregnancy outcomes.

**Keywords:**FetalGrowthRetardation,MachineLearningAlgorithm,DecisionTree,SupportVector Machine,Logistic Regression, Random Forest, Convolution Neural Network.

# IMPACTS OF LEVERAGING DIGITAL TECHNOLOGIES ON THE EDUCATIONAL SYSTEM A LITERATURE REVIEW

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The various ways that digital technologies have affected educational system are examined in this thorough review study. In the age of rapid technological development, teaching and learning have changed as a result of the incorporation of digital tools and platforms into classroom environments. The primary objective of this review paper is to evaluate how digital technologies are changing the educational landscape, examine how it affects curriculum design, pedagogy, and student involvement, and summarizes the key findings from a variety of empirical research and theoretical viewpoints. Based on a comprehensive study of the literature, this analysis provides insights into the opportunities and problems of using digital technologies in the classroom environment. Online learning environments, higher education, and K–12 education are only a few of the scenarios covered by the approach. The main conclusion indicates that although digital technologies have transformed education, it has also brought up concerns about digital inequality, privacy, and distraction. The review's conclusions indicate that intelligent legislation, innovative teaching strategies, and ongoing research are necessary to adequately utilize digital technologies in education.

**Keywords**: Digital Technologies, Educational System, Pedagogy.

# STREAMLINED DEEP LEARNING TECHNIQUES FOR WEED DETECTION IN IOT-DRIVEN SMART AGRICULTURE

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The integration of Internet of Things technologies and deep learning has transformed smart agriculture, presenting innovative solutions for weed identification and management. Traditional weed control methods are labor-intensive and often environmentally unsustainable. This paper explores streamlined deep learning approaches tailored to weed detection in IoT-driven smart agricultural systems. By leveraging advanced convolutional neural networks and transfer learning, these techniques enable accurate identification and real-time classification of weeds. The incorporation of IoT devices facilitates the collection and processing of data from agricultural fields, enabling timely intervention with minimal human involvement. These lightweight model architectures, optimized for resource-constrained IoT devices, balance computational efficiency with high detection accuracy. Techniques like data augmentation and edge computing are employed to enhance the robustness of the models while reducing dependency on centralized cloud systems. This research demonstrates the significant potential of these combined technologies to reduce herbicide usage, improve crop yields, and promote sustainable farming practices. By addressing critical challenges such as data scarcity, model scalability, and real-time decision-making, this study provides a comprehensive framework for deploying cost-effective, intelligent weed management solutions in precision agriculture, ultimately contributing to more sustainable and environmentally-friendly farming methods.

**Keywords:** Weed Detection, Objection Detection, Machine Learning, Deep Learning, IOT, Agriculture.

# DATA IMPUTATION INSIGHT WITH MACHINE LEARNING IN VARIOUS DOMAINS

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Data imputation has become a critical component in addressing the pervasive issue of missing data across diverse datasets. This paper provides an in-depth exploration of contemporary data imputation techniques, examining their applications, challenges, and emerging trends. It delves into classical imputation methods, such as mean and regression imputation, before surveying advanced approaches like multiple imputation and machine learning-based strategies. The paper investigates challenges inherent to imputation, including handling missing data mechanisms and ethical considerations. Furthermore, the paper concludes the integration of machine learning advancements and the incorporation of domain knowledge into imputation models.

**Keywords:** Data Imputation, Missing Data, Mean Imputation, Regression Imputation, Multiple Imputation, Machine Learning-Based Imputation, Missing Data Mechanisms, Ethical Considerations, Domain Knowledge Integration, Data Preprocessing.

# SOFTWARE VULNERABILITY DETECTION A COMPREHENSIVE SURVEY

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This survey paper focuses on software vulnerabilities that are critical threats for reliability and security of a system. Due to this the moderation becomes inevitable as the software plans are more effective and elaborated on vulnerability detection. The paper provides a detailed summary of the current methods, approaches, and tools for software vulnerability detection and classifies methods as fuzz testing methods, machine learning-based approaches, static analysis methods, and machine learning-based methods. Vulnerability detection is thereby studied for across each technique as to its capability. Given this context, we emphasize the importance of automated vulnerability code auditing tools, security testing frameworks and scanners to improve accuracy and efficiency of detection. It also looks at detection challenges, including the evolving landscape of cyber threats, false-positive rates, and scalability problems. This study completes with references for future research intended at improving software vulnerability detection methods.

**Keywords:**Software Vulnerabilities,Software Vulnerabilities, Static Analysis, Dynamic Analysis, Machine Learning-Based Methods.

# ADVANCEMENTS IN FRAME SAMPLING TECHNIQUES FOR HUMAN ACTION RECOGNITION A COMPREHENSIVE REVIEW

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Human action recognition is a technique, which aims to identify and classify human actions from video or several sensor data. Recent advancement in human action recognition has become a key area of interest within the computer vision community,as understanding the human actions plays a vital role in the variety of applications like surveillance, healthcare, entertainment, and more. However, despite these advancements, there still need to manage and minimize the computational cost while maintaining high accuracy and performance. The proposal of efficient frame sampling techniques plays an important role to reduce the computational cost while maintaining significant temporal and spatial information essential for action recognition.We present a thorough review of recent methods on frame sampling used for human action recognition in videos. We explore the aims, approaches, data sources, findings, and benefits of these initiatives and identifylimitations in the existing literature, recommending possible directions for prospective research to enable enhanced precision and productivity.

**Keywords:** Human Action Recognition, Frame Sampling Techniques, Computer Vision, Video Classification.

# INNOVATIVE INTRUSION DETECTION SYSTEMS FOR SECURING THE INTERNET OF VEHICLES (IOV)

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Intrusion Detection Systems are important in network security for the identification and prevention of malicious activities that could pose potential threats. Several IDS techniques have emerged over time, each with different strengths and weaknesses. Signature-based IDS depends upon predefined patterns of already known attacks. It is very accurate against known threats but performs poorly against zero-day attacks. Anomaly-based IDS uses machine learning and statistical methods to identify deviations from normal behavior. This can allow the detection of unknown threats but at the cost of higher false-positive rates. Hybrid intrusion detection systems balance the advantages of both detection precision and adaptability. Other methods that have advanced IDS include clustering, deep learning, and ensemble learning. As for instance, K-Means-based clustering techniques identify patterns in extremely huge data. Deep learning techniques such as CNN and RNN help process the vast and complex data efficiently. The Random Forest and XGBoost ensemble methods make a prediction based on multiple models to come up with higher overall accuracy. In recent years, the Internet of Vehicles (IoV) and its applications in scalable environments have garnered significant attention. This paper highlights the evolution of Intrusion Detection System (IDS) techniques for IoV, emphasizing the critical need for adaptive and intelligent systems to address the ever-changing cybersecurity landscape within connected transportation networks.

**Keywords**: K-Means, Deep Learning, CNN, XGBoost.

# CYBER FORENSICS: IMPROVING EVIDENCE COLLECTION IN DIGITAL CRIME INVESTIGATIONS

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A subfield of forensic science called "cyber forensics," or "digital forensics," is concerned with recovering, examining, and analyzing data from digital devices, frequently in connection with computer crimes. In order to solve digital crimes and maintain cyber security, law enforcement agencies, private enterprises, and legal professionals now depend heavily on cyber forensics as the world grows more technologically dependent. The scientific study and analysis of digital data to aid in legal investigations is referred to as cyber forensics. Data recovery, preservation, and interpretation from a variety of digital sources, such as PCs, mobile devices, networks, and cloud environments, are all part of this discipline. Data collection, file system analysis, network traffic, and volatile memory are important methods. Finding digital evidence, maintaining evidence integrity, evaluating evidence, and presenting findings are the goals of cyber forensics. Computer forensics, network forensics, mobile device forensics, cloud forensics, and malware forensics are some of the several forms of cyber forensics. Identification, preservation, collection, analysis, and reporting are the processes in cyber forensics investigations. The results of the literature review, early findings, study methods, ongoing work, and how technology may make an investigator's job easier and help with present challenges in cyber forensics will all be included in the research report.

**Keywords:** Cyber Forensics, Digital Evidence, Crime Investigation.

# WEARABLE AND AMBIENT SENSORS WITH APPLICATIONS: A REVIEW

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The technological landscape has changed dramatically in recent years, becoming more and more integrated into many facets of daily life. The creation of wearable and ambient sensor devices that can gather and analyze data in a variety of settings has been one of the most revolutionary developments. These sensors provide cutting-edge solutions for smart homes and urban planning in addition to improving personal health monitoring. The importance of these sensors keeps increasing as society grows more reliant on technology and health, which encourages both businesses and researchers to investigate their possible uses. The applications of wearable and ambient sensors will be explored in this study, along with their uses, advantages, challenges and potential future applications. In the end, comprehending these technologies will provide light on how they contribute to a world that is more interconnected, effective, and healthful while offering important insights into how human-technology interaction is constantly changing.

**Keywords:** Wearable Sensor, Ambient Sensor, Health Monitoring, Smart Homes, IoT, WSN.

# EXPLORING RECENT ADVANCEMENTS IN DATA MINING ALGORITHMS

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A key component of data science, data mining is always changing as new algorithms are developed to handle the complexity of contemporary datasets. An extensive analysis of recent developments in data mining algorithms is given in this work, with a focus on how well they handle large data sets, improve interpretability, and increase scalability. Graph-based algorithms, scalable distributed approaches, privacy-preserving strategies, and ensemble learning are some of the major developments covered. New avenues for applications in e-commerce, healthcare, and finance have been made possible by these advancements. An examination of potential developments and difficulties in data mining is included in the paper's conclusion.

**Keywords**: Data Mining Algorithms, Reinforcement Learning, Machine Learning Integration, Deep Learning Applications.

# A GAME-THEORETICAL FRAMEWORK FOR EDGE AI

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This paper proposes a game- theoretical framework for Edge Artificial Intelligence (Edge AI) to optimize resource allocation, minimize computational costs, and incentivize collaboration among distributed edge devices and servers. By formalizing the problem as a hierarchical Stackelberg game between edge servers (leaders) and end devices (followers), the framework provides efficient task offloading strategies and optimal resource pricing. Nash equilibrium conditions are furthere mployed to ensure fairness and stability in collaborative optimization. The framework integrates mathematical utility functions, constrained optimization models, and cost-sensitive strategies to address challenges such as energy efficiency, limited resources, and heterogeneous devices. Simulation results demonstrate significant improvements in system utility, reduced latency, and enhanced performance compared to traditional non-cooperative approaches, making this framework a robust solution for deploying scalable AI models in edge computing environments.

Keywords: Game Theory, Edge AI, Resource Allocation, Stackel berg Game, Nash Equilibrium.

# ADVANCEMENTS IN INTELLIGENT TRAFFIC LIGHT CONTROL: INTEGRATING MACHINE LEARNING AND OPTIMIZATION TECHNIQUES

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Efficient traffic light control is the key to relieving urban congestion and enhancing transportation sustainability. This literature review examines the progress made in traffic light management, focusing on the integration of machine learning and optimization techniques. It traces the evolution from static, rule-based systems to intelligent, adaptive approaches, including reinforcement learning, fuzzy logic, and deep neural networks, all dynamically adjusting traffic signals based on real-time conditions to enhance intersection efficiency. Recent studies have highlighted methodologies such as Q-learning for reinforcement-based optimization, fuzzy inference systems for adaptive control, and hybrid models of deep learning with reinforcement learning. Simulation environments like SUMO validate these techniques, showing significant travel delay and congestion reductions. Case studies further exemplify the effectiveness of intelligent traffic light systems in adapting to dynamic urban traffic patterns. The review identifies challenges such as computational complexity and scalability, putting forward future research directions to overcome these and further advance intelligent transportation systems worldwide.

**Keywords:** Intelligent Traffic Light Control, Machine Learning, Reinforcement Learning, Traffic Signal Optimization, Adaptive Traffic Management, Urban Congestion, And SUMO Simulation.

# AI MEDICAL EXPERT SYSTEM FOR HOMECARE

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Delay is a significant problem in today's healthcare system. An AI (Artificial Intelligence) Health Assistant website can provide people with quick and accurate information about their health. Many countries face a shortage of doctors, which is a significant problem. An AI Health Assistant website can provide people with information about their health and help them make informed decisions. Many people lack information about their health. An AI Health Assistant website can provide people with information about their health and help them make informed decisions. The high cost of healthcare is a significant problem in today's healthcare system. An AI Health Assistant website can provide people with information about their health and help them make informed decisions, which can reduce their healthcare costs. AI Health Care specializing is an online Consultant from doctor platform. It is an online system through which Females can view available self-Protections Portals; register or Appointment for Doctor. The major purpose to provide the Online Doctor Consultant to Patients online whose person have no time or save time. AI Health Care website is a web-based platform that allows your Patients to book Appointment online from the comfort of their own home or office. The platform should offer an administration interface where the AI Health Care website can manage the content, and access all Appointment and their information.

**Keywords:** Health Care Monitoring, Disease Management, Treatment Recommendation, Symptom Cheacker.

# REAL-TIME SUSPICIOUS ACTIVITY DETECTION USING VIDEO FRAMES AND DEEP LEARNING

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This research focuses on the implementation of a real-time suspicious activity detection system using video frames and deep learning techniques to address the growing need for enhanced security in public and private spaces. The primary objective is to identify and classify human activities captured through a webcam or surveillance camera into two categories: normal activities (e.g., walking, sitting, standing) and suspicious activities (e.g., falling, using a weapon, struggling). By leveraging a pre-trained convolutional neural network (CNN), the system is capable of analyzing video frames and categorizing activities into 13 predefined classes, such as "Fall," "Gun," and "Struggle." The system processes video feeds in real time, extracting and preprocessing frames before passing them to the CNN for activity recognition. When a suspicious activity is detected, the system generates immediate alerts, which include sound notifications, push notifications with images of the incident, and a live video stream link. These features make the system ideal for enhancing security in various environments, such as homes, offices, schools, and public spaces, allowing users to monitor activities remotely from anywhere.The trained model includes a user-friendly interface powered by Flask for live video streaming and monitoring. Extensive testing on a balanced dataset resulted in an overall accuracy of **95%**, demonstrating the system's high reliability in detecting both normal and suspicious activities effectively across all categories. This project highlights the practical application of artificial intelligence and deep learning in addressing real-world security challenges.

**Keywords:** Real-Time Suspicious Activity, Normal Activity, Convolutional Neural Network (CNN), Deep Learning.

# ANALYZING AND CLASSIFYING RICE GRAIN QUALITY THROUGH IMAGE PROCESSING METHODS

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Rice is a widely preferred and commonly consumed cereal grain in many Asian nations and is easily accessible worldwide. The quality of milled rice is the key factor that governs its market value, particularly in the import and export trade. Rice samples often contain various unwanted materials, such as paddy, chaff, damaged grains, weed seeds, and stones. The aim of this proposed approach is to offer a more efficient method for quality control and analysis, reducing time, cost, and effort. Image processing plays a crucial role in this field, driven by significant technological advancements. It involves manipulating images to perform specific tasks, improving and refining the final results. Additionally, image processing can extract valuable information from the input images. This study focuses on developing image processing algorithms that specialize in segmenting and identifying rice grains. By utilizing these algorithms, it becomes possible to analyze the quality of rice grains based on their size efficiently. This paper presents a solution for classifying and evaluating rice grains based on their dimensions and morphology using image processing techniques. While previous research has examined the morphological characteristics of grains, such as area and shape, these efforts often struggle to provide a universal method for classifying different rice varieties, given the significant variation in their shapes and sizes. In contrast, this paper enhances the analysis by incorporating Fourier features derived from grain images, improving the accuracy of the classification process.

**Keywords**: Image Processing, Morphological Operations, Edge Detection, Quality Analysis, Object Classification, Deep Learning, Food Quality Detection.

# ANIMAL SPECIES RECOGNITION SYSTEM USING DEEP LEARNING

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To provide Animal watchers a handy tool to admire the beauty of Animals, we developed a deep learning platform to assist users in recognizing species of Animals endemic to using app named the Animal species recognition system. Animal images were learned by a convolutional neural network (CNN) to localize prominent features in the images. First, we established and generated a bounded region of interest to the shapes and colors of the object granularities and subsequently balanced the distribution of Animals species. Then, a skip connection method was used to linearly combine the outputs of the previous and current layers to improve feature extraction. Finally, we applied the SoftMax function to obtain a probability distribution of Animals features. The learned parameters of Animals features were used to identify pictures uploaded by mobile users. The proposed CNN model with skip connections achieved higher accuracy of 95.00 % compared with the 93.98% from a CNN and 87.00% from the SVM for the training images. As for the test dataset, the average sensitivity, specificity, and accuracy were 93.79%, 96.11%, and 95.37%, respectively.

**Keywords:** Convolution neural network (CNN), TensorFlow (TF), Rectified linear unit (ReLU), Fully connected (FC), ImageNet, Central Processing Unit (CPU), Graphical Processing Unit (GPU), GoogleNet Inception V4 network.

# A REVIEW ON AI BASED CYBER SECURITY MECHANISMS

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In India digitization process of the Government system, Banking System, Academic Institutions, Election Process, Entertainment Industry, Business Sector, Taxation System etc. are taking place rapidly. We are stepping forward to evolve a digitally well-equipped society. As we are being well equipped digitally, we also need to ensure security of digital data. Cyber Security is the branch of computer science which takes care of the security of data as well as the communication network system. As the security threats of data are increasing exponentially, we need to seek for a better security solution super exponentially. Artificial Intelligence and Cyber Security can go hand in hand to provide such solutions with better throughput. This paper states such attempts to catch those efforts which are made to resolve cyber security threats with the help of Artificial Intelligence techniques.

**Keywords**: Confidentiality, Integrity, Availability, Artificial Intelligence, Security Attacks.

# CACHE COHERENCE IN EMERGING TECHNOLOGIES

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A major issue with contemporary computer designs is cache coherence, especially in light of the growing popularity of distributed systems and multi-core CPUs. The fast development of new technologies like high-performance computing (HPC), the Internet of Things (IoT), and artificial intelligence (AI) has made cache coherence more difficult to maintain. Consistent data representations across many caches in multi-core processors are guaranteed by cache coherence, a basic idea in shared-memory systems. In this study, the importance of cache coherence in the context of new technologies is explored, current coherence protocols are analyzed, their drawbacks are investigated, and new methods that cater to the particular needs of contemporary applications are investigated.

**Keywords**: Cache Coherence, Multi-Core CPUs.

# REVOLUTIONIZING BUSINESS: EXPLORING THE APPLICATIONS OF ARTIFICIAL INTELLIGENCE

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Artificial Intelligence (AI) is transforming the business landscape by providing innovative solutions to complex problems. This paper explores the various applications of AI in business, including predictive analytics, customer service chatbots, process automation, and decision-making. We discuss how AI-powered technologies, such as machine learning and natural language processing, are being leveraged by organizations to enhance operational efficiency, improve customer experiences, and drive revenue growth. The applications of AI in business are vast and varied. Predictive analytics enables companies to forecast market trends and make data-driven decisions. Customer service chatbots provide 24/7 support, improving customer satisfaction and reducing support costs. Process automation streamlines business operations, increasing productivity and efficiency. Decision-making is also enhanced through AI-powered tools, such as recommendation systems and expert systems. Our analysis highlights the benefits and challenges of AI adoption in business. While AI offers numerous advantages, including improved accuracy and speed, it also poses challenges, such as data quality issues and job displacement. The future directions of AI research and development are also discussed, including the potential applications of AI in emerging technologies, such as blockchain and the Internet of Things. The findings of this study provide valuable insights for business leaders, policymakers, and researchers seeking to harness the potential of AI to drive business success and economic growth.

**Keywords:** Artificial Intelligence, Business Applications, Machine Learning, Predictive Analytics, Customer Service, Process Automation, Decision-Making.

# SENTIMENT ANALYSIS OF TEXT USING MACHINE LEARNING TECHNIQUE

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Sentiment analysis, often known as opinion mining, is a critical part of natural language processing (NLP) that investigates and categorizes emotions, viewpoints, and attitudes expressed in textual data. It is increasingly valuable in a range of applications, such as social media monitoring, consumer feedback analysis, and market trend forecasting. Sentiment analysis has grown in popularity as a tool for translating unstructured data into actionable insights. This study demonstrates that the approach employed for sentiment analysis must correspond to the type of data, as each dataset has its own style, language, and structure. We produced precise results by employing a variety of methodologies, ranging from fundamental procedures to complicated models, such as anger, sadness, joy, and surprise.

**Keywords:** Sentiment Analysis, Natural Language Processing (NLP), Machine Learning.

# FEDERATED LEARNING FOR PRIVACY-PRESERVING AI IN HEALTHCARE

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One machine learning technique that has proven useful in healthcare is federated learning (FL), which allows for decentralised data analysis while yet protecting individual privacy. It is of the utmost importance to safeguard sensitive patient data while making use of massive datasets to improve results, given the growing use of AI in healthcare. Instead of storing data centrally as typical AI models do, FL lets data stay on local devices or servers and simply shares model changes. Thanks to this, healthcare providers may work together to train AI models in a way that respects patient privacy and complies with rules like as GDPR and HIPAA. FL boosts efficiency by facilitating the building of more accurate, generalisable AI models and by lowering the requirement for large-scale data transfers. For FL to be successfully integrated into healthcare systems, however, issues including model accuracy, communication overhead, and regulatory compliance need to be resolved.

**Keywords:**Federated Learning, Healthcare Data Security, Privacy-Preserving AI, Medical Applications, Data Protection, Secures Machine Learning.

# COMPARATIVE STUDY OF MACHINE LEARNING ALGORITHMS FOR VULNERABILITY PREDICTION

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The rapidly proceeding field of software development, attached with the continuous emergence of novel security threats, demands the constant refinement and adaptation of predictive models. Moreover, seamlessly incorporating these sophisticated methodologies into current software development workflows presents significant complexities and resource demands, imposing meticulous management and implementation. In response to these challenges, this research presents a thorough comparative evaluation of diverse machine learning algorithms for identifying potential software vulnerabilities. As the cybersecurity landscape becomes increasingly complex, the proactive detection of vulnerabilities in software systems has emerged as a critical factor in maintaining robust security protocols. Our research examines the effectiveness of several state-of-the-art machine learning techniques, including deep learning models, ensemble methods, and traditional algorithms, in predicting software vulnerabilities by analysing code patterns and historical vulnerability data. We evaluate these algorithms using a diverse dataset of software projects, considering metrics such as accuracy, precision, recall, and F1-score. The study aims to provide insights into the strengths and limitations of different machine learning approaches for vulnerability prediction, thereby contributing to the development of more effective tools for early vulnerability detection and mitigation in the software development lifecycle.

**Keywords**: ML (Machine Learning), DL (Deep Learning), SVM (Software Vulnerability Management), VPM (Vulnerability Prediction Model).

# ENHANCING MUSCULOSKELETAL ABNORMALITY DETECTION WITH VISION TRANSFORMERS: A FINE-TUNED APPROACH USING THE MURA DATASET

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With state-of-the-art performance on a variety of computer vision applications, Vision Transformers (ViT) have become a potent substitute for convolutional neural networks (CNNs). The vit_base_patch16_224 model, which was pre-trained on the ImageNet-21k dataset, is used in this work to tackle the difficult binary classification task in musculoskeletal radiographs using the MURA dataset. The model's capacity for learning long-range dependencies and fine-grained features makes it particularly suited for medical imaging, where subtle abnormalities must be detected.To mitigate overfitting and adapt the model to MURA dataset, we employ augmentation and regularization techniques. The binary classification head of the Vision Transformer is fine-tuned to infer labels directly from the image paths, which contain implicit information about the class (normal or abnormal). Our results demonstrate that combining ViT with transfer learning and AugReg yields a high-performing model.This study highlights the potential of Vision Transformers in medical imaging, showcasing their effectiveness in transferring knowledge from large-scale datasets to specialized domains. By incorporating augmentation and fine-tuning strategies, we demonstrate that publicly available datasets and models can achieve results comparable, making this approach accessible and cost-efficient. The adoption of transformer-based architectures in healthcare applications is being progressively more supported by these findings.

**Keywords**: Vision Transformers (Vit), Musculoskeletal Radiographs, MURA Dataset, Binary Classification.

# A SYSTEMATIC REVIEW ON STOCK MARKET PREDICTION USING MACHINE LEARNING TECHNIQUES

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The stock market has become a cornerstone of the global financial system, significantly influencing economies worldwide. With the continuous growth in market capitalization, stock trading has attracted both investors and researchers, focusing on predicting future stock prices. However, stock market prediction is a complex task due to factors such as the Efficient Market Hypothesis (EMH), nonlinearity, data diversity, and parameter optimization challenges. Numerous analysts and researchers have developed various tools and techniques to forecast stock price movements, aiding investors in making informed decisions. This paper provides a comprehensive review of literature on stock market prediction methods, including 68 research papers from 1995 to 2024 are reviewed, highlighting that Indian stock market datasets are the most frequently used. Commonly applied evaluation metrics include accuracy and Mean Absolute Percentage Error (MAPE). Among statistical techniques, ARIMA is identified as the most frequently employed for stock prediction, while Long-Short Term Memory (LSTM) and Support Vector Machine (SVM) are prevalent machine learning algorithms. Deep-Reinforcement Learning (DRL) offers a promising alternative by training agents to learn optimal trading policies through direct market interaction, optimizing for cumulative rewards such as profit or risk mitigation. This review also examines the advantages and limitations of widely used evaluation metrics, as well as statistical, machine learning, and deep learning approaches.

**Keywords:** Stock Market Prediction, Machine Learning, Deep Learning, Reinforcement Learning.

# MENTAL HEALTH PREDICTION USING MACHINE LEARNING

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Mental health (MH) is a pressing global concern, closely tied to anxiety, depression, and even fatal outcomes. The complex interplay between an individual's personal, social, and economic circumstances has a profound impact on their mental wellbeing. This research aims to leverage Deep Learning and AI-ML algorithms to accurately assess an individual's mental health. By developing a predictive model that integrates AI-driven analytics and ML-based algorithms, this research work seeks to identify early warning signs of mental health issues and inform data-driven interventions. The ultimate goal is to ensure the safety and wellbeing of individuals by providing a proactive and personalized approach to mental health management, thereby reducing the risk of adverse outcomes. The model is trained on a comprehensive dataset incorporated with a range of factors and parameters, including sleep patterns and disturbances, appetite changes and fluctuations, interest and pleasure in activities, fatigue and low energy levels, worthlessness and guilt feelings, concentration difficulties and cognitive impairment, agitation and restlessness, suicidal ideation and behaviors, sleep disturbance and insomnia, aggression and irritability, panic attacks and anxiety episodes, hopelessness and despair, and restlessness and agitation etc. A Mixed-Methods Approach (MMA) is employed, combining quantitative and qualitative data to develop a comprehensive understanding of mental health outcomes. Model is trained using Logistic Regression (LR), K-NN Classifier (KNN), Decision Tree Classifier (DT), Random Forest (RF), validated using the dataset, with a focus on accuracy, precision, and recall. The expected outcomes include a novel, multimodal approach to mental health assessment that integrates AI and ML, a predictive model that is Mental Health Prediction Model (MHP) which can identify early warning signs of mental health issues with accuracy-98%, and a framework for data-driven interventions that can be tailored to individual needs and circumstances.

**Keywords:** Mental Health (MH), Mixed-Method Approach (MMA), Mental Health Prediction (MHP), Logistic Regression (LR), Random Forest (RF), Decision Tree (DT), K-Nearest Neighbour (K-NN).

# ENHANCING ACADEMIC PERFORMANCE PREDICTION FOR COMPUTER SCIENCE STUDENTS USING AI AND MACHINE LEARNING TECHNIQUES

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The ever-increasing importance of education has driven researchers and educators to seek innovative methods for enhancing student performance and understanding the factors that contribute to academic success. This paper presents a methodology for predicting student performance (SPP) that leverages machine learning techniques to forecast students' academic achievements based on a variety of features, such as demographic information, academic history, and behavioral patterns. The proposed SPP method utilizes a real-world collected dataset from multiple educational institutions to ensure an accurate and comprehensive analysis. The proposed methodology starts with a data preparation stage, where the data is cleansed and organized for analysis. This process encompasses tasks such as handling missing values, scaling the data, and transforming variables if necessary. The RFE selection technique was used to select the most important features for the SPP model. Several machine learning classifiers were tested, and the linear regression algorithm was found to be the best performer. The evaluation results showed that the linear regression algorithm can be used to predict the student performance with a mean absolute error (MAE) of 0.23 and a root mean square error (RMSE) of 0.29. The results of this study demonstrate the potential of machine learning algorithms in predicting student performance and identifying key factors that influence academic success. This information can be leveraged by educators and academic institutions to develop targeted intervention strategies, tailored learning experiences, and personalized recommendations for students, ultimately fostering a more effective learning environment and improving overall educational outcomes.

**Keywords**: Student Performance Prediction (SPP), Academic Success, Machine Learning Techniques, Mean Absolute Error (MAE), Root Mean Square Error (RMSE), Recursive Feature Elimination (RFE).

# INTERNET OF THINGS (IOT) BASED SMART PLANT MONITORING SYSTEM

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The Internet of Things (IOT) has revolutionized various industries, including agriculture. This paper presents an IOT-based Smart Plant Monitoring System designed to enhance plant care and cultivation. The system integrates various sensors, such as temperature, humidity, soil moisture, and light intensity sensors, to collect real-time data on environmental conditions. By leveraging IOT technology, the system can automate the irrigation process based on soil moisture levels, ensuring plants receive the optimal amount of water. Additionally, the system provides timely alerts and useful insights to users, making plant care more efficient and reducing water waste. The proposed system utilizes a microcontroller to process sensor data and make smart decisions, improving the accuracy, economic benefits, and efficiency of agricultural practices. This innovative approach to plant monitoring demonstrates the potential of IOT in transforming traditional farming methods and promoting sustainable agriculture.

**Keywords:** IOT, Smart Plant Monitoring, Agriculture, Sensors, Automation, Irrigation, Sustainability, Real-time Data, Microcontroller.

# ENHANCING MACHINE LEARNING BASED HEART DISEASE PREDICTION THROUGH FEATURE SELECTION

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Heart disease remains a leading cause of mortality worldwide, emphasizing the need for accurate and timely diagnosis to enable effective treatment and prevention. Machine learning has emerged as a critical tool for heart disease prediction, offering the potential to improve early diagnosis and treatment strategies. However, the high-dimensional nature of medical datasets often contains irrelevant or redundant features, which can negatively affect model performance. Feature selection plays a pivotal role in addressing these challenges by identifying and prioritizing the most relevant attributes. This study explores the impact of feature selection techniques, such as statistical methods, wrapper approaches, and embedded methods, on heart disease prediction. By reducing dimensionality, minimizing noise, and mitigating overfitting, feature selection enhances computational efficiency, interpretability, and the overall robustness of predictive models. Findings of this study reveals that optimal feature selection not only improves accuracy, precision, and recall but also ensures more explainable and efficient systems. These findings emphasize the importance of feature selection as a vital preprocessing step in building reliable machine learning systems, paving the way for personalized and precise healthcare solutions. This will contribute to better clinical decision-making, enabling more effective management and treatment of heart disease.

**Keywords:** Heart Disease, Machine Learning, Feature Selection.

# EyeHeal: A MACHINE LEARNING-BASED NETWORK TOOL FOR EYE HEALTH

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The increasing use of digital devices, especially among students, has raised significant concerns regarding eye health. Prolonged screen time can lead to a range of eye-related issues, including digital eye strain, blurred vision, dryness, and discomfort. With the rising dependency on devices such as laptops, smartphones, tablets, and desktops for studying and entertainment, it is crucial to monitor and manage screen time to mitigate these health risks. However, existing solutions often lack integration across devices or fail to offer personalized insights into eye health. In response to this growing issue, we introduce EyeHeal: A Machine Learning-Based Network Tool for Eye Health, a comprehensive system designed to track and manage screen time while promoting eye health. The tool connects multiple devices, including laptops, mobiles, desktops, and tablets, to a central network, allowing real-time monitoring of screen usage patterns. By analysing eye health parameters such as screen exposure time, blue light intensity, and blink rate, EyeHeal provides personalized recommendations to users, helping them avoid excessive screen time and take necessary breaks based on individual needs.

**Keywords**: Eye Strain, Blurred Vision, Network Tool, Blue Light Intensity, Blink Rate.

# ADVANCING INTERNET OF VEHICLES (IOV) WITH CHALLENGES OPPORTUNITIES AND INNOVATIONS FOR INTELLIGENT TRAFFIC SYSTEM

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The rapid pace of improvements for the IoT has redefined connectivity such that it allows for the building of this new Internet of Vehicles, that is one of the fundamental transformative technologies through which smarter, safer, and more efficient traffic systems are destined to become real. Building from the foundations in VANETs, IoV extends these possibilities to enable perfect interaction between vehicle, infrastructure, and environment. IoV promises much, but it still faces many problems, such as network coverage, security, dynamic topologies, and heterogeneous communication systems. The paper conducts an extensive survey of the existing literature, identifies, and categorizes the challenges, particularly in terms of their implications for urban deployment. Current technical limitations and innovative solutions, as well as future directions that address the barriers, are discussed. This study provides a roadmap for overcoming obstacles and unlocking the full potential of IoV technologies for intelligent traffic systems by doing so.

**Keywords:** VANET, Internet of Things, Internet of Vehicle.

# GENERATIVE AI IN CURRICULUM DEVELOPMENT: A NEW ERA IN EDUCATION

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As the field of Generative Artificial Intelligence (AI) grows in prominence, the way that a curriculum is developed is becoming radically different. ChatGPT and DALL·E, generative AI tools, could reshape how educational content is created, personalized or delivered. In this paper, we investigate how we can utilize AI to dynamically, adaptively, and personalized design curricula that fit a wide range of students' learning needs. With the help of AI, educators can create bespoke teaching material, course outline, interactive learning modules and assessment tools, most suitable to students' learning styles. It means it can take in student performance data to analyse performance, pinpoint areas for improvement and provide relevant content. This paper discusses the benefits and challenges of harnessing Generative AI for curriculum development based on exploring case studies and practical implementations, and how it can facilitate more innovation and efficiency of an educational system.

**Keywords**: Curriculum Development, Adaptive Education, Educational Innovation, Generative AI, Personalized Learning.

# IOT BASED SMART SCHOOL SECURITY SYSTEM USING RFID AND GPS MODULE

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In today's world, after witnessing accidents and misdeeds the safety of students has become a matter of concern. Now in the generation of science and technology to keep parents concern free to these problems the research will be helpful. Proposed study will be help in eliminating the worries of parents and authority by using RFID and GPS technologies. The Research will be used to ensure the safety of children and monitor their attendance from the time they arrive. RFID tag will be attached to the students ID card and will automatically track the attendance of the students, which will strategically read the entrance and departure from the school. Time will also be tracked simultaneously, GPS module will be installed in a school bus and it will track and provide real time location, thus providing transportation of students safely. Parents and authorities will be able to access this bus location instantly. System features secure data storage and encrypted transmission to maintain confidentiality and improved safety, efficient attendance management, and optimized bus routine. This Integrated solution aims to provide peace of mind to parents, enhance operational efficiency for school administrators, and create a safer environment for students. This research tends to develop a security system for tracking the student's transportation well as enhancing the efficiency of attendance using a RFID tag.

**Keywords**: Student's Safety. School Security System, RFID, GPS, Real Time Tracking, Attendance Monitoring, Bus Location, Students Tracking, ID Card.

# HANDWRITTEN DIGIT RECOGNITION WITH DEEP LEARNING

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Handwritten digit recognition system holds a significant place in the field of information processing. It detects scanned images of handwritten digits and also allows writing digits on the screen with the help of an integrated GUI for recognition. The applications of digit recognition include postal mail sorting, bank check processing, OCR devices, converting handwritten documents into editable text, and enabling smart devices to interpret handwritten inputs. In the proposed work, a handwritten digit recognition system has been built using deep learning techniques. For building the model, two datasets have been used. One dataset is collected by authors having 2000 images and another is a publicly available MNIST dataset. Images of datasets were pre-processed through normalization, resizing, and augmentation. Multiple models, including Logistic Regression, Support Vector Machines (SVM), Random Forest, and various deep learning techniques like Convolutional Neural Networks (CNN), Long Short-Term Memory networks (LSTM), and Recurrent Neural Networks (RNN) were evaluated to identify the most effective model for handwritten digit recognition. The training of deep learning-based models was optimized using different algorithms such as Adam, SGD, and RMSprop. The proposed system achieved the highest accuracy of 99.2% with CNN with Adam optimizer showing superior performance of the model.

**Keywords:** Handwritten Digit Recognition, Deep Learning, Convolutional Neural Network (CNN), Hyper-Parameter Tuning.

# IMAGE PROCESSING BASED IMAGE TO CARTOON GENERATION COMPLEXITY OF LARGE COMPUTATION ARISING FROM DEEP LEARNING

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This paper proposes an approach to convert real life images into cartoon images using image processing. The cartoon images have sharp edges, reduced color quantity compared to the original image, and smooth color regions. With the rapid advancement in artificial intelligence, recently deep learning methods have been developed for image to cartoon generation. Most of these methods perform extremely huge computations, require large datasets, and are time consuming, unlike traditional image processing, which involves direct manipulation of the input images. In this paper, we have developed an image processing-based method for image to cartoon generation. Here, we perform parallel operations of enhancing the edges and quantizing the color. The edges are extracted and dilated to highlight them in the output color image. For color quantization, the colors are assigned based on proposed formulation on separate color channels. Later, these images are combined and the highlighted edges are added to generate the cartoon image. The generated images are compared with existing image processing approaches and deep learning-based methods. From the experimental results, it is evident that the proposed approach generates high quality cartoon images that are visually appealing, have superior contrast and can preserve contextual information at lower computational cost.

**Keywords**: Python, Image Processing & Cloud Computing, WAMP or XAMPP Server.

# TRANSFORMATIVE IMPACT OF DEEP LEARNING ON MEDICAL IMAGE ANALYSIS: A REVIEW

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Medical image analysis has seen a revolution because to deep learning, which makes diagnostic workflows more precise, automated, and effective. In tasks including disease detection, organ segmentation, tumor classification, and multi-modality picture fusion, deep learning techniques have shown impressive effectiveness by utilizing large-scale datasets and sophisticated neural architectures. Faster healthcare delivery, tailored treatment, and better clinical decision-making have all been made possible by these capabilities. Recent developments in deep learning methods for medical imaging are summarized in this review paper. Convolutional neural networks (CNNs), generative adversarial networks (GANs), and vision transformers are among the fundamental designs that are examined, along with their uses in a variety of medical imaging modalities, including ultrasound, MRI, CT, and X-ray. In order to improve model performance, robustness, and scalability, emerging technologies including self-supervised learning, federated learning, and hybrid models are examined. The difficulties that deep learning in medical imaging faces—such as data imbalance, interpretability, computational complexity, and the requirement for domain-specific adaptation—are critically assessed in this work. Additionally looked at are ethical issues including guaranteeing data privacy, equity, and algorithm clinical validation. Additionally, a possible avenue for further research is the integration of deep learning with cutting-edge technologies such as edge computing, quantum computing, and the Internet of Medical Things (IoMT). This research highlights the potential of deep learning to transform medical image analysis by examining recent advancements and identifying knowledge gaps. For academics and practitioners looking to improve diagnostic precision, increase precision medicine, and create next-generation healthcare systems, it offers practical insights.

**Keywords:** Deep Learning, Generative Adversarial Network (GAN), Self- Supervised Learning.

# AI BASED BOOK RECOMMENDATION SYSTEM

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Recent developments in Artificial Intelligence (AI) have led to innovations in the user experience of digital platforms, most notably in personalized recommendation engines. Here, we present an AI-Based Book Recommendation system that is Capable of recommending books to the user based on the user's preferences, reading history, and sentiment analysis. Using Natural Language Processing (NLP) algorithms, the system interprets user inputs, be it text or keywords, and determines the sentiment behind it- whether it is positive, negative or neutral relevant books from a comprehensive database like open library API's. Let's take a closer look at the requirements of our job. We aim to create a comprehensive website that allows users to browse books and access catalogs. The key features are a robust dashboard and a user-centered system. Users should have the ability to search for books by title or author. Archivists will have a specific login, giving them privileges to manage departments and books, and check the status of the book. Additionally, our work includes presenting a model that can understand users' emotions and recommend books accordingly. This innovative approach, unlike traditional system employs filtering techniques to remove duplicate suggestions and favor diversity in the behavior over time, leading to a more tailored and engaging experience. in addition, the system employs filtering techniques to remove duplicate suggestions and favor diversity in the recommendations. The system features a user- friendly interface.

**Keywords**: Emotion Detection, Sentiment Analysis, Book Recommendation, Book Rental System, Face Recognition.

# SMART HOME CONTROL SYSTEM WITH SMART FEATURES

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A smart home automation system is a modern technology that allows us to control household appliances conveniently. Using wireless protocols like Wi-Fi or Bluetooth, this system lets us operate devices such as lights, fans, air conditioners, and security cameras through a smartphone. It relies on advanced IoT (Internet of Things) technology, enabling users to manage all connected devices via the internet or Wi-Fi. The system is equipped with a Wi-Fi module for connectivity, making it easier to operate appliances remotely. It reduces the need for manual effort, provides comfort, and helps save time and energy. The main purpose of this smart system is to address situations where we might forget to turn off appliances when leaving the house. For example, if lights or fans are left on, they can be switched off remotely through the system. Additionally, it can tackle safety issues, such as LPG gas leaks, by providing alerts. This creates a safer environment, as the system allows us to monitor and control devices even when we are away. The smart home automation system enhances security, offers real-time alerts on unusual activities, and simplifies daily tasks. It is a practical and reliable way to manage home appliances efficiently.

**Keywords:** Smart Home Control System, LPG Gas Sensor, Exhaust Fan Control, Wi-Fi Module, Relay Module.

# ENHANCING OBJECT DETECTION THROUGH THE EVOLUTION OF YOLO ALGORITHMS

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Real-time object detection has revolutionized many industries, from robots to self-driving cars and surveillance. The YOLO (You Only Look Once) algorithm has become a popular tool for these applications because it provides a middle ground between speed and accuracy. Since its inception, YOLO has evolved with each iteration, resolving previous difficulties. This research paper briefly describes the evolution of the YOLO algorithm. Additionally, conduct a comparative analysis of different YOLO variants, evaluating their performance based on key factors like detection precision, adaptability and speed. The purpose of this comparative analysis is to clearly demonstrate the advantages and disadvantages of each YOLO variant, enabling researchers and practitioners to make informed decisions regarding model selection and optimization for their specific object detection tasks.

**Keywords:** YOLO algorithm, Object detection, Computer vision, Deep learning.

# COMPREHENSIVE REVIEW OF SIGNATURE-BASED INTRUSION DETECTION SYSTEMS FOR IOV SECURITY

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The Internet of Vehicles (IoV) has revolutionized transportation by introducing advancements in traffic management, safety, and smart mobility. However, the interconnected nature of IoV exposes it to significant cybersecurity risks, making robust protection mechanisms imperative. Signature-Based Intrusion Detection Systems (IDS) serve as a cornerstone in safeguarding IoV networks by utilizing pre-defined patterns of known cyberattacks to deliver precise and efficient threat detection. This paper explores the application of signature-based IDS in IoV environment within in-vehicle systems, roadside infrastructure, and cloud platforms. It also discusses advanced methodologies, such as machine learning-enhanced pattern recognition and blockchain-based signature updates, which address the challenges of scalability and false positives in resource-constrained environments. While signature-based IDS excel in detecting known threats, their limitations such as vulnerability to zero-day attacks and encrypted traffic are critically analyzed. The paper concludes by identifying future directions, including the integration of hybrid IDS and AI-driven enhancements, to fortify IoV systems against evolving cybersecurity threats.

**Keywords:** Internet of Vehicle, IDS, Signature Based IDS.

# A REVIEW: STOCK PRICE FORECASTING USING TIME SERIES MODELS AND OPINION MINING FROM SOCIAL MEDIA AND NEWS DATA

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Stock price forecasting is a multifaceted, sophisticated field and can be dominate by various qualitative and quantitative factors. Legacy methods such as the Time-Series models, have shown significant success in capturing historical trends and patterns in stock prices. Now with the growth of social media and news outlets, investor opinion has emerged as a critical factor that dominates market moments. this paper presents a review of stock price forecasting methodologies focusing on the integration of sentimental analysis and Long-Short-Term-Memory based models. Sentiment analysis or opinion mining is used to extract investors' emotions and opinions from social media platforms, such as Twitter, news articles etc. On the other hand, time series-based models such as LSTM, Bidirectional LSTM, stacked LSTM etc. as well as the hybrid models that integrate LSTM with other models to improve predictive performance like Convolutional Neural Network-LSTM (CNN-LSTM), LSTM-attention-LSTM, Autoregressive Integrated Moving Average-LSTM (ARIMA-LSTM), Multi Source-Sparrow Search Algorithm-LSTM (MS-SSA-LSTM) etc., are used for forecasting purposes. The synergy of these approaches enhances the prediction accuracy. This review also highlights the advantages of combining other models with the LSTM model for forecasting purposes, and opinion mining for valuable insights gathering.

**Keywords:** Stock Market, Stock Price, Deep Learning, Forecasting, LSTM, Sentiment Analysis.

# INTERNET OF THINGS (IoT) BASED SMART CAR PARKING SYSTEM USING RFID AND MICROCONTROLLER

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This research proposes an Internet of Things (IoT) based smart car parking system using Radio Frequency Identification (RFID) and microcontroller. The system aims to solve the parking problem in urban areas by providing real-time parking availability information and automating the parking process. A microcontroller-based control system uses RFID tags to identify vehicles and provide parking availability information. A web-based interface allows users to access parking availability information and book parking slots online. The system utilizes IoT technology to collect and analyze data in real-time, enabling efficient parking management. The system's benefits include time and fuel savings, improved parking availability information, and enhanced security. The use of RFID and microcontroller technologies ensures accurate and reliable vehicle identification and parking management. The proposed system has the potential to improve urban parking management and reduce traffic congestion. Overall, the system provides a convenient, efficient, and secure parking experience for users. It can be integrated with existing parking infrastructure, making it a cost-effective solution for urban parking management. By providing real-time parking availability information, the system can help reduce traffic congestion and decrease the time spent searching for parking. The system's automated parking process also reduces the need for manual parking attendants, making it a more efficient and cost-effective solution.

**Keywords**:IoT (Internet of Things), Smart Car Parking, RFID (Radio Frequency Identification), Microcontroller, Real-time Parking Availability, Automated Parking, Urban Parking Management, Intelligent Transportation Systems (ITS).

# MACHINE LEARNING BASED DIABETES RISK PREDICTION

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Diabetes is one of the chronic diseases that causes blood sugar levels to rise. Predictive analytics in healthcare is a difficult challenge, but it can eventually assist physicians in making timely decisions. The aim of this research work is to create a model that can reliably predict diabetes in patients using machine learning classification algorithms: Logistic Regression, SVM, Decision tree, Random Forest. This study presents an evaluation of classification model's performance on a wids dataset 2021. A comprehensive analysis is done calculating the value of sensitivity, specificity, recall, and F1-score. These findings indicate a high level of accuracy and effectiveness in the model's ability to correctly classify instances, suggesting its potential for practical application in classification tasks.

**Keywords**: Diabetes, Classification, Prediction, Machine Learning, Accuracy.

# IOT BASED SEED PROTECTION FOR SMART AGRICULTURE

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One critical challenge in agriculture is protecting seeds during storage, addressing issues such as moisture control, temperature regulation, pest infestation from environmental threats such as animal, rain, and adverse climatic conditions. Smart agriculture leverages the Internet of Things (IoT) to address critical challenges in modern farming, such as seed protection and productivity enhancement. Seed protection is a crucial aspect of agriculture, ensuring healthy germination and optimal yield. This study proposed an IoT-based smart agriculture, focusing on safeguarding seeds from environmental threats during the storage and seed drying. The proposed system integrates smart sensors, ultra sonic, and relay monitor critical parameters like moisture, temperature using predictive analytics the system can deploy countermeasures such as irrigation, temperature regulation, motion detector. Proposed approach highlights the potential of smart technologies in revolutionizing agricultural storage practices and supporting food security.

**Keywords**: Seed Protection, IoT, Sensors, Smart Agriculture, Arduino Uno.

# PLANT DISEASE DETECTION SYSTEM FOR SMART AGRICULTURE

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Plant diseases pose a significant threat to agricultural productivity, leading to reduced crop yields and financial losses for farmers. This research presents a Plant Disease Detection system that employs machine learning and image processing techniques to detect and diagnose plant diseases accurately. By using a deep learning model trained on an extensive dataset of plant images, the system can recognize a variety of plant diseases such as leaf spots, powdery mildew, and bacterial blight. Farmers can easily capture images of their plants using a mobile device, and the system provides immediate diagnoses along with recommendations for treatment. The Plant Disease Detection system is designed to be a cost-effective, efficient, and easy-to-use solution for farmers, regardless of the size of their operation. By enabling early disease detection and offering timely treatment suggestions, the system reduces the dependency on traditional methods and minimizes the excessive use of chemicals. This approach improves crop health, enhances agricultural productivity, and supports sustainable farming practices. The system provides farmers with an accessible tool to manage plant diseases more effectively, ultimately benefiting both small-scale farmers and large agricultural operations.

**Keywords:** Plant Disease Detection, Machine Learning, Image Processing, Agriculture, Early Diagnosis, Mobile App.

# MYOCARDIAL DISEASE PREDICTION AND CLASSIFICATION USING DATA MINING TECHNIQUE

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Myocardial diseases are among the leading causes of mortality worldwide, making early detection and accurate classification vital for effective medical intervention. This study explores the application of data mining techniques for myocardial disease prediction and classification, leveraging advanced algorithms to analyze medical datasets and uncover patterns that aid in diagnosis. A comprehensive dataset comprising clinical, demographic, and lifestyle parameters is utilized to train and validate models. Main techniques employed include feature selection, data preprocessing, and the application of machine learning algorithms such as decision trees, support vector machines, and deep neural networks. The system evaluates various performance metrics, including accuracy, sensitivity, specificity, and F1 score, to determine the most effective approach. The proposed framework not only enhances predictive accuracy but also provides interpretable insights into the contributing risk factors. This research demonstrates the potential of data mining as a transformative tool in myocardial disease management, paving the way for improved healthcare outcomes through timely and precise diagnostics.

**Keywords**: Risk Prediction, Clinical Data Analysis, Heart Disease Diagnosis, Feature Selection, Supervised Learning, Healthcare Analytics, Predictive Modeling, Early Detection, Decision Support System, Medical Data Mining.

# LOAD BALANCING IN SOFTWARE DEFINED NETWORK (SDN): BRIDGING SCALABILITY AND PERFORMANCE FOR NEXT-GENERATION NETWORKS

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Software-Defined Networking (SDN) is an innovative approach to modern networking for a more efficient and flexible network with centralized control and programmability. However, as network demands increase and become more dynamic, scalability and performance will remain a challenge. This paper concentrates on load balancing in SDN, one of the very important techniques for traffic distribution among network resources to optimize utilization and avoid bottlenecks. We review and classify existing load balancing strategies, from static and dynamic methods to further hybrid and artificial intelligence-enhanced methods, analyzing their performances in different situations. By addressing both current challenges and emerging opportunities, this paper provides a comprehensive roadmap for implementing robust load balancing solutions that bridge the gap between scalability and performance in next-generation networks.

**Keywords**: SDN, Load Balancing.

# AN ADAPTIVE RADAR NETWORKS FOR ENHANCED DETECTION

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Managing safety and detection in various environments, such as transportation and surveillance, can be complex, especially when it comes to ensuring accuracy, real-time monitoring, and efficient data analysis. This paper introduces a Radar System designed to address these challenges by integrating advanced radar sensors with real-time data processing algorithms. The system utilizes high-frequency radar waves to detect objects at varying distances, providing critical information about their position, speed, and movement. With capabilities for both short-range and long-range detection, the system can be applied in applications such as autonomous vehicles, security surveillance, and industrial monitoring. Additionally, the Radar System features a cloud-based interface, allowing users to access real-time data and monitor radar detections remotely via secure mobile or web platforms. This system offers enhanced safety and situational awareness by continuously scanning the environment for potential threats or obstacles, providing timely alerts and insights. The integration of intelligent signal processing algorithms ensures high accuracy and reduces the risk of false alarms, even in complex environments. The developed system is cost-effective, scalable, and adaptable, making it suitable for a variety of uses, from automotive safety systems to perimeter security. By leveraging radar technology with cloud connectivity, it ensures better data analysis, improves operational efficiency, and enhances the overall security and safety of its users. With the ability to provide continuous monitoring, real-time alerts, and remote control, the system contributes to a safer, more efficient environment in diverse applications.

**Keywords**: Radar System, Real-Time Data Processing, Object Detection, Radar Sensors, Cloud-Based Interface, Signal Processing, Remote Monitoring, Autonomous Vehicles, Industrial Monitoring, Safety Systems, Situational Awareness.

# PREDICTING THE PERFORMANCE ANALYSIS OF SUPERVISED LEARNING TECHNIQUES USING A CARDIOVASCULAR DISEASE DATA

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Cardiovascular diseases (CVD) are a major global health concern, necessitating effective predictive models for early detection and prevention. This study focuses on evaluating the performance of various supervised learning techniques using cardiovascular disease datasets. The research involves the application of algorithms such as decision trees, support vector machines, random forests, k-nearest neighbors, and neural networks to identify the most effective approach for accurate prediction. Comprehensive data preprocessing, including feature selection, normalization, and handling of missing values, is employed to enhance model performance. The evaluation metrics—such as accuracy, precision, recall, F1-score, and area under the ROC curve are analyzed to compare the strengths and weaknesses of each technique. The study highlights the importance of algorithm selection and parameter tuning in predictive analytics and provides insights into optimizing supervised learning models for CVD prediction. The findings contribute to developing robust, data-driven diagnostic tools for improving cardiovascular health outcomes.

**Keywords**: Cardiovascular Disease, Performance Analysis, Supervised Learning Techniques, Predictive Modeling, Machine Learning, Classification Algorithms, Data Mining, Decision Trees, Random Forest, Support Vector Machines, Neural Networks, K-Nearest Neighbors, Accuracy Metrics, Feature Selection, Healthcare Analytics.

# DATA ANALYSIS ON PREDICTING A STUDENT'S ACADEMIC PERFORMANCE WITH MACHINE LEARNING ALGORITHMS

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Academic predictions about student success in classroom instruction are frequently made using educational data mining approaches. Nonetheless, the majority of previous studies examined and assessed students' academic achievement in relation to their exam passing score. In addition to mining and analyzing the data that influences students' academic success, this work uses a logistic regression model to predict students' academic achievement. According on the findings, the suggested model's classification accuracy ranged from 70 to 75%. Only three categories of parameters were used to make the predictions: faculty, department, and midterm test marks. These data-driven researches are crucial for developing a framework for learning analysis in higher education and for influencing decision-making. Lastly, this research offers an addition to the early prediction.

**Keywords**: Student Performance Prediction, Performance Analysis, Educational Data Mining, Predictive Modeling, Machine Learning, Classification Algorithms, Data Mining, Random Forest in Education, Neural Networks, Decision Trees, Learning Analytics, Feature Selection, Educational Predictive Models.

# IOT BASED INTELLIGENT WHEELCHAIR WITH ALERT SYSTEM

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The development of an intelligent wheelchair incorporating sensor technology marks a significant advancement in assistive mobility devices, providing enhanced safety and convenience for users with mobility challenges. This project introduces a multi-functional wheelchair equipped with a buzzer system, a location tracker, and an innovative fall-prevention mechanism utilizing sponge deployment technology. The wheelchair is designed to address critical needs, including user safety, real-time monitoring, and accident prevention. The buzzer system serves as an immediate alert mechanism, notifying caregivers or nearby individuals in case of emergencies or unusual situations. The integration of a location tracker allows for continuous monitoring of the wheelchair's position, enabling caregivers or family members to track the user's location through platforms like Google Maps. This feature provides an added layer of security, particularly for users prone to wandering or in unfamiliar environments. A standout feature of this intelligent wheelchair is its fall-prevention mechanism. Sensors embedded in the wheelchair detect the likelihood of a fall or imbalance. Upon detection, a cushioning system deploys sponges to mitigate the impact, reducing the risk of injury to the user. The integration of these systems demonstrates the potential of modern technology to revolutionize assistive devices. The intelligent wheelchair combines practicality with technological solutions, alert system, ensuring mobility, safety, and peace of mind for users and their caregivers.

**Keywords:** Intelligent Wheelchair, Location Tracker, Fall-prevention Mechanism, Buzzer System, Monitoring, Sensor.

# INTERNET OF THINGS (IoT) BASED SMART AGRICULTURE MONITORING SYSTEM

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An IoT-based Smart Agriculture Monitoring System aims to revolutionize traditional farming practices by integrating Internet of Things (IoT) technologies to monitor and manage agricultural processes efficiently. This system utilizes a network of sensors, such as soil moisture, temperature, humidity, pH, and light sensors, to collect real-time data from the agricultural environment. We use machine learning algorithms for processing our data. One of the key components of this system is an automatic irrigation system that operates based on soil moisture levels, reducing water consumption and ensuring precise irrigation. The climate control in greenhouses adjusts environmental conditions based on real-time data creating optimal growth conditions for crops. The system also integrates weather forecasting data, which enables farmers to anticipate weather changes and adjust their practices accordingly. Additionally, the system provides a user-friendly mobile applicationfor farmers to remotely monitor and control farm activities, receive notifications, and take timely action. By minimizing resource wastage, this smart agriculture systemoffers improved crop yields, cost savings, and environmental sustainability.

**Keywords:** IoT, Smart Agriculture, Sensors, Data Analytics, Machine Learning, Automatic Irrigation, Precision Farming, Wireless Communication, Cloud Platform, Sustainable Farming.

# INTERFACE BETWEEN EMERGING TECHNOLOGIES AND QUEUEING MODELS

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Interface plays a crucial role in assessment of performance measures of various queueing models having applications in various real life situations including manufacturing, service delivery systems, health care systems, and computer networks etc. where queuing models are used to design, optimize and manage the system for optimum service with minimum latency. This interface is need of today because emerging technologies are influenced by queueing models and similarly emerging technologies also influence queueing models.

**Keywords**: Queueing Models, Emerging Technologies, Performance Measures, Optimum Service.

# IOT BASED SMART IRRIGATION SYSTEM

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Smart irrigation systems are a new technology that uses sensors and weather data to optimize watering schedules for crops. These systems can save water and energy while also improving crop yields. Smart irrigation systems use a variety of sensors to monitor soil moisture, weather conditions, and plant growth. We also used a mobile application (iOS) for the data dump. The data from these sensors is retrieved and processed by a computer model, which changes the irrigation requirement accordingly. For example, if the weather forecast predicts a lot of rain, the system will reduce or shut off irrigation to save water. Additionally, smart irrigation systems can be integrated with other technologies, such as weather forecasting and precision agriculture, to further improve efficiency. Overall, smart irrigation systems have the potential to revolutionize agriculture by reducing water usage, improving crop yields, and increasing efficiency. Smart irrigation system uses sensors and controllers to automatically adjust watering schedules based on the needs of the landscape. They can be used in a variety of applications, including: Reducing water waste, conserving water, protecting hardscape, increasing crop output, Supporting sustainable development, Labor savings. Smart Irrigation Technology: New Controllers: Climate-Based Controllers, Soil Moisture Sensor Controllers, Smart Irrigation Technology: Add-on Sensors, Soil Moisture Sensors, Rain and Freeze Sensors, Wind Sensors

**Keywords**: IOT, Weather Forecasting, Sensors.

# HARNESSING AI FOR EARLY DIAGNOSTIC BIOMARKER DISCOVERY IN PANCREATIC CANCER

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Pancreatic cancer is one of the deadliest malignancies due to late diagnosis and poor prognosis. Identifying biomarkers for early detection is crucial to improving survival rates. This research explores the use of artificial intelligence (AI) models to discover biomarkers for early-stage pancreatic cancer using multi-omics data. Advanced machine learning techniques, including feature selection, dimensionality reductions, and predictive modeling, were applied to extract meaningful biomarkers from complex biological datasets. The identified biomarkers demonstrated robust performance in distinguishing cancer patients from non-cancer individuals, validated across multiple independent datasets. This study illustrates the transformative potential of AI-driven biomarker discovery, giving a solid foundation for future research in cancer diagnostics. The outcomes highlight the worth of utilizing various kinds of omics data, like proteomics, metabolomics, and genomics, to capture the complexity of cancer progression. And, the study highlights the importance of merging clinical data and computational biology to enhance biomarker performance and enable earlier interventions. In the end, this approach not only supports the development of non-invasive diagnostic tools but also improves personalized treatment strategies, addressing a major gap in pancreatic cancer management.

**Keywords**: Pancreatic Cancer, Biomarkers, Artificial Intelligence, Machine Learning, Early Detection, Multi-Omics Data, Cancer Diagnostic.

# IOT-BASED INTEGRATED FISH MONITORING SYSTEM

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The Internet of Things (IoT) has emerged as a transformative technology in various fields, including aquaculture. This project report presents an IoT-based fish monitoring system designed to monitor water quality parameters critical to fish farming, such as temperature, pH, dissolved oxygen, and ammonia levels. By integrating sensors with a microcontroller and a cloud platform, the system provides real-time data collection, visualization, and alerts, enabling efficient aquaculture management and sustainable practices.

**Keywords**: Internet Of Things (IoT), Aquaculture, Fish Monitoring System, Water Quality Monitoring, Temperature Sensor, Ph Sensor, Dissolved Oxygen, Ammonia Levels, Real-Time Data, Cloud Integration, Smart Aquaculture, Sustainable Fish Farming, Environmental Monitoring, Sensor Network, Microcontroller.

# CROP DISEASE CLASSIFICATION USING K-MEANS CLUSTERING ALGORITHM

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Modern Agriculture has been amassing prominence in various developing countries. There are various kinds of obstacles arise in the life of plants due to less soil nutrients, paste, blight and environmental disorders, that can be direct affect visualized in the quality of Agriculture product. Therefore, in Agriculture sector, leaf disease recognition plays a critical role. It requires more care for the plants. It can be easily identified by the leaves are the face of plant, either any types of diseases are arise in plant then symptoms can visualized in the leaves, such as black, yellow, The leaves on that tree are turning yellow, pale yellow, Dark green or purple discoloration, Marginal scorch (browning around the edges of the leaves) and spots like dark sunken, oval,rectangular, circular, leaves damaged and stunted growth of the leaves. That can be identified by the machine learning as well as the deep learning methods. Especially K-Nearest Neighbors gives 98**.7**% result as the accuracy good level.

**Keywords:** Clustering, K- means. Computer vision, Machine Learning, Precise Agriculture.

# EVALUATING IMPACT OF SENSOR NODE OPERATING SYSTEMS FOR WIRELESS SENSOR NETWORKS

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Wireless sensor network (WSN) is considered as one of the most important techniques in the 21st century. Two different operating system types are currently considered for sensor networks: event driven and multithreaded. Wireless sensor network operating system is the core and also the essential part of the WSN system, and its high efficiency and flexibility directly impact on the performance of the real-time system. As wireless sensor networks are growing fast so they need for effective system software (OS) as well. There is currently enormous research potential in the field of wireless sensor network OS. Thus, we need to be familiar with the current research in this field. After survey on the major topics in operating systems for wireless sensor network indicating that WSN developers need to be aware of differences of different OS in behavior to improve the overall performance of their nodes.This paper will introduce the performance evaluation of the two WSNOS. We implemented and tested the performance of these solutions in simulations using TOSSIM with TinyOS and COOJA with ContikiOS. In this paper; we presented results obtained from a simulation Experiments aiming to measure the packet delivery ratio of two different operating systems for WSN and theoretical aspect of process execution model, memory allocation, programming, power, networking etc.

Traditional operating systems do not take into consideration the limitations in many aspects (i.e. space, energy, process, memory etc.) of wireless sensor networks. One of the motivations of our research is to find a WSN OS architecture that is appropriate for the efficient sensor management and the qualified user service providing. Finally, we provide simulation results that will validate our proposed techniques.

**Keywords**: Wireless Sensor Networks, Operating Systems, TinyOS, ContikiOS, TOSSIM, COOJA.

# DEEPLEARNINGTECHNIQUESFOR VEHICLE DETECTIONAND CLASSIFICATION

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Detecting and classifying vehicles from images and videos is a complex task due to variations in appearance, environmental conditions, and perspective. The rapid advancements in deep learning (DL) have significantly enhanced the capabilities of computer vision, enabling the development of efficient, accurate, and time-sensitive solutions for vehicle detection and classification. This paper presents a comprehensive overview of DL-based approaches, focusing on their applications in traffic density estimation, real-time monitoring, and related domains. A detailed analysis of DL techniques, benchmark datasets, and foundational concepts is provided, alongside a comparison of existing methods using key performance metrics. By highlighting the strengths and limitations of current approaches, this study identifies critical challenges and opportunities for advancing vehicle detection and classification systems.

**Keywords:**DeepLearning,VehicleDetectionandClassification, CNN.

# IMPACT OF MACHINE LEARNING ALGORITHMS ON DIGITALLY EVALUATION PROCESS OF SCHOOL STUDENT PERFORMANCE

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School student performance Prediction is most important concern for any education institutions and very difficult to evaluate the performance prediction on school student. Dropout is one more major factor that effected education institution progress on each level primary, upper primary and secondary level. There are many reasons for school student's dropout like family, financial, lack of facilities or teachers in schools. In this paper we aim to solve this problem and present a novel model for analyzing the condition of different schools and their performance in academic area using Machine learning techniques. In our model the description of dataset is from the schools of Raipur block and different districts of Chhattisgarh state. Here, we have collected various student datasets, from questionnaire, which was distributed in the form of Google forms. Secondary dataset was collected from UDISE portal. We take here dataset five sessions starting from 2018 to 2023.This paper illustrates to provide qualitative study for improvement of academia or helps to evaluate the performance of teacher, students and enhance the education structure. With the help of proposed SDR model we can know about the school condition and student dropout reason properly and understand the main problem behind the academic cause of hindrance in educational progress and try to improve school's condition.

**Keywords**: Student dropout, Prediction, Machine learning Algorithms, School, Raipur.

# ABSTRACTIVE TEXT SUMMARIZATION FOR HINDI NEWS HEADLINES GENERATION

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Text summarization is a technique that condenses large volumes of text while retaining essential information, significantly reducing reading time. However, generating high-quality summaries remains a challenging task, as it is difficult to replicate human-like summarization. Most existing summarization tools primarily focus on the English language, with limited availability for other languages. In this work, we propose an abstractive text summarization model for Hindi, aimed at generating concise headlines from news articles. The model is trained on a Hindi news dataset covering various domains such as sports, politics, and crime. After pre-processing and text cleaning, Word2Vec is used for word embedding. The summarization model is built using an encoder-decoder architecture with Long Short-Term Memory (LSTM), leveraging LSTM's ability to retain long-term dependencies effectively. To evaluate the quality of the generated summaries, ROUGE and BLEU scores are computed. Additionally, we explore pre-trained transformer-based models like BART and T5 to further enhance summarization accuracy. The proposed approach aims to bridge the gap in Hindi text summarization, offering an effective solution for generating meaningful and concise summaries in underrepresented languages.

**Keywords**: Text summarization, LSTM, RNN, Neural Network, Rouge, Bleu BART, T5.

# DEVELOPMENT OF NOVEL METHOD FOR RECOGNITION OF HUMAN BEHAVIOUR USING MACHINE LEARNING TECHNIQUES

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Detection of Human Behavior is very complex task from various old era. Still, no one easily detect the behavior of human. Our measure goal of this research is easily identifying the human behavior through machine techniques. Our researches easily detect the behavior of human and give the result about their behavior.

**Keywords**: ML, Detection Techniques, Behavior Analysis, Deep Learning, Supervised Learning.

# DIETARY PLANTS OF SOLANACEAE FAMILY FOR TREATMENT AND PREVENTION OF KIDNEY STONE A MICROCOSM STUDY

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India being an agronomic country, majority of its population is dependent on farming mode to earn its livelihood and thus India has a diverse range of more than 6000 cultivated species. Few of these crops are responsible for majority of food supply across the Globe. Solanaceae is one such family having a vast economical asset, its species form an integral part of human civilization as food sources and drug remedies since thousands of years and lately as ornamentals, its alkaloids include solanine, nicotine, solasonine, scopolamine, atropine & hyoscyamine. For pharmaceutical use it becomes an utmost need to study the medicinal parameter of plants. In the present investigation two plants were selected from Solanaceae family, i.e. *Solanum nigrum* and *Solanum xanthocarpum*. Qualitative phytochemical test of plant sample gave a brief idea about its property. Nutritional value was also analyzed which gave a fruitful comparison between the two plants. In this work total carbohydrate, protein, phenol, ascorbic acid, and fatty acid value was analyzed and documented. In the present work we also focused on Urolithiasis a condition where urinary calculi are formed in the urinary tract. Urolithiasis is also responsible for kidney stone. Urolithiasis, is nothing but a deposition of stones in urinary tract. It is a clinical problem in day today life resulting from stressful life and bad eating habits. Urinary stones have attracted greater scientific attention not only due to their high frequency of occurrence but also due to the serious functional implications associated with formation of such stones. Human renal stones are composed of crystalline and non-crystalline phases; 80% of stones are composed of calcium oxalate (CaOX). CaOX crystal are growth inhibitors (proteins, lipids, glycosaminoglycans, and inorganic compounds) have been proposed to play an important role in renal stone disease. During the last few decades more and more research has been done at the cellular and molecular levels. In spite of these advances however, the clinical treatment of urolithiasis remains far from satisfactory. Plant based therapy are reported to be effective at different stages of stone pathophysiology.

**Keywords**: Urolithiasis (Kidney Stone), CaOX (Calcium Oxalate), Solanaceae.

# OPTOELECTRONIC AND ADSORPTION PROPERTIES OF CU-DOPED NI FOR $CO_2$ CAPTURE APPLICATIONS A DFT-BASED APPROACH

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A major greenhouse gas $CO_2$ capture and conversion technologies are vital for addressing environmental concerns with materials that efficiently adsorb $CO_2$. In this preliminary study we investigated the potential of Cu-doped Ni slab structure as an alternative material for $CO_2$ adsorption and reduction. We used Density Functional Theory (DFT) based tool SIESTA for the analysis of structural, electronic, optical and adsorption properties of Cu-doped Ni slab. A significant change due to Cu doping in Ni is observed in electronic propertie viz density of states, projected density of states and band gaps, which enhances $CO_2$ adsorption. The computation of various optical properties, such as the optical conductivity, absorption coefficient etc. are also performed in this system. Adsorption energy calculation also indicates that Cu doping improves $CO_2$ binding with the surface of CuNi promoting its activation for potential reduction reactions. This study shows that Cu-doped Ni can be a promising candidate for $CO_2$ capture technologies, providing a cost-effective solution for sustainable energy and environmental chemistry.

**Keywords:** $CO_2$ Adsorption, Cu-doped Ni, Cohesive Energy, Enthalpy of Formation,Optical Conductivity.

# EMERGING CHALLENGES IN GREEN CHEMISTRY FOR THE TREATMENT OF PLASTIC POLLUTANTS

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The green chemistry revolution is posing a huge number of issues for chemists working in research, industry, and education. Despite these difficulties, there are also plenty of chances to learn and use new chemistry, boost the profitability of chemical production, and change the formerly negative perception of chemistry. Based on his 1998 Inaugural Lecture at the University of York, Professor Clark discusses some of the difficulties, looks at some of the new and effective "greener" chemistry in practice, and uses two branches of chemistry to analyze the scope and variety of contemporary issues as well as the fascinating prospects for creative chemistry research and application. Current plastic waste treatment technologies generally require severe reaction conditions or long reaction times, resulting in high energy consumption and capital costs. Recently, plasma, Fenton and electrochemical technologies have emerged to recycle waste plastics under mild conditions and effectively remove microplastics. The basic principles and applications of plasma, Fenton and electrochemical technologies in plastic waste treatment are discussed.

**Keywords**: Green Chemistry, Scope, Plastic Treatment, Technology.

# STRUCTURAL, ELECTRONIC AND OPTICAL PROPERTIES OF GALLIUM DOPED PALLADIUM A FIRST PRINCIPLE APPROACH

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We have studied the structural, electronic, and optical properties of pristine Palladium (Pd) and Gallium-doped Palladium (GaPd), with varying doping concentrations, using the density functional theory (DFT) incorporated in SIESTA code. Band structure, density of states (DOS) and projected density of states (PDOS) study shows significant changes in the electronic structure of Pd due to Gallium (Ga) doping. All the materials exhibit metallic behavior and are mechanically stable as well as the enthalpy of formation and cohesive energy calculations, further validates their thermodynamic stability. GaPd reflects stronger molecular interactions than pure Pd, which enhances adsorption characteristics which increases with Ga doping levels. This opens a new pathway in its potential in catalytic applications including chemical synthesis, hydrogen storage, and pollutant degradation. GaPd demonstrates better energy absorption compared to pure Pd, especially in the low energy range showing its potential application for optoelectronics and photonics. Our study demonstrates that Ga doping induces significantly induces its stability, electronic, and optical properties of Pd, making GaPd a promising material for catalytic, optoelectronic, and sustainable energy applications. Which offers valuable insights into the design of advanced materials for next-generation technologies.

**Keywords:** DFT, Electronic Property, Ethanol Catalytic Potential, Optical Property, Ethanol Fuel Cell

# CONCENTRATION DEPENDENT ANALYSIS OF Sn-DOPED Pd-STABILITY, OPTOELECTRONIC PROPERTIES AND CATALYTIC POTENTIAL FOR DIRECT ETHANOL FUEL CELLS – A DFT STUDY

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Direct ethanol fuel cells (DEFCs) is a promising alternative to conventional energy systems due to ethanol's renewable nature and high energy density. However, challenges like incomplete ethanol oxidation reaction and the high cost of Pt and Pt-based catalysts pose a significant challenge to the large-scale production of direct ethanol fuel cells (DEFCs). This study provides a concentration-dependent analysis of Sn-doped Pd catalysts in a slab-type structure, investigating their structural and optoelectronic properties to determine their suitability as cost-effective alternatives. Using first-principles calculations with the SIESTA tool, the stability of these materials is confirmed, with cohesive energies and enthalpy of formation indicating thermodynamic viability. Electronic properties viz Projected densities of states, band gap and optical properties viz complex dielectric functions, optical conductivity and absorption coefficient has been compared. Adsorption energies for ethanol molecules on pure and Sn-doped Pd slab surfaces reveal enhanced catalytic properties with increasing tin concentration. The results demonstrate that Sn doping significantly enhances catalytic performance, establishing SnPd as a viable candidate for advanced DEFC applications.

**Keywords:** Direct Ethanol Fuel Cells, Sn-Doped Pd, Catalytic Potential, Cohesive Energy, Adsorption Energy.

# A REVIEW ON ENVIRONMENTALLY BENIGN METAL-ORGANIC FRAMEWORKS

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The development of metal-organic frameworks has progressed remarkably due to environmental concerns and growing demand for sustainable technologies. Metal-Organic Frameworks (MOFs) have gained a lot of attention for their versatile applications. However conventional synthesis methods are often associated with toxicity and excessive waste. In this review, we explore green synthesis techniques, characterization methods, and applications of MOFs. Various sustainable synthesis methods, like solvent-free, microwave-assisted, and aqueous-based techniques, are discussed. Furthermore, we emphasize the role of advanced characterization techniques, including in situ powder X-ray diffraction and spectroscopy, in understanding the properties and performance of green-synthesized MOFs. The review also explores potential applications of eco-friendly MOFs in fields like carbon capture, water purification, and energy storage. We aim to inspire further research and development of environmentally benign MOFs for industrial and environmental applications.

**Keywords:** Metal-Organic Frameworks (MOFs), Green Synthesis, Eco-friendly Materials, Solvent-Free Synthesis, Microwave-Assisted Synthesis, Aqueous-Based Synthesis, Characterization Techniques, Powder X-ray Diffraction, Spectroscopy, Carbon Capture, Water Purification, Energy Storage, Environmental Applications, Sustainable Chemistry.

# PHOSPHATE-SOLUBILIZING EFFICIENCY OF RHIZOSPHERIC FUNGI ISOLATED FROM PADDY FIELDS: A COMPARATIVE STUDY OF ASPERGILLUS AND PENICILLIUM SPECIES

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Fungi represent indispensable components of soil microbiota, playing a fundamental role in maintaining biodiversity and facilitating nutrient cycling through their involvement in critical soil metabolic processes. The present study isolated 20 distinct fungal cultures from paddy crop field rhizosphere, from which four isolates were selected for comprehensive analysis of their performance in liquid broth cultures supplemented with various carbon and nitrogen sources. Among these, two fungal isolates—taxonomically identified as Aspergillus sp. and Penicillium spp.—were subjected to extensive investigation. All isolates underwent systematic evaluation through in vitro assays utilizing Pikovskaya agar medium as the growth substrate. Notably, the phosphate-solubilization efficiency exhibited by the selected isolates demonstrated significantly enhanced performance in liquid media containing PKV broth culture compared to standard liquid broth culture conditions. These findings indicate a strong correlation between the phosphorus-solubilization capabilities of fungal isolates and their metabolic processes within phosphate-solubilizing fungi (PSF) cultures. Given these promising results, subsequent investigations focusing on these high-efficiency PSF isolates are warranted to further elucidate their potential applications and underlying mechanisms.

**Keywords**: Paddy Crop, Tricalcium Phosphate (TCP), Phosphate Solubilization.

# HEPATOPROTECTIVITY OF SYNTHESIZED PROPOLIS NANOPARTICLES AGAINST LIVER DAMAGE: IN VIVO DEMONSTRATION WITH A RAT MODEL OF FIBROSIS INDUCED BY THIOACETAMIDE

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Propolis is a resinous mixture collected by honey bees from different flowers and plants parts and possess several biological activities. In current scenario chronic liver diseases are worldwide problem due to several factors, till date it is still unclear that how propolis affects liver fibrosis caused by thioacetamide. The current study sought to ascertain whether or not propolis in its nanoform provides defense against thioacetamide induced rat hepatic fibrosis. In present investigation, thioacetamide (200 mg/kg) was given orally three times per week, while propolis nanoparticles were given orally three times per week (5, 10, and 15 mg/kg) for eight weeks. Hematological, serological, biochemical, histological, and ultrastructural analysis were done to assess recovery pattern of propolis nanoparticles. Propolis nanoparticles reversed histopathological and ultrastructural changes, decreased the levels of AST, ALT, ALP, γ-GT, bilirubin, HDL, TG, cholesterol and increases the level of albumin, glucose, and LDL. Propolis nanoparticles significantly reduced oxidative stress induced by thioacetamide in terms of LPO, cholesterol, triglycerides. Hydroxyproline which is a marker of liver fibrosis was also restored by propolis treatment. SOD, catalase, GSH, GR, GPx, GST, G6PDH level was upshifted in propolis nanoparticles treated groups. These findings provided new insight into the role of propolis nanoparticles in the treatment of liver fibrosis.

**Keywords:** Propolis Nanoparticles, Liver Fibrosis, Thioacetamide, Oxidative Stress, Antioxidant Enzymes.

# SPECTROSCOPIC AND PHYSICO-CHEMICAL ANALYSIS OF SOIL IN THE GEOTHERMAL AREA OF TATTAPANI BALRAMPURCHHATTISGARH INDIA

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Soil fertility management is essential for crop cultivation, fodder, organic farming, green house and nursery production. In our study soil sample are collected from geothermal area of Tattapani which is situated at NH 343, 12 to 13 km from Balrampur, Chhattisgarh. Soil samples were randomly taken, 200 meters from north direction of lord Shiv temple near to geothermal hot water spring origin (Tattapani) and 100-200 meter from south direction. Physical parameter of soil like pH, TDS, Conductivity, Salinity, Turbidity have been determined. Chemical parameter for heavy metals like Zn, Cu, Cr, Co, Mn, As and Ni are analyzed by AAS. Some cations such as $Li^+$, $Na^+$, $NH_3^+$, $K^+$,$Mg^{2+}$, $Ca^{2+}$ and anions $F^-$, $Cl^-$ ,$NO_2^-$, $Br^-$, $NO_3^-$, $PO_4^{3-}$ and $SO_4^{2-}$ are studied by Ion Chromatography. Above in all physical parameters TDS and conductivity is higher in concentration, in heavy metals Mn (mg/L) present higher amount and Cr is low in concentration, in cation $Ca^{2+}$ present in maximum & $NH_3^+$ in minimum, in anion $Cl^-$ present in high quantity and $F^-$ has lower concentration in our soil sample. pH of the soil sample is less acidic and its near to neutral value. Analytical results and data of our present study may be helpful to know about nutrients, fertility and composition of the soil to introduce people who are growing crops in this area as well as to aware reason behind the origin of geothermal hot water spring.

**Keyword:** Soil Analysis, Physico-Chemical Parameters, Cations, Anions, Tattapani, Balrampur.

# A COMPREHENSIVE REVIEW ON APPLICATION OF PLANTBASED BIOADSORBENTS FOR EFFECTIVE REMOVAL OF CR(VI) FROM VARIOUS ENVIRONMENTAL SEGMENTS

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In recent years, research has focused on plant-origin bioadsorbents for the effective removal of heavy metals. Industrial activities generate substantial amounts of hazardous wastes containing relatively high concentrations of chromium, recognized as one of the most toxic inorganic pollutants in various environmental segments. This review study aims to identify suitable plant-based bioadsorbents for the removal of Cr (VI) from diverse environmental segments. The adsorption behavior of Cr (VI) is examined through various research papers, presenting a comparative study of bioadsorbent based on their pH, Concentration, Kinetic behaviors, and methodologies. The findings highlight the efficiency of each bioadsorbent in adsorbing Cr (VI) at specific concentration. Additionally, characterization techniques such as FTIR, XRD, and SEM reveal the surface structures and interaction between the bioadsorbent and the contaminant during the adsorption process. The equilibrium data is analyzed using various isotherm and kinetic models to assess the practical applicability of these adsorbents.

**Keywords:** Adsorption, Cr (VI), Bioadsorbents, Isotherm Kinetic Model.

# OPTIMIZATION OF PHYSIOLOGICAL PARAMETERS FOR ENHANCED PRODUCTION OF SINGLE CELL PROTEIN FOLLOWING RESPONSE SURFACE METHODOLOGY

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Lignocellulosic waste, a significant by-product of agricultural and industrial processes, represents a renewable and abundantly available resource which is often underutilized. Efficient conversion of this waste into the value-added products, such as single-cell protein (SCP), provides a sustainable solution for waste management while addressing challenges of global food security. It is protein-rich biomass derived from the microbial sources and holds promise as a nutritional supplement in the food and feed industries. This study aims to optimize the physiological parameters for enhanced production of SCP using lignocellulosic waste as a substrate. Optimization of physiological parameters is crucial for maximizing microbial efficiency, enhancing product yield, reducing costs, and ensuring process sustainability. Response Surface Methodology (RSM) with Box-Behnken Design (BBD) was employed to systematically evaluate and optimize critical factors, including pH, temperature, fermentation period, and inoculum size, to maximize the yield of SCP. The statistical approach facilitated a comprehensive understanding of interactions between the parameters and determined optimal conditions for the production of SCP. The findings demonstrated a substantial increase in the SCP yield under optimized conditions compared to the baseline, demonstrating effectiveness of the applied methodology. This research underscores the potential of integrating RSM for cost-effective and sustainable production of SCP. Accumulated results pave the way for scaling-up SCP processes, contributing to the development of circular bioeconomy practices and resource-efficient protein alternatives.

**Keywords**: Microbial Protein; Lignocellulosic Waste; Response Surface Methodology; Box-Behnken Design; Optimization.

# MICROWAVE-ASSISTED GREEN SYNTHESIS OF TETRAHYDROBENZO[B]PYRANS *VIA* ONE-POT MULTI-COMPONENT REACTIONS UNDER CATALYST AND SOLVENT-FREE CONDITIONS

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The development of an environmentally friendly protocol for synthesizing tetrahydro benzo [b] pyrans is currently a priority, given their significance as versatile intermediates. In this regard, employing Microwave (MW) irradiation without catalysts or solvents can serve as an eco-friendly and efficient method. We have successfully demonstrated the production of tetrahydro benzo [b]pyran derivatives via multi-component reactions of aldehydes, dimedone and malononitrile using MW irradiation under catalyst-free and solvent-free conditions. The resulting products were purified through recrystallization in ethanol. The synthesis of tetrahydro benzo [b]pyran derivatives was achieved with high isolated yields (70-80%) in short reaction times, as confirmed by melting point determination and $^{1}$H NMR spectroscopic analysis. This transformation likely involves sequential Knoevenagel condensation, Michael addition, and intramolecular cyclization steps. The MW irradiation-based protocol for synthesizing tetrahydro benzo [b]pyran derivatives offers several advantages: operational simplicity, absence of catalysts, solvents, bases, and additives, compatibility with various functional groups, straightforward purification, rapid reaction times, and cost-effectiveness. Additionally, it provides high isolated yields in short reaction times without generating byproducts.

**Keywords:** Tetrahydro Benzo [B] Pyrans, Microwave Irradiation, Catalyst-Free Synthesis, Solvent-Free Reaction, Green Chemistry, Multi-Component Reaction (MCR), Aldehydes, Dimedone, Malononitrile.

# INTEGRATIVE AYURVEDA APPROACH FOR REMISSION IN ACUTE MYELOID LEUKEMIA: A DETAILED CASE REPORT

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**Purpose:** Acute Myeloid Leukemia (AML) is a hematological malignancy characterized by the rapid proliferation of abnormal myeloid cells in the bone marrow, resulting impeded production of hematopoietic cells. This case report delves into the clinical journey and integrated Ayurvedic methods employed for patients diagnosed with Acute Myeloid Leukemia (AML). This study aims to amalgamation of different holistic methods to help improve the overall well-being and possibly achieve remission in AML.

**Methods:** Prior to the start of the treatment, the patient received a solitary session of chemotherapy in conjunction with specific conventional medications. The study involved analysing patient blood reports and biochemical investigation as well as physical change, both before and after the integrated therapies including Yoga, Pranayams, Ayurvedic medicines, naturopathy sessions and a balanced diet for a period of 10 months.

**Results:** After undergoing 10 months of integrated treatment, the patient showed a noteworthy alleviation of AML-related symptoms. Simultaneously, he experienced confidence, happiness as well as improved Quality of Life. His blood reports also showing balanced parameters. At present, he leads a normal and fulfilling life, signifying the positive impact of treatment on his overall health and quality of life.

**Conclusions**: In this case report, a positive and effective outcome was observed through a holistic strategy, the patient actively engaged in holistic healing practices. The combined influence of these alternative therapies significantly contributed against patient's remarkable recovery from AML. Although, further research and exploration are needed to conduct larger clinical trials in this regard.

**Keywords:** Actue Myeloid Leukemia, Ayurvedic treatment, Yoga, Naturopathy, Diet.

# ANALYSIS OF RAINFALL TRENDS IN THE MAHANADI BASIN AREA CHHATTISGARH INDIA

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The spatial and temporal variability of rainfall across eight districts within and surrounding the Mahanadi Main Canal Command (MMCC) area. The analysis is based on rainfall data collected over a 102-year period (1901–2002), with a focus on both annual and seasonal time series. The maximum annual rainfall recorded during this period was 2,350 mm**,** while the minimum was 650 mm**,** illustrating the variability in precipitation across the region. To assess the homogeneity and identify change points in the time series, three methods were used: Pettitt's test, the Standard Normal Homogeneity Test (SNHT), and Buishand's test. Change point analysis was conducted to detect potential shifts within the data. For trend analysis, the entire time series was divided into three segments: the full period, the pre-change point period, and the post-change point period. Mann-Kendall (MK) tests and Sen's slope estimator were applied to evaluate rainfall trends. The Mann-Kendall test showed a significant decreasing trend in annual rainfall in six districts—Dhamtari, Durg, Kanker, Mahasamund, Raigarh, and Raipur—while no significant trend was observed in Bastar (MK statistic = -1.24) and Bilaspur (MK statistic = +1.01). The affected area for the decreasing rainfall trend across these districts is approximately **65%** of the total area within the MMCC command. Additionally, the spatial distribution of changes in annual and seasonal rainfall was analyzed to detect temporal variations across the region. This was achieved through spatial interpolation methods, such as inverse distance weighting, within a GIS framework. The findings indicate a significant decline in annual rainfall in 55% of the MMCC area, with annual rainfall values reaching a maximum of 2,350 mm and a minimum of 650 mm. A non-significant increase in post-monsoon rainfall was observed in about **25%** of the region. The overall trend shows that the canal command area is experiencing a significant reduction in annual rainfall, with some localized increases in the post-monsoon period.

**Keywords**: Rainfall Trends, Mahanadi Main Canal Command, Spatial Variability, Change Point Detection.

# FLAVORS OF NATURE: CASSIA TORA SOUP REDEFINES FUNCTIONAL FOODS

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Cassia tora, a resilient plant native to tropical and subtropical regions of Asia, offers a versatile profile encompassing medicinal, nutritional, agricultural, and industrial applications. This study explores the sensory attributes and consumer acceptability of Cassia Tora Soup, a novel preparation leveraging the plant's nutrient-rich leaves. The preparation process optimized the soup's flavor, appearance, aroma, and consistency. A sensory evaluation conducted with 30 untrained panelists assessed key attributes on a 9-point hedonic scale. Results revealed high overall acceptability, with average scores ranging from 7.8 to 8.0 across all parameters. Taste emerged as the most appreciated feature, while aroma, influenced by the distinct herbal profile of Cassia tora, showed potential for enhancement. The study also highlights the plant's bioactive compounds—anthraquinones, flavonoids, and essential oils—that contribute to its therapeutic benefits, including anti-inflammatory and antioxidant properties. Nutritionally, the soup incorporates Cassia tora's vitamins, minerals, and fibers, making it an attractive option for health-conscious consumers. Suggestions for improvement focus on balancing the herbal flavor and enhancing visual appeal to cater to a broader audience. The findings underscore the potential for Cassia Tora Soup as a functional food product with significant commercial viability, aligning with the growing demand for health-promoting dietary options.

**Keywords**: Cassia Tora, Sensory Evaluation, Functional Food, Medicinal Plants and Consumer Acceptability.

# HEXAGONAL BORON NITRIDE: A DFT-BASED EXPLORATION OF STABILITY AND ELECTRONIC PROPERTIES

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Using the SIESTA package, hexagonal boron nitride (BN-Hexa), a two-dimensional material, is studied for its electronic and structural properties. The BN hexagonal structure allows for a high surface area, which is beneficial in applications like catalysis and energy storage. His hexagonal structure confers several advantages that make h-BN highly desirable in numerous applications, especially in electronics, thermal management, lubrication, and energy storage. Using first-principal calculation with the Density Functional Theory (DFT) based tool SIESTA, we investigated the structural stability and optoelectronic properties. the material stability is confirmed through cohesive energy and enthalpy of formation. A detailed analysis of the electronic properties, including densities of states, projected density of states, and band structure.

**Keywords:** Cohesive Energy, Enthalpy of Formation, Density Functional Theory, Density Plot Diagram.

# TRANSFORMING INVASION INTO INNOVATION: A COMPREHENSIVE REVIEW OF WATER HYACINTH UTILIZATION FOR SUSTAINABLE RESOURCE MANAGEMENT

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This review aims to explore the multifaceted application of water hyacinth. Water hyacinth (Eichhornia crassipes) is an aquatic plant notoriously known for its rapid growth and invasive nature, often leading to significant ecological and economic challenges in hydrological ecosystem. On contrary to this stigma associated with water hyacinth recent studies have highlighted its potential as a sustainable resource for multiple products that can contribute to water conservation and environmental management, including its use in bio energy production, bioremediation and as raw material for biodegradable products. Additionally in this paper we discuss innovative approaches to harnessing water hyacinth for the production of value-added products such as bio-plastics, animal feed and construction materials. By synthesizing current research findings, this review aims at providing a multifaceted understanding of the potential applications and challenges associated with the utilization of water hyacinth. Later in this paper we advocate for integrated management strategies that leverage this invasive species as a resource, thereby contributing to water conservation and promoting sustainable development.

**Keywords**: Water Hyacinth, Invasion, Innovation, Sustainable Development, Conservation.

# SYNTHESIS AND CHARACTERIZATION OF MONO-2-CHLORO-6-NITROANILINE PHOSPHATE ESTER

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Organic phosphates play vital role in living being as a part of DNA and RNA. It has many applications in various forms such as plasticizer, pesticides, adhesive, prodrugs, medicine and antimicrobial compounds. The present study focusses on the synthesis, Mono- phosphate ester synthesized from substituted aniline with the reaction of phosphorylating agent Phosphorus Pentoxide ($P_2O_5$) by treatment and precipitation by Ba $(OH)_2$ further purification and washing done by glacial acetic acid and water. This compound is confirmed with the help of elemental analysis and characterization by various spectroscopic technique such as Infrared and $^1H$ NMR analysis. Different kinetic parameter study done from the spectrophotometric analysis.

**Keywords**: Phosphate, Esters, Synthesis, Characterization, Hydrolysis.

# THERAPEUTIC EFFICACIES OF PHYTOFABRICATED NANOPARTICLES IN COMBATING ACCELERATED AGEING-INDUCED DETERIORATIONS

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Aggravated production of active oxygen species (AOS) instigates oxidative damages to macromolecules, resulting in metabolic dysfunction and reduces quality of seeds, affecting germination and stand establishment thereby yield. Studies regarding seed rejuvenation mediated by nanoparticles (NPs) is still in its developing state. Nanoparticles are minuscule (1 to 100 nm) powerful entities, with relatively larger surface area, and instantaneous reactivity, they contribute to improve seed quality and increase crop yield. They can be fabricated from both metals and metal oxides, and may exists in both natural and simulated forms. Aiming to promote sustainable nano-agriculture, biocompatible zinc oxide (ZnO) and, silver (Ag) NPs have been fabricated using fruit juice of Citrus lemon to rejuvenate accelerated aged (AA) seeds of Cajanus cajan. Accelerated aged seeds pulsed with (0.5%, v/v) each of green ZnONP and AgNP, revealed substantial enhancement in germination and vigor compared to those exposed with their bulk counterparts. Supplementation of NPs regulated AOS accrual in AA seeds, enhanced α-amylase activity and total sugar content for fueling germinating seeds. Meantime, alterations in the AOS levels contributed to hormonal signaling, augmented gibberellic acid (GA) concentrations in NP amended AA seeds. Modulation in antioxidants, aquaporins and cell cycle genes suggested their important roles in managing AOS levels, water uptake, and cell division, respectively, and contributed enhanced germination of NP provided AA seeds. Comparatively, green ZnONP supplementation was found to pose more profound impact on redox regulation of AA seeds, hence; significantly more improvement of germination attributes.

**Keywords**: Active oxygen species, Ageing, Antioxidants, Aquaporins, Cajanus cajan, Cell cycle, Hormones, Nanoparticles.

# SYNTHESIS AND LUMINESCENCE STUDIES ON RARE EARTH DOPED$M_5(PO_4)_3X$ (M=CA, SR, BA) (X=F/CL/BR/I) PHOSPHORS: A REVIEW

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In this research the material phosphate based $M_5(PO_4)_3X$ (M=Ca, Sr, Ba) (X=F, Cl, Br, I) phosphor were prepared by different methods mean bycombustion synthesis and solid-state reaction method, and characterized by XRD (x-ray diffraction), PL (photoluminescence) techniques, TL(thermoluminescence) techniques, SEM (scanning electron microscopic) and FTIR spectroscopic. Investigated PL study observed emission and excitation spectra in different - different wavelength in different range of UV and calculated light yields. Hence PL emission in rare earth (Eu and Dy) may be efficient photoluminescent materials for solid-state lighting phosphors.[11]. They are for near UV based wLEDs and display devices.

**Keywords:**Phosphate, Chemical Method, Photoluminescent Materials, Thermoluminescence, Dosimetric.

# SOME BEST PROXIMITY THEOREMS FOR INTERPRETATIVE PROXIMAL CONTRACTION IN NON- TRIANGULAR METRIC SPACES

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In this paper, we introduce novel best proximity point theorems for interpretative proximal contractions within the framework of non-triangular metric spaces. Unlike traditional metric spaces that satisfy the triangle inequality, non-triangular metric spaces allow for more generalized distance structures, broadening the scope of fixed-point theory. We focus on situations where a mapping does not necessarily possess a fixed point, and instead, we seek a best proximity point—a point that is as close as possible to being a fixed point under the given constraints. By establishing specific contractive conditions for interpretative proximal contractions, we demonstrate the existence and uniqueness of best proximity points in such spaces. These results extend and improve upon previous findings by incorporating more flexible structural assumptions, thus enabling their application to a wider class of problems in functional analysis and optimization. Several illustrative examples are provided to validate the theoretical results and showcase their practical significance. The techniques and methods developed herein contribute to the ongoing advancement of fixed-point theory in abstract spaces, offering new perspectives and tools for analyzing mappings in more generalized settings.

**Keywords**: Best Proximity Point, Nonlinear Contractions, Metric Space, Altering Distance Function, Fixed Point Theory.

# THE ROLE OF CIRCULAR ECONOMY PRINCIPLES IN INDUSTRY 5.0

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The circular economy is a powerful framework for creating a more sustainable and regenerative economic system. By adopting circular economy principles, businesses, governments, and individuals can reduce waste, conserve resources, and promote sustainable growth. It is a sustainable economic system that aims to reduce waste and the consumption of resources by promoting the reuse and recycling of products. It's a holistic approach that seeks to transform the way we produce, consume, and dispose of goods.The basic principles of Circular Economy includes Design for circularity, where, Products and services are designed to be recycled, reused, or biodegradable, secondly, Sharing and collaboration, where, Companies and individuals share resources, expertise, and assets to reduce waste and improve efficiency, further, Closed-loop production, where, Products are designed to be recycled and reused, reducing the need for new raw materials and finally, Biodegradable materials for reduction and management of wastes, where, Materials are designed to be biodegradable, reducing waste and the environmental impact of production. The integration of circular economy principles in Industry 5.0 has the potential to transform the way industries produce, consume, and manage resources. This research paper aims to propose Strategies for Sustainable Resource Management based on Application of Circular Economy Principles in Industry 5.0. Apart from the benefits of Circular Economy in Industry 5.0, there are Challenges and Limitations for its implementation, which are addressed here. Approximately, 20 companies in India have been taken up for case studies, who adopted the principles of Circular Economy in Industry 5.0. Descriptive statistics and Content analysis has been used to analyze the case study data. This research will be helpful to meet the objectives to develop a framework for implementing Circular Economy principles in Industry 5.0, to investigate the potential impact of Circular Economy principles on Industry 5.0 business models and to identify the skills and competencies required for implementing Circular Economy principles in Industry 5.0.

**Keywords**: Circular Economy, Industry 5.0, Sustainable Resource Management, Waste Reduction, Recycling and Reuse, Sustainable Growth, Industrial Transformation, Sharing Economy, Green Innovation.

# GREEN SUPPLY CHAIN MANAGEMENT: CHALLENGES AND BEST PRACTICES

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In an era of growing environmental consciousness and regulatory pressures, Green Supply Chain Management (GSCM) has emerged as a critical strategy for organizations seeking sustainable business operations. This study examines the challenges and best practices associated with implementing GSCM, focusing on its role in reducing environmental impact while maintaining operational efficiency and profitability. The research identifies key challenges in adopting GSCM, including cost implications, resistance to change, limited supplier cooperation, and the complexity of integrating sustainability into existing supply chain processes. It also addresses the lack of standardized metrics for evaluating green initiatives and the trade-offs between economic and environmental goals. To overcome these challenges, the study outlines best practices drawn from leading organizations. These include adopting circular economy principles, leveraging technology such as big data analytics and blockchain for transparency, and fostering collaborative partnerships with suppliers and stakeholders. Additionally, the importance of leadership commitment, employee training, and customer engagement in driving GSCM success is emphasized. The findings highlight that while transitioning to a green supply chain presents significant hurdles, it also offers substantial benefits, such as cost savings through energy efficiency, enhanced brand reputation, and long-term competitive advantage. This paper provides actionable insights for organizations aiming to integrate sustainability into their supply chain operations, thereby contributing to both environmental and business sustainability goals.

**Keywords**: Green Supply Chain Management (GSCM), Sustainability in Supply Chains, Eco-Friendly Logistics, Sustainable Procurement, Green Manufacturing, Environmental Sustainability in Operations, Circular Economy, Green Practices in Supply Chains, Supply Chain Sustainability Challenges, Sustainable Supplier Collaboration.

# COMPARATIVE ANALYSIS OF CONSUMER METRICS BETWEEN TRADITIONAL AND OMNI-CHANNEL MARKETING STRATEGIES WITHIN THE MANUFACTURING SECTOR IN INDIA

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This study examines the comparative effectiveness of traditional and omni-channel marketing approaches in the manufacturing sector, focusing on consumer engagement metrics. Traditional marketing, rooted in offline methods such as print advertisements, in-store promotions, and billboards, has long been a staple in the industry. However, the rise of digital technologies has paved the way for omni-channel marketing, which integrates online and offline touch points to create seamless consumer experiences. Using key metrics like reach, conversion rates, retention, and customer satisfaction, this analysis highlights the strengths and limitations of each approach. Findings indicate that while traditional methods provide localized impact and brand authenticity, omni-channel strategies excel in personalization, scalability, and real-time consumer interaction. This research provides actionable insights for apparel brands aiming to optimize their marketing strategies and foster deeper connections with their target audiences.

**Keywords**: Comparative, Traditional, Omni Channel, Personalized, Marketing.

# A STUDY ON TAX AND INVESTMENT LITERACY AMONG SALARIED CLASS WOMEN IN BILASPURCHHATTISGARH

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As nations strive to increase their citizens' financial literacy and knowledge, tax literacy has drawn a lot of attention worldwide. However, a major obstacle to attaining widespread financial literacy, especially in tax understanding, in India is the consistently lower literacy levels among women in the salaried class women. Even while women in India have made progress in their financial literacy, primarily due to their increased employment rates, they still face several obstacles in obtaining thorough tax literacy. This disparity in tax knowledge affects not just individual financial security but also more general economic engagement and empowerment. Following the recent economic crisis, the importance of financial literacy has only grown, and the increased complexity of financial markets, services, and products has fueled a global movement to improve consumer financial literacy. Having sufficient Tax knowledge and abilities to make wise investment decisions is a crucial requirement for making well-informed Tax decisions. Tax literacy enhances a person's comprehension of Tax issues, allowing them to use investment opportunities and services efficiently by weighing the risks and rewards involved and ultimately selecting the options that are most appropriate for them. Through this research, an attempt has been made to determine the degree of Tax literacy and investigate the connection between salaried-class women's Tax literacy and their inclination toward different investment avenues in Bilaspur, Chhattisgarh.

**Keywords**: Tax Literacy, Financial Literacy, Salaried-Class Women, Investment Decisions, Economic Empowerment, Financial Security, Tax Knowledge, Investment Avenues, Financial Inclusion, Bilaspur, Chhattisgarh, Financial Awareness, Employment and Literacy, Financial Markets Complexity, Consumer Financial Literacy.

# ADVANCEMENT IN INFORMATION AND COMMUNICATION TECHNOLOGY FOR TEACHING-LEARNING

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In the swiftly evolving domain of education, advancements in Information and Communication Technology (ICT) have profoundly altered the conventional teaching-learning paradigm. The incorporation of ICT into educational frameworks has significantly improved the accessibility, efficiency, and engagement associated with both pedagogical and learning activities. Transitioning from traditional chalkboards to smartboards, from printed textbooks to e-books, and from physical classrooms to virtual learning environments, the evolution of ICT instruments has facilitated a more learner-centric, interactive, and inclusive educational approach. ICT fosters innovative pedagogical methodologies such as blended learning, flipped classrooms, and online collaborative learning, which effectively accommodate diverse learning styles and paces. The incorporation of multimedia content, simulations, and interactive platforms enhances the cognitive engagement of learners, thereby promoting critical thinking, creativity, and problem-solving competencies. Additionally, real-time feedback, digital assessments, and learning analytics empower educators to monitor student progress and customize instructional strategies accordingly. The advent of Artificial Intelligence (AI), Augmented Reality (AR), and Virtual Reality (VR) in educational contexts further expands the horizons of immersive learning experiences. These technologies afford personalized learning opportunities, virtual laboratories, and experiential learning modalities that were previously inconceivable within traditional educational environments. Moreover, the global transition toward remote and hybrid instructional models, particularly in the context of the COVID-19 pandemic, has accentuated the essential role of ICT in facilitating educational continuity. Learning Management Systems (LMS), video conferencing platforms, and mobile applications have emerged as fundamental components of the contemporary educational toolkit. Nevertheless, the integration of ICT is accompanied by challenges such as the digital divide, inadequate infrastructure, the deficiency of digital literacy, and the necessity for ongoing professional development for educators. Addressing these challenges is imperative for the equitable and effective implementation of ICT within educational settings.

**Keywords:** Information and Communication Technology (ICT), Artificial Intelligence (AI), Augmented Reality (AR), Virtual Reality (VR).

# MULTIMODAL APPROACH OF HEALTH CARE DIAGNOSIS

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The dynamically evolving landscape of healthcare increasingly necessitates the synthesis of diverse data modalities to enhance diagnostic precision, operational efficiency, and patient outcomes. A multimodal strategy for healthcare diagnostics encompasses the concurrent application of various data forms—including clinical records, medical imaging, genomic data, laboratory results, and patient-reported symptoms—to yield a more holistic comprehension of an individual's health status. This methodology capitalizes on the unique advantages inherent in each data modality, thereby empowering clinicians and healthcare systems to identify patterns and anomalies that may remain undetected when dependent solely on a singular data source. Recent advancements in artificial intelligence (AI), machine learning (ML), and data fusion methodologies have been instrumental in rendering multimodal diagnostics both more feasible and robust. By amalgamating structured and unstructured data from an array of sources, AI systems can augment clinical decision-making through predictive analytics, timely disease detection, risk stratification, and customized treatment strategies. For example, in the field of oncology, multimodal diagnostics can synergistically integrate radiological imaging, histopathological slides, and genetic information to enhance tumor classification accuracy and inform targeted therapeutic approaches. The incorporation of wearable technologies and mobile health (mHealth) applications further enriches the healthcare framework by providing real-time physiological and behavioral data, facilitating continuous monitoring and bolstering preventive care initiatives. Moreover, natural language processing (NLP) plays a critical role in the extraction of significant insights from clinical documentation and patient narratives, thereby contributing to a more comprehensive diagnostic process. Notwithstanding its promise, the multimodal approach encounters several challenges, including issues related to data standardization, interoperability, privacy considerations, and the requirement for a robust computational infrastructure. Mitigating these obstacles is imperative for unlocking the full potential of multimodal diagnostics within clinical environments.

**Keywords:** Multimodal Diagnosis, Healthcare Technology, Artificial Intelligence (AI), Machine Learning (ML). Electronic Health Records (EHR).

# INFORMATION COMMUNICATION TECHNOLOGY AND NEP 2020

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The National Education Policy (NEP) 2020, inaugurated by the Government of India, signifies a pivotal transformation within the nation's educational paradigm, aspiring to render education more comprehensive, adaptable, interdisciplinary, and congruent with the exigencies of the 21st century. A fundamental component of this metamorphosis is the incorporation of Information and Communication Technology (ICT) across all tiers of education. ICT possesses the capacity to mitigate the digital divide, augment pedagogical and learning experiences, and advance equity and inclusivity within the educational landscape. NEP 2020 envisages the utilization of technology not merely as an instrument, but as a formidable catalyst for enhancing access, quality, and educational outcomes. The policy underscores the establishment of a National Educational Technology Forum (NETF) to foster discourse regarding the application of technology in education and to encourage the advancement of digital infrastructure, e-content, and online learning modalities. It endorses the assimilation of ICT within classrooms through the deployment of smart boards, digital resources, and online evaluations, whilst concurrently promoting teacher professional development and capacity enhancement in digital pedagogy. Furthermore, NEP 2020 champions the creation of accessible technologies for learners with disabilities and seeks to cultivate an ethos of innovation and research via technology-driven learning platforms. The pandemic-induced transition to online education has further accentuated the indispensable role of ICT in guaranteeing the continuity of education and has highlighted the imperative for a resilient digital ecosystem.

**Keywords**: Information and Communication Technology (ICT), National Education Policy (NEP) 2020, Digital Learning, E-education, Educational Technology.

# RULE-BASED SENTIMENT ANALYSIS FOR HINDI-ENGLISH CODE-MIXED EXPRESSIONS: A LINGUISTIC APPROACH

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Code-mixed expressions, a blend of two or more languages, have become increasingly prevalent on social media platforms, especially in multilingual societies like India. Hindi-English code-mixed expressions commonly referred to as Hinglish, present unique challenges for sentiment analysis due to their informal structure, varied grammatical rules, and reliance on transliteration. This study proposes a rule-based framework for sentiment analysis of Hindi-English code-mixed texts, leveraging linguistic features, domain-specific dictionaries, and syntactic patterns to identify sentiment polarity. The proposed methodology incorporates rules tailored for handling transliteration, mixed grammar, and the presence of culture-specific expressions. Using a corpus of real-world code-mixed social media data, the framework demonstrates its ability to achieve high accuracy and interpretability in sentiment classification. Comparative analysis with machine learning models highlights the strengths and limitations of rule-based approaches in dealing with under-resourced and informal linguistic data. The results underline the importance of linguistic insights and rule-based techniques in addressing the complexities of code-mixed language processing, offering a foundation for further research in this domain

**Keywords:** Code-mixed expressions, Sentiment Analysis, Hinglish, Rule Based Approach, social media.

## 1. INTRODUCTION

Code-mixing, the practice of combining words and phrases from two or more languages within a single conversation or text has become increasingly prevalent on social media platforms. Hindi-English code-mixed text, also known as "Hinglish," is widely used among bilingual speakers, posing unique challenges for computational linguistics and sentiment analysis. Traditional sentiment analysis models, primarily trained on monolingual datasets, struggle to interpret the linguistic structure and contextual nuances of code-mixed text. This paper presents a rule-based sentiment analysis model that leverages linguistic rules and sentiment lexicons to analyze Hindi-English code-mixed expressions.

### 1.1. Background and Motivation

Hindi-English code-mixing is characterized by the blending of Hindi syntax and English vocabulary or vice versa. The informal nature of social media text further complicates the analysis due to inconsistent spelling, abbreviations, and emojis. Existing sentiment analysis models, particularly machine learning and deep learning approaches, often require large annotated datasets and computational resources. Rule-based models, on the other hand, offer a linguistically grounded alternative that can address the lack of annotated code-mixed data while providing interpretable results.

### 1.2. Research Problem

The primary challenges in sentiment analysis of code-mixed text include:

- Inconsistent language switching within a single sentence.
- Handling context-sensitive sentiment expressions.
- Addressing polarity shifts caused by negations and modifiers.
- Identifying the sentiment orientation of transliterated words.

### 1.3. Research Objectives

This study aims to:

- Develop a rule-based sentiment analysis model for Hindi-English code-mixed text.
- Construct a sentiment lexicon for code-mixed expressions.
- Evaluate the model's performance on social media datasets.

## 2. LITERATURE REVIEW

### 2.1. Sentiment Analysis in Monolingual Text

Sentiment analysis has been extensively studied for monolingual text using approaches such as lexicon-based models, machine learning, and deep learning. Lexicon-based models rely on predefined sentiment dictionaries, while machine learning approaches use supervised learning with labeled datasets.

### 2.2. Code-Mixed Sentiment Analysis

Studies on code-mixed sentiment analysis have focused on machine learning approaches, such as Support Vector Machines (SVM), Naive Bayes, and Recurrent Neural Networks (RNN). However, these models require large annotated datasets, which are limited for code-mixed text. Some studies have explored transfer learning and domain adaptation to address data scarcity.

### 2.3. Rule-Based Sentiment Analysis

Rule-based approaches use linguistic rules to determine sentiment polarity. Previous studies have employed part-of-speech tagging, dependency parsing, and sentiment lexicons. Rule-based models offer advantages in terms of interpretability and domain-specific customization.

## 3. METHODOLOGY

### 3.1. Data Collection

The dataset used in this study was collected from social media platforms, including Twitter and Facebook, focusing on Hindi-English code-mixed text. The data was preprocessed to remove noise, such as URLs, emojis, and special characters.

### 3.2. Sentiment Lexicon Development

A sentiment lexicon was constructed by combining existing English sentiment dictionaries (e.g., SentiWordNet) with manually curated Hindi sentiment words. Transliteration rules were applied to handle phonetically transliterated Hindi words.

### 3.3. Rule Formulation

The rule-based model includes:

- **Polarity Detection:** Rules were defined to assign sentiment polarity based on the presence of positive and negative words in the lexicon.
- **Context Handling:** Rules were created to handle context-sensitive words such as "आसमानछूना"that is positive in context of performance of a player in sports but negative in context of financial inflation.
- **Negation Handling:** Inversion of polarity was applied for negation words preceding sentiment expressionssuch as "नहीं/ना" and "किंतुपरंतु/लेकिन/."
- **Mixed Polarity:** Sentences with conflicting sentiment expressions were resolved using intensity-based weighting.

### 3.4. Sentiment Classification

The model classifies text into three sentiment categories:

- **Positive:** Overall sentiment score > 0.
- **Negative:** Overall sentiment score < 0.
- **Neutral:** Overall sentiment score = 0.

## 4. RESULTS AND DISCUSSION

### 4.1. Performance Metrics

The model was evaluated using the following metrics:

- **Accuracy**
- **Precision**
- **Recall**
- **F1 Score**

### 4.2. Comparative Analysis

The rule-based model was compared with baseline machine learning models, including SVM and RNN. The rule-based model demonstrated higher accuracy and F1 score due to its ability to handle linguistic nuances and context dependencies.

Table 1: Performance Comparison of ML Model on different matrices

| Model | Accuracy (%) | Precision (%) | Recall (%) | F1 Score (%) |
|---|---|---|---|---|
| Rule-Based Model | 82.5 | 80.2 | 83.1 | 81.6 |
| SVM | 76.3 | 75.1 | 76.8 | 75.9 |
| RNN | 78.5 | 77.8 | 79.2 | 78.5 |

### 4.3. Error Analysis

Misclassifications were primarily observed in highly informal text with ambiguous sentiment orientation. Contextual dependency errors occurred in sentences with multiple language switches.

## 5. CONCLUSION

This paper presented a rule-based sentiment analysis model for Hindi-English code-mixed text, addressing the challenges of language switching, polarity shifts, and context sensitivity. The model outperformed machine learning-based models in terms of accuracy and interpretability. Future work will focus on enhancing the sentiment lexicon and incorporating context-aware deep learning models for further improvement.

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# ASPECT-LEVEL SENTIMENT ANALYSIS OF USER-GENERATED TEXT IN HINDI: A LINGUISTIC APPROACH

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Aspect Level Sentiment Analysis provides a granular understanding of user sentiments by identifying sentiment polarity for specific aspects within a given text. In a multilingual society like India, where Hindi is one of the most widely used languages, analyzing user-generated content in Hindi presents unique linguistic and computational challenges. This study introduces a linguistically-driven framework for aspect-level sentiment analysis of Hindi user-generated text. The proposed approach combines aspect identification, sentiment lexicon-based classification, and rules tailored to handle linguistic nuances such as word-order variations, morphological inflections, and context-specific expressions in Hindi. A dataset of Hindi user-generated reviews and social media posts is used to evaluate the framework, highlighting its ability to effectively capture sentiment nuances for diverse aspects. Experimental results demonstrate the efficacy of the proposed method, particularly in addressing challenges like implicit aspect detection and sentiment ambiguity. The findings underscore the significance of leveraging linguistic knowledge in building robust sentiment analysis systems for underrepresented languages. This work contributes to the growing field of sentiment analysis in resource-constrained languages, offering a pathway for future research and applications in opinion mining and decision-making systems

**Keywords:** Aspect Level Sentiment Analysis, UGC, Lingustics Rules, Social Media.

## 1. INTRODUCTION

User-generated content, such as product reviews, social media posts, and online discussions, contains valuable information regarding public sentiment. Sentiment analysis involves classifying the sentiment expressed in the text as positive, negative, or neutral. Traditional sentiment analysis methods focus on document-level or sentence-level classification, which overlooks the sentiment associated with specific aspects within a text. Aspect-level sentiment analysis (ALSA) addresses this limitation by identifying and evaluating sentiments linked to specific entities or attributes mentioned in the text. Hindi, as one of the most widely spoken languages in the world, presents unique challenges for sentiment analysis due to its complex grammar, rich morphology, and contextual dependencies. User-generated content in Hindi is often informal and highly context-sensitive, making it difficult for standard machine learning models to capture sentiment accurately. This study proposes a rule-based approach that combines linguistic knowledge, sentiment lexicons, and syntactic parsing to perform aspect-level sentiment analysis on Hindi text.

### 1.1. BACKGROUND AND MOTIVATION

Aspect-based sentiment analysis has gained increasing attention due to its ability to provide fine-grained sentiment insights. For instance, in a restaurant review, a user may express positive sentiment toward the food but negative sentiment toward the service. Existing sentiment analysis models are primarily focused on English-language content, and there is limited research on aspect-based sentiment analysis for Hindi. The development of effective ALSA models for Hindi will enable businesses and researchers to gain deeper insights into user opinions and preferences.

### 1.2. RESEARCH PROBLEM

The primary challenges in aspect-based sentiment analysis of Hindi user-generated content include:

- Identifying aspect terms in morphologically rich and syntactically complex Hindi text.
- Handling variations in spelling, transliterations, and informal expressions.
- Resolving contextual ambiguity in sentiment expressions.
- Developing a robust sentiment lexicon for Hindi.

### 1.3. Research Objectives

The objectives of this study are:

- To develop a rule-based aspect-level sentiment analysis model for Hindi text.
- To construct a sentiment lexicon tailored for Hindi user-generated content.
- To evaluate the performance of the proposed model using real-world datasets.

## 2. LITERATURE REVIEW

### 2.1. Sentiment Analysis

Sentiment analysis has been extensively studied for monolingual text, particularly in English. Traditional approaches include lexicon-based methods, machine learning models, and deep learning architectures. Lexicon-based approaches rely on predefined dictionaries of sentiment words, while machine learning models use supervised learning with labeled datasets.

### 2.2. Aspect-Level Sentiment Analysis

Aspect-level sentiment analysis focuses on extracting specific aspects from text and determining their sentiment polarity. Previous studies have employed techniques such as dependency parsing, part-of-speech (POS) tagging, and word embeddings for aspect extraction. Machine learning models such as Support Vector Machines (SVM), Naive Bayes, and Recurrent Neural Networks (RNN) have been used for aspect-based sentiment classification.

### 2.3. Rule-Based Sentiment Analysis

Rule-based models are grounded in linguistic rules and domain-specific knowledge. These models use sentiment lexicons, negation handling, and syntactic patterns to classify sentiment. Rule-based models offer advantages in terms of interpretability and domain adaptability but require manual tuning and development of linguistic rules.

## 3. METHODOLOGY

### 3.1. Data Collection

User-generated content in Hindi was collected from social media platforms (e.g., Twitter, Facebook) and review websites. The dataset includes product reviews, movie reviews, and general discussions in Hindi. Preprocessing steps included:

- Removal of stopwords, punctuation, and special characters.
- Normalization of spelling variations and transliterations.
- Tokenization and lemmatization.

### 3.2. Aspect Term Extraction

Aspect terms were extracted using a combination of:

- **Part-of-Speech (POS) Tagging:** Identifying nouns and noun phrases.
- **Dependency Parsing:** Extracting subject-verb-object relations.
- **Lexicon Matching:** Using a predefined aspect lexicon.

### 3.3. Sentiment Lexicon Development

A sentiment lexicon for Hindi was developed by combining:

- Existing Hindi sentiment dictionaries.
- Manually curated lists of positive and negative words.
- Context-based polarity adjustments.

### 3.4. Rule-Based Sentiment Classification

The sentiment polarity of each aspect term was determined using the following rules:

1. **Polarity Detection:** If an aspect term is followed by a positive or negative word, the sentiment is assigned accordingly.
2. **Negation Handling:** If a negation word (e.g., "नहीं "– "not") precedes a sentiment word, the polarity is inverted.
3. **Context Handling:** Sentiment shifts due to conjunctions ("लेकिन "– "but") were adjusted using context-based rules.
4. **Mixed Polarity Resolution:** In the case of conflicting sentiments, the intensity score was used to assign the overall polarity.

### 3.5. Sentiment Aggregation

The overall sentiment toward each aspect was computed using a weighted average of individual sentiment scores.

## 4. RESULTS AND DISCUSSION

### 4.1. Performance Metrics

The model was evaluated using the following metrics:

- **Accuracy**
- **Precision**

- **Recall**
- **F1 Score**

### 4.2. Comparative Analysis

The proposed rule-based model was compared with machine learning-based models (SVM, RNN). The results are summarized in the table below:

Table 1: Performance Comparison of ML Model on different matrices

| Model | Accuracy (%) | Precision (%) | Recall (%) | F1 Score (%) |
|---|---|---|---|---|
| Rule-Based Model | 84.5 | 82.2 | 85.1 | 83.6 |
| SVM | 78.1 | 76.4 | 77.8 | 77.1 |
| RNN | 79.3 | 78.6 | 79.1 | 78.8 |

### 4.3. Error Analysis

The primary sources of error included:

- Ambiguous sentiment terms in highly informal text.
- Context shifts due to complex sentence structures.
- Incorrect polarity assignment due to incomplete lexicon coverage.

## 5. CONCLUSION

This paper presented a rule-based aspect-level sentiment analysis model for Hindi user-generated content. The model effectively handled language-specific challenges such as morphological variation, transliteration, and contextual dependencies. The rule-based approach demonstrated superior performance compared to machine learning models, particularly in terms of interpretability and domain adaptability. Future work will focus on expanding the sentiment lexicon and incorporating context-aware deep learning models to improve sentiment classification accuracy.

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# USING THE J48 ALGORITHM TO ASSESS STUDENT SATISFACTION IN EDUCATIONAL INSTITUTIONS

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Higher Education of a country perform a significant role in our India to develop every sector as well as build the backbone of a nation by providing higher, Specialized and job-oriented education to the young generation. At present, around 459 state University, and 56 central University in Indian government and University Grant Commission of India (UGC). Recently Indian Government and UGC have taken the biggest discussion to ensure the quality of education, organization criteria to create productive graduates, post graduates, and researchers. Student satisfaction is mostly biggest challenges for university, institute and colleges. Our work is solving this problem for java programing and WEKA to predict the result of a student satisfaction for administration, academic, and placement for five-year session (2017-2023). If student found not going to do well in the student traced administration, academic and placement satisfaction ratio for this college. Student our satisfaction ratio inters and vote the university, and ii

College rating for NAAC grading. Higher education is the essential rights of our youth. Policies of higher education give performers and underperformers. Lots of studies are ongoing to evaluate policies and end products of higher education. In this work we have reviewed work and predicted the suggestions given by various authors. Machine learning play important role in analysis of data related to higher education. We have selected J48 classification technique for our work. At last; we have set outcomes of our suggested work using machine learning technology.

**Keyword:**Student Satisfaction, J48 Algorithm, Machine Learning, Data Mining, Higher Education.

## 1. INTRODUCTION

**S**atisfaction is a feeling of happiness that obtain when a person fulfilled. His or her needs and desires. Students' satisfaction as a short-term attitude, Resulting from an evaluation of a student's educational experiences. It is a Positive antecedent of student loyalty and is the result and outcome of an educational system.

Student satisfaction can be defined as a function of relative level of experience and perceive performance about educational service during the study period. satisfaction refers to the evaluation of a service and comprises Cognitive, affective, and attitudinal components. Higher satisfaction is associated with consumer loyalty and positive effect, in research that has mostly tested cross-sectional associations. Therefore, institutional outcome such as word- of – mouth recommendation, enrolment, and retention relate to student satisfaction but reciprocal relations are possible. Student satisfaction can also have important implications for teaching due to its bidirectional associations with student's engagement and achievement.

## 2. NEP-2020

The National Education Policy (NEP), 2020 has been approved by the Union Cabinet on 29th July 2020. NEP 2020 is the first education policy of the 21st century, which aims to address the many growing developmental imperatives of our country and is aligned to the 2030 Agenda for Sustainable Development. The National Education Policy, 2020 is built on the foundational pillars of Access, Equity, Quality, Affordability and Accountability **(NEP-2020).**

## 3. HIGHER EDUCATION

Quality Universities and Colleges: A New and Forward-looking Vision for India's Higher Education System divided into 5problems

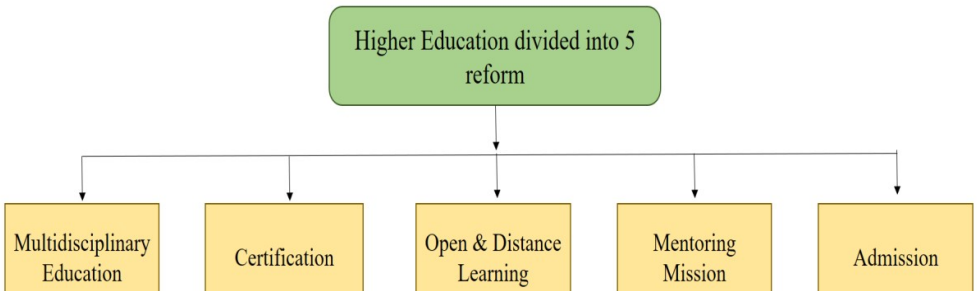



**Fig 1.1 Higher Education System**

### 3.1. Multidisciplinary Education

This reform use in multidisciplinary education in Multidisciplinary used in flexible curriculum, creative combination of subject, Integration of vocational education.

### 3.2. Certification

Reform 2 used in certification in UG education can be of 3 or 4 year with multiple exit options. Appropriate certification within this period **(Sadia Ijaz et al., 2022)**.

### 3.3. Open & Distance Learning

Emphasis on online course digital repositories improved student service credit-based recognition of MOOC, etc.

### 3.4. Mentoring Mission

A large pool of outstanding a senior retired faculty. Including those with the ability to teach in Indian Languages. Be willing to provide short- and long-term mentoring/ professional. To University/ College teacher **(Sadiq Hussain et al., 2018)**

### 3.5. Admission

3.5 crores new seats will be added to higher education institutions. Single entrance exam for other than medical and legal student.

## 4. OPTIMAL LEARNING ENVIRONMENTS AND SUPPORT FOR STUDENTS

- Optimal learning requires a comprehensive approach that involve appropriate curriculum engaging pedagogy, continuous formative assessment, and adequate student support.
- The curriculum must be interesting and relevant, and updated regularly to align with the latest knowledge requirements and to meet specified learning outcomes.
- High-quality pedagogy is the necessary to successfully impart the curricular material to students **(Saurabh Bhagvatula et al., 2015)**.
- The assessment methods must be scientific, designed to continuously improve learning and test the application of knowledge.
- The development of capacities that promote student wellness such as fitness, good health, psycho-social well-being, and sound ethical grounding are also critical for high-quality learning.

## 5. LITERATURE REVIEW ON HIGHER EDUCATION

**Hoang Thai Son et al. (2018),**This paper reviews the part of pupil satisfaction and factors that may impact pupil satisfaction and presents the empirical exploration with the case of the University. assessing the satisfaction of manly and womanish scholars.**Jwel Hoque (2018),**In the 21st century, those countries will lead

the world who have quality advanced education systems because advanced education not only generates larger particular and social wealth, but all the aspects of development similar to education, the Government of India has started RashtriyaUchchatar Shiksha Abhiyan(RUSA), a Centrally Sponsored Scheme in 2013 and as a result, at present the registration rate is 25.(Litesh Poojari etal., 2019).This can prompt a wrong career choice and thus work in a field that has not been designed for them, therefore reducing the productivity of the mortal resource. thus, it's veritably important to make a correct decision regarding the race at an applicable age to avoid the consequences due to the wrong selection of the race.Richi Simon, (2020).Through this paper, the experimenter will bandy the conception of quality, advanced education, and problems in the Higher Education System and will also suggest measures to palliate these problems. The paper is grounded on secondary sources and has deduced information from applicable journals, books, and websites.

(T. Thilagaraj et al., 2021).Likewise, then data mining is used in the educational field to prize retired patterns. The bracket is used to classify the records grounded on the medication set and also it uses the pattern to classify the new records. This paper aims to show the colorful ways of educational data mining that companion the operation to take better action on scholars at threat. (Sadia Ijaz et al., 2020).This paper reviews the most important and applicable objects in educational data mining. The review describes the styles and objects of data mining in EDM. Each study describes different data mining ways, approaches, and methodologies, further Classic by the data types and the academic tasks and problems that they break.Bailin Chen, (2022).In addition, most of the current introductory courses of entrepreneurship in advanced vocational sodalities are generally classified as public courses, and the academy-wide unified “course- selection- course” approach is espoused, which results in a lack of necessary professional rigidity. One of the ways to break this problem is to establish and ameliorate the class bracket system. seminaries can combine the literacy requirements of different majors and different grades, cantering on “problem-acquainted literacy” and scientifically classify the introductory courses of entrepreneurship in the form of class modules.

(Yupei Zhang et al., 2021).This paper reviews former studies from the five data mining ways, including data collection, problem expression, habituated system, ratiocination target, and practical operations. Specifically, we reviewed three education styles, i.e., online, offline, and blending courses. As the online classroom increases, big data is easy to collect to enhance the significance of SPP.Jiechao Cheng, (2017).There are a number of openings live in EDM, from an analysis at an organizational position to an analysis at the individual position. What’s more, EDM is extensively used and applied by learners, experimenters, and preceptors, indeed institutions.Jashim Khan, (2021).The findings indicate that the direct connection between the cost of study (freights) and overall satisfaction is positive as the cost of study (freights) increases, pupil satisfaction decreases. still, pupil prospects of choice factors intervene in the relationship between the cost of study and satisfaction; and scholars’ comprehensions of employability after scale intervene in the relationship between the cost of study and the liability of making a recommendation to their peers.

## 6. Learning Environment

Conceptually, the learning environment refers to diverse components and activities within which teaching and learning occur. Hence, it takes into consideration several variables that directly and indirectly affect students.

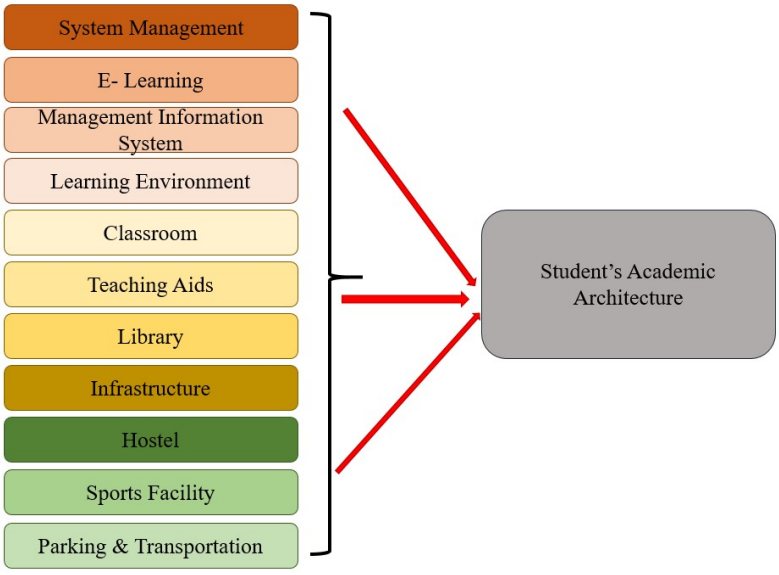



**Fig. 1.2 Concept Framework of the Study**

Productive teaching and learning require the blending of many factors which include the classroom seats and sitting arrangement, painting and lighting, classroom climate, air quality and ventilation. had evaluated the mathematics achievement of students with regards to the learning environment. The study proved that learning environment is a vital key factor for their academic accomplishment. pointed out that high achievers are likely to have undergone curriculum content under a conducive and ideal environment. found that the essential factors for a healthy and positive environment are school climate conditions such as the structure of the school building and the relationship between students and teachers. Apart from that, said that a good learning environment must have good features of facilities itself. According to research has proven that schools with the friendly and conducive environment will have students achieve higher in comparison to schools with the dull and poor learning environment. Recall is the number of correct classifications divided by the total number of positives. So,

R= TP/ (TP + FN) = TP / P

Precision is the number of correct positive classifications divided by total number of positive classifications.

So, P = TP / (TP + FP)

F-score is harmonic mean of precision and recall.

So, F= 2PR / (P+R)

Accuracy is the number of all correct classifications divided by the total numbers of cases.

So, Accuracy = (TP+TN) / (TP+TN+FN+FP) = (TP+TN) / (P+N)

MAE estimates how far the predictions or forecasts differ from the actual values.

$$MAE = \frac{1}{n}\sum_{i=1}^{n} | x_i - x|$$

### 6.1. Preparation of Dataset

For our work we have designed a google form and circulated in various colleges and universities of Chhattisgarh. Raw data was collected and preprocessing was applied to remove noisy data.All questions were related to students of higher education. These questions helped us to find students view about higher education. We have also gone through National Education Policy 2020. We have finalized six features on which work has been done.

### 6.2. Feature Extraction and Feature Selection

In our work we have selected six features which are given as follows

**Table 1.1. Details of Feature Selection**

| Student Satisfaction | Academic Support | Admin Support | Infrastructure | University Reputation | Placement |
|---|---|---|---|---|---|

## 7. Proposed Methodology

We have proposed two hypotheses for our work

**H1** To find out student satisfaction in higher education based on five parameters

**H2** To find the accuracy of student satisfaction.

Machine Learning techniques are widely preferred over statistical analysis. Because of that in this research proposal, a data mining technique will be used. Data mining supervised and unsupervised data and techniques include clustering, classification, association, etc. tools to study the data. In this research work-appropriate algorithm preferred to fulfill the objective of the research objective. In our work, we have collected datasets and received various patterns of student interest in various higher education organizations.

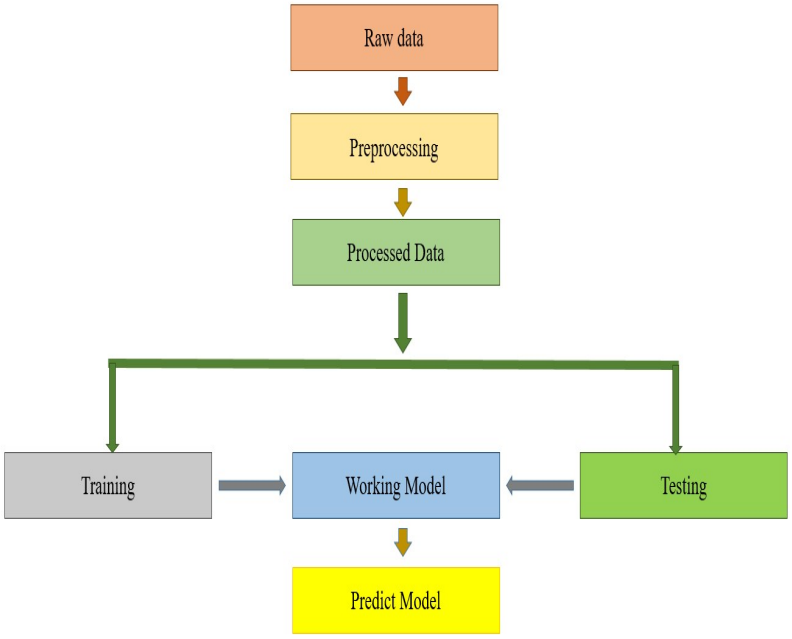



**Fig. 1.3. Predicted Model**

### 7.1. Preparation of Dataset

For our work we have designed a google form and circulated in various colleges and universities of Chhattisgarh.Rawdatawascollectedandpreprocessingwasappliedtoremovenoisydata.Sampleofgoogleformisgiven below. To excel our research, we have developed a questionnaire based on the results of the literature review measuring students' satisfaction. In total 30 items were created in the categories teachers role (such as fairness, mentoring) course curriculums (such as relevant assignment and project works are given to help us learn the subject ),college facilities administrative staff (such as the administrative staff responds to my needs promptly), future prospects (such as the college organization guest speakers to help us be informed about job market), college location (e.g. the college is accessible to transportation) and overall satisfaction (such as I have gained positive environment from the institute). Later on, demographic characteristic such as gender, age, course, year of student's a were measured.

Intheabovedesignedform,wehavetakentwelvequestions.Allquestionsarerelatedtostudentsofhighereducation.These questionswillhelp ustofindstudentsviewabouthighereducation. Wehave alsogonethroughNationalEducationPolicy2020.

| Id | Stream | College | Gender | Water | Washroom | Campus | Teaching | Pedegory | Holistic | National | International | Package | Percenta... |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 84101648 | PG | Pragti College | Female | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 55 |
| 84101680 | PG | Mats College | Male | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 55 |
| 84101695 | PG | Mats College | Female | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 84101727 | UG | Pragti College | Female | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 77 |
| 84101742 | PG | Mats College | Male | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 33 |
| 84101773 | UG | Pragti College | Female | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 44 |
| 84101789 | UG | Pragti College | Female | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 77 |
| 84101820 | UG | Pragti College | Female | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 55 |
| 84101836 | Phd Scholar | Pragti College | Female | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 44 |
| 84101867 | UG | Mats College | Male | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 55 |
| 84101883 | UG | Pragti College | Male | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 33 |
| 84101914 | UG | Mats College | Male | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 66 |
| 84101930 | PG | Mats College | Male | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 88 |

**Fig 1.4. Student Satisfaction Data 2018-2019**

This model has been installed WEKA tab there is a package manager in classification. This model is appearing we have also installed the GitHub and package URL is given in WEKA. Given figures is the screenshot of our model in WEKA.

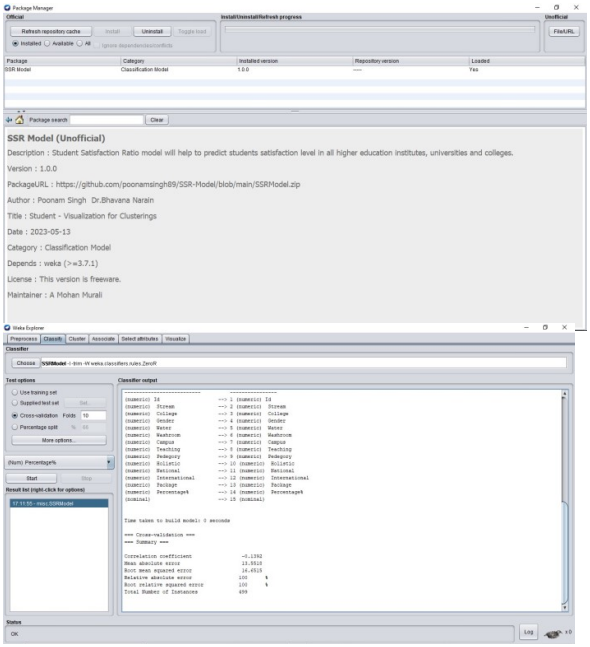



**Fig. 1.5.(A-B). Shown this screenshot is URL Package in upload GitHub, This Classifier Show the Error List**

Given below fig. 1.5(A-B) is the screen short of error list of our SSR model. We have taken error list all instance of our model and separated instance of our model.

## 8. J48 Algorithm in Research Work

As we know that J48 Decision tree classification is the process of building model classes from a set of records that contain class labels. A decision tree algorithm is to find out the way the attributes-vector behaves for a number of instances. Also, on the basis of instances. Also, on the basis of the training instances, the classes for the newly generated instances are being found. this algorithm generates the rules for the prediction of the target variable. with the help of a tree classification algorithm, the critical distribution of the data is easily understood. J48 is an extensionof ID3. The additional features of J48 are accounting for missing values ranges, decision tree pruning, continuous attribute value ranges, derivation of rules, In the WEKA data mining tool, J48 is an open-source Java implementation of the C4.5 algorithms. The WEKA tool provides a number of options associated with tree pruning. In case of potential overfitting, pruning can be used as a tool for précising. In another algorithm the classification is performed recursively till every single leaf is pure, that is the classification of the data should be as perfect as possible. This algorithm is generating the rules from which the particular identity of the data is generated. The objective is progressively generalization of a decision tree until it gains equilibrium of flexibility and accuracy.

J48 is associate open supply Java implementation of the C4.5 algorithms in the Weka data mining tool.C4.5 may be a program that makes a choice tree supported a group of labeled computer file. This algorithm was developed by Ross Quinlan.C4.5 is associate extension of Quinlan's earlier ID3 formula. The decision trees generated by J48 can be used for classification and builds decision trees from a set of labeled training data using the concept of information entropy. It uses the very fact that every attribute of the info may be wont to build a choice by cacophonous the info into smaller subsets. J48 examines the normalized the information gain (difference in entropy) that results from choosing an attribute for splitting the data. To make the choice, the attribute with the highest normalized information gain is used.

Then the algorithm recurs on the smaller subsets. The cacophonous procedure stops if all instances in a very set belong to identical category. Then a leaf node is made within the call tree telling to decide on that category. But it also can happen that none of the options offer any data gain. In this case J48 creates a choice node to a higher place within the tree victimization the expectation of the category.Further it provides an option for pruning trees after creation.

### 8.1. **Algorithm J48:**

INPUT:
D //Training data
OUTPUT
T //Decision tree
DTBUILD (*D)
T= {

Create |produce">produce root node and label with rending attribute;
T= Add arc to root node for every split predicate and
label;
For each arc
do
D= Database created by applying splitting predicate to
D;
If stopping point reached for this path,
then
T'= create leaf node and label with appropriate class;
Else
T'= DTBUILD(D);
T= add
T' to arc;
}

While building a tree, J48 ignores the missing values i.e. the value for that item will be expected supported what's renowned concerning the attribute values for the opposite records. The basic plan is to divide the information into vary supported the attribute values for that item that square measure found within the coaching sample. J48 permits classification via either call trees or rules generated from them

**8.2. Roll of j-48 algorithm in the context of student satisfaction**

j-48 is a decision tree learning algorithm, and it could be a valuable tool for understanding student satisfaction. Here's how:

**Classification:** C4.5 builds a tree-like structure where student responses (satisfied/dissatisfied) are classified based on answers to survey questions. It reveals the decision-making process behind student satisfaction, highlighting factors that most significantly influence their feelings.

**Interpretability:** Similar to random forest, C4.5 decision trees are easy to understand, clearly showing how different factors contribute to student satisfaction.

**Clear visualization:** The tree structure provides a visual representation of the decision-making process, aiding in communication and explanation of results.

**Complexity:** Decision trees can become complex with many factors, making them less suitable for very large datasets or situations with intricate relationships between variables.

**Overfitting:** C4.5 can be prone to overfitting, where the model performs well on training data but struggles with unseen data. Careful validation techniques are needed.

8.3. **Implementation of Student Satisfaction Ratio Model**

SSRM (Student Satisfaction Ratio Model) is chosen for implementation of model. The objective of selecting this model is to understand the basic concepts of student satisfaction is organization and also application of these model define percentage of student satisfaction ratio in real time. SSRM is helpful in learning the basic concepts of college and university basic facility for student with different options and analyzes the output that is being produced.

Implementation Procedure Used in SSRM (Student satisfaction ratio model):

The dataset file is fed in to java model and the classification for SSRM are implemented as defined in the following steps:

a) First step enrolled student in SSRM model for student detail.
b) Second step is feed organization or collage detail, session, and password.
c) Third step is ticking the different penal for satisfaction ratio in student.
d) All panel show percentage for student satisfaction ratio.
e) This model main purpose improvement quality for college and university for student satisfaction.

Our proposed model is student satisfaction Ratio Model. We have created to two panel

1. Student Panel
2. Organization Panel

Student create the student id. Inter the student window and fill the detail like (Collage, Session, Qualification, ID, Gender).

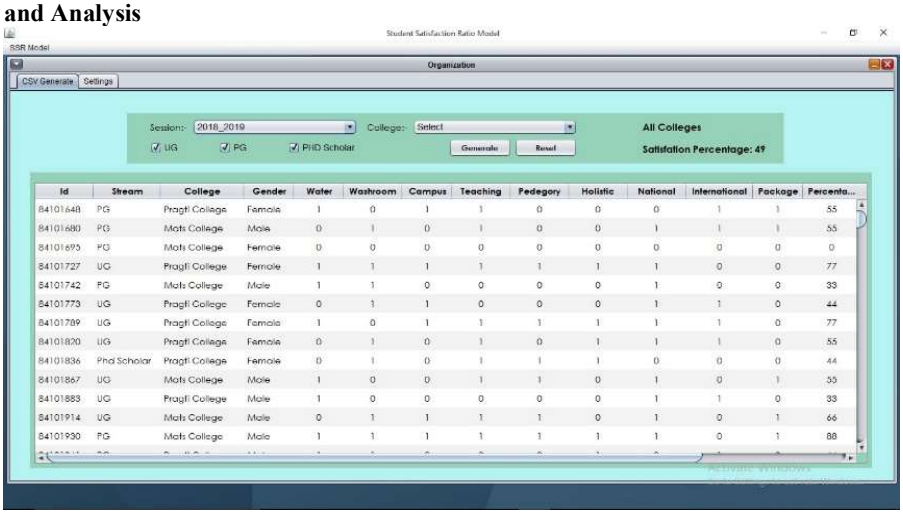
**Fig 1.6.(A-B-C-D-E-F). Student Personal Detail Option, Student Password Window, Organization First Window, Organization panel show the session period, Organization panel Session create Successfully, organization Panel show All Session**

I have provided different collage name, five-year session (2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023). Student fill the qualification (UG, PG, Ph.D. Scholar). User id like 525, and gender (Male, Female, Other). Then enter the Password

### 8.4. Organization Panel

The first student satisfaction ratio model is opened in the organization panel, in this model student enters some detail like (college, session, qualification, id, and gender) after entering all details, the password has to be entered, and as soon as we enter a password, organization panel open. The organization panel manages three options (Session, College, and Password). If we go to the session-wise we are provided with 5 years of the session here in which (2018 to 2019, 2019 to 2020, 2020 to 2021, 2021 to 2022, 2022 to 2023) we get this 5-year session which we have to choose the session and click to ok. then show the session created successfully.

## 9. Result and Analysis




| Id | Stream | College | Gender | Water | Washroom | Campus | Teaching | Pedegory | Holistic | National | International | Package | Percenta... |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 84101883 | UG | Pragti College | Male | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 33 |
| 84101914 | UG | Mats College | Male | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 66 |
| 84101930 | PG | Mats College | Male | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 88 |

**Fig 1.7. Student Satisfaction Data 2018-2019**

This is an output and data collection sheet from our model. This sheet stores all panel questions student response details.

**Table. 1.2. The composition of value sample of the questionnaire on student satisfaction ratio in the basic question in college and university.**

| Variable | Category | Number of Student | Percentage (%) |
|---|---|---|---|
| Administration | Male | 320 | 90% |
| | Female | 180 | 89% |
| Academic | Male | 275 | 92% |
| | Female | 269 | 93% |
| Placement | Male | 194 | 92% |
| | Female | 450 | 95% |

**Table. 1.3. SSRM Compare to Other model for different session with Baseline model**

| Classification Algorithm | 2018-2019 | | | 2020-2021 | | | 2022-2023 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Administration (%) | Academic (%) | Placement (%) | Administration (%) | Academic (%) | Placement (%) | Administration (%) | Academic (%) | Placement (%) |
| **J48** | 71 | 76 | 60 | 72 | 79 | 61 | 78 | 82 | 65 |
| **Random Forest** | 73 | 80 | 65 | 76 | 81 | 70 | 79 | 89 | 72 |
| **Bagging** | 64 | 70 | 72 | 69 | 72 | 75 | 71 | 75 | 77 |
| **SSRM** | **75.66** | **63.66** | **83.33** | **86** | **82.66** | **75.33** | **93** | **90** | **93** |

Table 1.2 show the ratio of all department in gender wise survey for improving the organization criteria. The composition of value sample of the questionnaire on student satisfaction ratio in the basic question in college and university.

## 10. Conclusion and Future Work

The proposal to design the status is to find out how certified the student is from the different facilities of the college and university and we can improve the report of that college by knowing what is lacking in any college and university through this student satisfaction ratio model.

In future work, we will convert this model using deep learning techniques. So that model can be trend-accurate result can be Gant's new model will be using Python language. We will pattern our model and make it available for maximum higher education organizations like (universities, and colleges) so that they can find out the loop point of their organization higher education organizations remove all the lacuna so that a maximum number of students can be satisfied from their organization our model will be available for of app.

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# UNDERSTANDING THE IMPACTS AND CHALLENGES OF CYBERCRIME: INSIGHTS FROM A QUALITATIVE ANALYSIS

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Technology playing a central role in our routines, the prevalence of cybercrimes has surged significantly. The proliferation of social media platforms and the exponential growth in data usage globally have made sensitive information, including trade secrets and privacy concerns, increasingly vulnerable. Cybercrimes, escalating in frequency, can have profound repercussions on individuals, organizations, and even entire nations. This research endeavors to raise awareness about cybercrimes by conducting a comprehensive analysis of the awareness levels, impacts, and challenges faced by those susceptible to such offenses. Employing a qualitative research methodology, the study seeks to delve into the intricate dynamics of cybercrimes and their ramifications. Ultimately, the research aims to propose actionable recommendations to mitigate these challenges and to explore avenues for future investigation.

**Keywords: Cybercrime; Internet; Challenges; Technology; Impact; Awareness**

## 1. Introduction-

The proliferation of cybercrime represents a significant challenge in today's digital landscape, emerging as one of the fastest-growing sectors within the criminal sphere [1]. Cybercrime encompasses a broad spectrum of illicit activities involving computers, networked devices, or interconnected systems. These crimes vary widely in their objectives and methods, ranging from financially motivated schemes to direct attacks aimed at disrupting or disabling computer systems [2]. Additionally, cybercriminals exploit technology to disseminate malware, illegal content, or unauthorized information across networks, further complicating the cybersecurity landscape.

As technology continues to advance at a rapid pace, cybercrimes evolve in both scale and complexity, posing an ever-increasing threat to individuals, organizations, and governments worldwide [3]. The escalating incidence of cybercrimes underscores the urgent need to address the challenges they present and to develop effective strategies for combating them.

This paper seeks to provide a comprehensive analysis of the impact and challenges associated with cybercrimes. By examining the various dimensions of cyber threats, including their economic, social, and technological implications, the paper aims to shed light on the multifaceted nature of the cybersecurity landscape. Furthermore, the paper will discuss potential solutions and recommendations to mitigate the challenges posed by cybercrimes, thereby enhancing cybersecurity measures in an increasingly interconnected world.

## 2. Literature Review

The presented paper explores the utilization of Information Technology by organized crime groups, delving into both low-tech and high-tech cybercrimes. However, it suggests that further research is needed to analyze the impacts of these crimes. The study focuses on the youth's perception of cybercrime in South Asia, employing a detailed questionnaire for research. Notably, the scope is limited to the youth, prompting the recommendation for additional research across different age groups and professions.

In a different study, the authors provide a concise overview of the top five cyber frauds and cybercrime categories, but advocate for further exploration into the impacts and challenges posed by these crimes. Another paper narrows its focus to cyber threats faced by small businesses, suggesting the need for extended research to understand the resulting impacts. While the research identifies emerging cybercrimes and suggests measures to minimize cyber fraud, it advocates for a more comprehensive analysis of the impacts that may arise due to cybercrimes.

A study analyzing cyber-attacks identifies patterns and trends, briefly touching upon the impact of cybercrimes but suggesting a need for a more detailed examination. The countermeasures that IT organizations can adopt are

highlighted, yet the reasons behind the increasing prevalence of cybercrimes in India are explored without clear delineation of challenges. Another study emphasizes social engineering in the context of cybercrimes but limits the challenges to psychological variables faced by organizations.

In a comprehensive overview of cybercrimes' evolution, a taxonomy of various cybercrimes is proposed, but the challenges remain relatively limited. Similarly, a survey of cybersecurity introduces a new taxonomy, providing detailed classifications of cybercrimes, with challenges identified but not thoroughly discussed. Another research paper details various types of cybercrimes and cites challenges faced by organizations but lacks a comprehensive examination of these challenges.

Examining Personally Identifiable Information (PII) exposure to cyber threats, the author suggests potential challenges faced by organizations. Phishing, illustrated through the example of PayPal, is explored in detail, emphasizing its impact on organizations. A proposed model investigates employees' fear of cybercrimes and their compliance with Information Security policies, considering it an impact on organizations. The study also delves into spamming formats and challenges, as well as cyber harassment against women using social media.

In a final analysis, the research paper discusses the costs of cyber-attacks, their causes, and presents a descriptive analysis of cyber events. Table 1 summarizes the literature review details, outlining the authors, paper titles, sources, and identified gaps or future scopes.

| Author | Title | Source | Gaps found/Future scope |
|---|---|---|---|
| E. Rutger Leukfeldt, Edward R Kleemans, Edwin W. Kruisbergen and Robert A. Roks | Criminal Networks in a digested world: on the nexus of borderless opportunities and local embeddedness | CORE | Further study on impact and challenges |
| Kamruzzaman, Md Ashraful Islam, Md Shahidul Islam, Md Shakhawat Hossain, Md Abdul Hakim | The plight of Youth Perception on Cybercrime in South Asia | Google Scholar | Examination of perception across different age groups |
| Rajesh Kumar Goutam, Deepak Kumar Verma | TOP 5 Cyber frauds | Google Scholar | Analysis of impacts and challenges |
| Brenda Van Rensburg, Tim Kennedy | Online vulnerabilities facing small business today | Google Scholar | Further exploration of cybercrime types and their impacts |
| Kumar Harsh, Tanya Singh, Pramod Kumar Singh | Emerging threats of cybercrimes | Google Scholar | Study of impacts of emerging threats |
| Andreea Bendovschi | Cyber-Attacks – Trends, Patterns, and Security Countermeasures | Google Scholar | Detailed investigation into the impacts of cyber-attacks |
| June Iqbal, Bilal Maqbool Beigh | Cybercrimes in India: Trends and Challenges | Google Scholar | Clear definition and exploration of challenges in Indian context |
| Nabil Y Conteh and Paul J. Schmick | Cybersecurity: risks, vulnerabilities, and countermeasures to prevent social engineering attacks | Google Scholar | Comprehensive examination of challenges beyond psychological variables |
| Mr. Kush Kalra | The emergence of Cybercrimes: A challenge for the new millennium | IEEE | Research on the impacts of emerging cybercrimes |
| Harmandeep Singh Brar and Gulshan Kumar | Cybercrimes: A Proposed Taxonomy and Challenges | Google Scholar | Extensive exploration of challenges related to proposed taxonomy |
| P. K. Paul & P. S. Aithal | Cybercrime: Challenges, Issues, Recommendation, and suggestion in the Indian context | Google Scholar | Clear articulation and study of challenges in the Indian context |
| Dr.P.B.Pathak | Cybercrime: A Global Threat to Cyber community | Google Scholar | Further research on the impacts of cybercrimes |
| A.J. Burns, Eric Johnson | The Evolving Cyberthreat to Privacy | IEEE | Examination of challenges related to disclosing Personally Identifiable Information (PII) |

| | | | |
|---|---|---|---|
| Brad Wardman | Assessing the Gap: Measure the Impact of Phishing on an Organization | Google Scholar | Study on the threats and risks caused by phishing attacks as a future research avenue |
| Jaffar Ahmad Alalwan | Fear of Cybercrime and the Compliance with Information Security Policies: A Theoretical Study | ACM | Further exploration of challenges related to compliance with information security policies |
| Mamoun Alazab | Spam and criminal activity | Google Scholar | Research on the impacts of spamming and criminal activities |
| Sloane Burke Winkelman, Jody Oomen-Early, Ashley D. Walker, Lawrence Chu, Alice Yick-Flanagan | Exploring cyber harassment among women who use social media | Google Scholar | Study on the various impacts caused by cyber harassment among women who use social media |
| Sasha Romanosky | Examining the costs and causes of cyber incidents | Google Scholar | Further research on the effects of cyber incidents |

## 2. Research Methodology

This study employs a systematic qualitative questionnaire developed to capture insights into the awareness, impact, and challenges of cybercrimes across different age groups and professions [5]. The questionnaire is meticulously designed to gather qualitative data, with respondents providing responses primarily through a Likert scale format. The research methodology utilized involves qualitative data analysis grounded in theory.

Data collection is facilitated through a Google Form comprising questions aimed at understanding the impact and challenges of cybercrimes [6]. The survey's objective is to gather information that yields valuable insights and provides a comprehensive understanding of the prevailing scenario. Questions in the survey encompass personal details such as age, gender, profession,organization affiliation, designation, and location of residence. To uphold respondent privacy [7], certain fields such as profession, organization, and designation are optional, and respondents are provided with the option to refrain from disclosing their gender.

## 4. Conceptual Model

Understanding the impact and challenges of cybercrimes necessitates an examination of their causes and effects [8], as depicted in Figure 1.

### 4.1 Causes of Cybercrimes

**Economically Motivated:**
Many cybercriminals are driven by financial gain, exploiting the anonymity afforded by networks to engage in activities such as malware dissemination, phishing, identity theft, and other fraudulent schemes, targeting individuals or organizations for substantial monetary rewards [9].

**Personal Factors:** Some cybercrimes stem from personal motives, such as disgruntled employees perpetrating attacks by injecting viruses into systems, or individuals creating fake accounts to send threatening messages to acquaintances on email or social media, seeking revenge for past conflicts [10].

**Ideological Motivators:** Cybercriminals may also be motivated by moral, ideological, or ethical reasons to engage in cybercrimes, aiming to disrupt networks or damage computer equipment as a means of expressing grievances against individuals, organizations, or governments [11].

### 4.2 Effects of Cybercrimes

Financial Losses: Cybercrimes often result in significant financial losses for individuals and organizations. Cybercriminals exploit sensitive company information to extort money, threatening to misuse or leak the data online [12]. Individuals may also suffer financial losses through various fraudulent schemes such as job fraud, charity fraud, or get-rich-quick scams.

Reputation Loss: Security breaches that compromise clients' sensitive information can tarnish a company's reputation, leading to a loss of trust and confidence among customers [13].

## 5. Results

The questionnaire garnered responses from 110 participants, comprising 42 females (38%), 67 males (61%), and one participant who did not disclose their gender (1%).

Respondents provided answers on a Likert scale ranging from 1 (Least aware) to 5 (Highly aware). The majority of respondents across different demographics demonstrated awareness of cybercrimes, with 23 marking 5, 37 marking 4, 17 marking 2, and 7 marking 1.

When asked about their likelihood to read an article on cybercrimes, 40 respondents marked 5, 33 marked 4, 3 marked 1, and 10 marked 2, indicating a significant interest in the topic.

Regarding the practice of sharing personal information or One Time Passwords with strangers claiming to be bank employees over the phone, 95 respondents strongly disagreed, while 86 respondents strongly disagreed with the notion of clicking on unknown sources and providing personal details in exchange for rewards or job offers.

### 5.1 Impact

Among the 110 respondents, 81 individuals reported being victims of cybercrimes at least once. Of these, 31 were females (aged 18-24) and 49 were males (aged 55-64). Additionally, four females and 11 males experienced cybercrimes multiple times, while seven individuals (both male and female) had never been victims. Notably, homemakers and government employees were the most common targets among females and males, respectively.

In terms of specific cybercrimes, hacking was the most encountered, followed by internet harassment, online frauds, phishing, spamming, and virus attacks. Different age groups were prone to different types of cybercrimes, with hacking being predominant among individuals aged 25-64, while harassment was more prevalent among those aged 18-24, and online frauds affected the age group 55-64 the most.

Regarding fears related to cybercrimes, fraud victimization was the most feared, followed by hacking, internet harassment, phishing, and virus attacks. These findings highlight the diverse impacts of cybercrimes across various demographics.

### 5.2 Challenges

A significant portion of respondents (56 out of 110) indicated that they had not received any training or information about cybercrimes in their respective organizations. Additionally, 51 respondents disagreed strongly with the notion that organizations, educational institutions, or media are adequately spreading awareness about cybercrimes.

Moreover, a majority of respondents (78 out of 110) expressed distrust in sharing personal information online. Many respondents attributed the increase in cybercrimes to factors such as negligence, lack of awareness, weak security policies, and advancements in technology.

Furthermore, a notable percentage of individuals belonging to older age groups (55-64 and 65 plus) rated themselves lower in terms of proficiency in using IT products or tools compared to younger age groups. This knowledge gap poses a significant challenge in combating cybercrimes effectively.

Additionally, a considerable number of respondents (36 individuals) reported being unaware of laws or regulations protecting them against cybercrimes, highlighting another significant challenge in addressing cybercrime.

## 6. Implications and Recommendations.

### 6.1.1. Implications

The analysis reveals that spamming emerges as the most prevalent cybercrime among the various types examined. To counteract spam emails effectively, individuals are advised to utilize anti-spam software and

activate spam filters. It's crucial to exercise caution when encountering suspicious emails or messages, avoiding clicking on links or providing personal information. Additionally, countries with anti-spam legislation, such as the USA, Canada, and Australia, impose significant penalties for violations, serving as a deterrent against spam-related offenses.

Furthermore, the study identifies internet frauds as the most feared cybercrime due to their potential for substantial financial losses, reputational damage, and emotional distress. The ramifications extend beyond individual victims to impact companies when their customers fall prey to fraudulent schemes.

### 6.1.2 Recommendations

Addressing the challenges identified in the survey, the following recommendations are proposed:

Training: Organizations and educational institutions should conduct regular training sessions to keep employees/students informed about the latest cybercrime trends and preventive measures. Monthly updates can help reinforce awareness and readiness to respond to evolving threats.

Awareness: Efforts to raise awareness about cybercrimes should be intensified across various platforms, including media campaigns, educational initiatives, and organizational outreach programs. By educating the public about the consequences of cybercrimes, individuals can make more informed decisions to protect themselves and their data.

Internet Safety: Individuals should exercise caution when sharing personal information online, limiting disclosures to trusted sources and verifying the legitimacy of websites before providing sensitive data. Familiarizing oneself with privacy policies and terms of service can help mitigate risks associated with online transactions.

Technology Literacy: Recognizing the challenges faced by older age groups in navigating IT tools and devices, initiatives to bridge the digital divide should be encouraged. Youth can play a pivotal role in providing tech support and guidance to seniors, empowering them to navigate digital platforms with confidence.

Legal Awareness: Greater emphasis should be placed on educating individuals about cybercrime laws and regulations through training sessions, public awareness campaigns, and educational curricula. By understanding their rights and legal protections, individuals can take proactive steps to safeguard themselves against cyber threats.

Preventive Measures: Given the perception of negligence as a significant factor contributing to the rise in cybercrimes, individuals must prioritize cybersecurity hygiene and adopt proactive measures to protect their information. Practicing vigilance and discernment in online interactions can significantly reduce susceptibility to cyber threats.

## 7. Conclusion

Recent assessments of the defense landscape highlight a concerning trend of escalating cyber threats, signaling a persistent rise in cybercrime activities. Despite concerted efforts by global law enforcement agencies to combat cyberattacks, illicit gains from such activities continue to soar to unprecedented levels. This surge in cybercrime poses an unsustainable burden on economies already grappling with the repercussions of global downturns.

To mitigate the detrimental impact of cybercrimes on our society and economy, collaborative action is imperative. The research conducted in this study identified six key challenges and four significant impacts associated with cybercrimes. By examining these challenges and their effects through a comprehensive questionnaire analysis, potential solutions have been proposed.

While it may be challenging to completely eradicate cybercrimes in an era of rapid technological advancement, concerted efforts can significantly mitigate their impact. Implementing necessary precautions and adhering to fundamental cybersecurity practices can help safeguard sensitive data and minimize vulnerabilities to cyber threats. Moreover, increasing awareness about cybercrimes and the legal frameworks in place to protect individuals against such offenses is crucial in empowering individuals to defend against cyber threats effectively.

In essence, while the threat of cybercrime persists, proactive measures and heightened awareness can effectively reduce its impact on individuals, organizations, and economies worldwide. By working together and embracing a culture of cybersecurity vigilance, we can strive to create a safer and more resilient digital environment for all.

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# ENHANCED ACCURACY IN STOCK MARKET FORECASTING USING SUPPORT VECTOR MACHINE OR RF: INSIGHT FROM APPL DATASET

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Machine learning techniques are among the most widely used approaches because of their ability to discern stock trends from vast volumes of data that represent the underlying dynamics of stock prices. We can create intelligent systems with the ability to make decisions on their own with the aid of ML. It then gives us the expected outcomes based on the data that was learned. To get the best outcomes, we employ SVM-Supervised machine learning algorithms or Random Forest. For this purpose, a Python program is implemented in Google Colab to run the machine learning algorithms. The dataset is retrieved from Yahoo Finance of a famous and profitable company, AAPL (Apple Inc.), and an attempt has been made to build an intelligent model that helps the analyst or researcher. For that, the algorithms are to ascertain which yields the best forecast value. January2015, marks the beginning of the dataset, and January 2024. Numerous performance indicators, like Moving Average Convergence Divergence (MACD), Average True Range (ATR), and Relative Strength Index (RSI), etc., are also discussed, along with the type of analysis, which includes fundamental analysis and technical analysis, and the study of different types of data, such as microeconomic data, raw data, fundamental data, and text data, market data, and so on. Accuracy, $R^2$score, MAE (Mean Absolute Error), MSE (Mean Square Error), and other performance parameters are evaluated to find the error values, and actual or predicted values have been employed.

**Keywords**: Random Forest,Stock Market, Stock Traders, Stock Market Prediction, Financial Exchange, Machine Learning, Intelligent Systems.

## 1. INTRODUCTION

Forecasting the stock market and managing massive data sets is, if there is one major issue confronting analysts today, it is this. Although there has always been interest in this market, the equity (sometimes called stock) market has established a distinct and specific niche for itself since COVID-19. The question of which approach or tactics to employ in order to surpass the previous researcher in accuracy has become a topic of study. the primary goal of the current study was to increase the forecasting accuracy of a set of SVMs employed as a feature selection optimizer as noted by Nti, I. et al. (2020). There is a substantial financial incentive for participants, and financial data analysis has been done extensively. Consequently, a number of research have been carried out in an effort to predict and foresee future patterns in the price of stocks. To find emotions and other quantitative data from relevant financial information sources, some people utilize machine learning techniques like support vector machines (SVM), while others use text analysis as discussed through Torres, P. et al. (2019).

Although stock prices change at random, the current price is a systematic representation of the company's financial facts. An efficient market is one in which prices consistently reflect all available information, according to the Efficient Market Hypothesis (EMH), which categorizes market efficiency into three types: Weak form, strong form, and semi-strong form as noted Vuong, P. H. et al. (2024)

## 2. REVIEW OF LITRATURE

For stock price prediction, Kuo, R. J. et al. (2024) developed a hybrid model called MVl-SVM that combines Support Vector Machines (SVM) and multi-view learning. Using both single and multivariate datasets, this model was contrasted with the ARIMA and conventional SVM models. The concepts of ANN and SVM for stock market prediction were examined by Kurani, A. et al. (2023). In fields like financial risk management, innovation is crucial. Network performance is unaffected by artificial neural networks (ANN). Second, researchers start by looking at the many technologies that are utilized to anticipate the stock market. SVM's distinct decision boundaries avoid overfitting and provide them a variety of characteristics. Kumar, D. et al. (2022) employed machine learning approaches and statistical tools for SMF. They noted that the data acquired from many sources like Yahoo Finance, Twitter, etc. is noisy and stagnant. ML models were examined to cope with such data and boost the accuracy of stock market forecasting. Sharma, K. et al. (2022) talked about a number of methods for predicting the stock market, with a particular emphasis on technical and fundamental analysis. According to Omar, A. B. (2022), the primary objective of this research is to use a machine learning model to accurately predict stock index values throughout three time periods: the whole era, the pre-Covid-19 period, and the Covid-19 period.

Rajpurohit, A. S. et al. (2021) investigates a number of stock price prediction algorithms on a company-focused platform. The four primary models under investigation are LSTM (Long Short-Term Memory), ARIMA (Autoregressive Integrated Moving Average), RNN (Recurrent Neural Network), and sentiment analysis. LSTM is an artificial recurrent neural network (RNN) architecture that works well with time series data for processing, classification, and prediction. Main aim to improve prediction performance by combining artificial intelligence techniques, including neural networks, Fuzzy logic, and meta-heuristic algorithms like Genetic algorithm, Harmony search algorithm, Firefly algorithm, Hill-climbing, and optimization mass particle algorithm. The combination of these techniques provides a significant improvement in prediction performance.

## 3. METHODOLOGY

### 3.1 Support Vector Machine (SVM)

SVMs are the finest binary classifiers because they establish a border that separates the points according to their category. Compared to merely guessing during prediction, the SVM model's outcomes are a tenth of a point better. Feature Selection has the most influence on the accuracy of the machine learning model discussed by Chhajeret al.(2022). SVM is based on the concept of Risk Minimization and is closely related to the Regularization theory. It is used for data classification and regression and primarily uses kernel functions and mathematical programming approaches to produce a hyperplane or collection of hyperplanes (classes) that can then be used for classification. SVM can be used to learn polynomial, Radial Basis Function (RBF), and MLP classifiers. when it comes to classification, the SVM approach works very well.

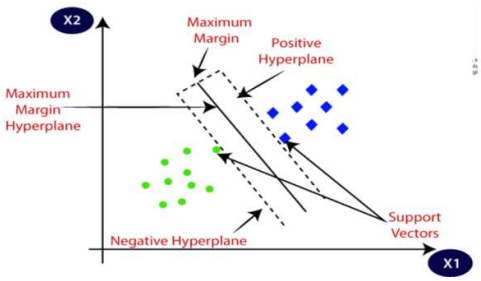


Figure 1: Support Vector Machine

The main reason SVM is used is due of its superior generalization abilities. Even though fewer learning stages might result in more ideal outputs, this strategy is time-consuming to learn. SVM is used for outlier identification, medical diagnosis, picture classification, text analysis, and prediction. It also performs well with large data sets. As noted by Singh,G. (2022)

**3.2 Random Forest (RF)**

Random Forests are used for decision tree generation, classification, and regression. RFs correct the practice of customizing decision trees to the training set. Two parameters are needed in Random Forest: (i) mtry: the number of features in each split; (ii) ntree: the number of trees.

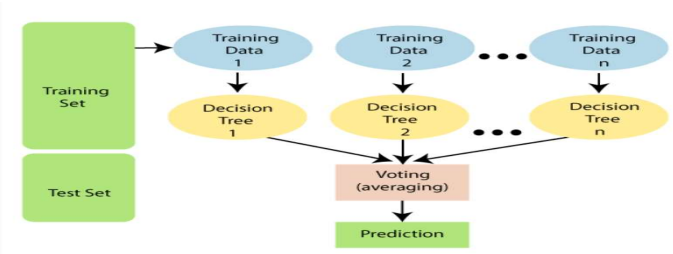


Figure 2: Random Forest

Numerous investigations have indicated that utilizing the default parameters might give adequate outcomes. The results are more reliable the more trees there are. The model is unchanged even if it is not essential to use more trees than are needed as highlighted Singh, G. et al. (2022). The random forest classifier is one type of supervised approach and ensemble classifier. Essentially, it creates a set of decision trees that culminate in a certain result. The primary approach of the random class classifier is to take the decision aggregate of those decision trees and generate a final class or outcome based on the votes of the random subset of decision trees.(Sadia, H . K. et al.2019)

**Some Type of Data defined used for SMF**

**A) Market data:**

Market data includes all of the trading activity that occurs in a stock market, including open, high, low, and closing prices as well as trade volume. It functions as an input feature (like the previous prices in a look-back window) as well as a prediction target (like the closing price of the next day).

**B) Text data:**

"Text data" is the word used to describe the text that individuals have contributed, for example, through online searches, social media, and news. These data may provide important insights not available in market data, despite the fact that they are challenging to get and evaluate as alternative data. Sentiment analysis of these text data can produce a sentiment factor (e.g., positive, neutral, or negative) that can be used to make predictions.

**4. TECHNICAL INDICATORS**

The technical indicators, including Moving Average Convergence Divergence (MACD), Average True Range (ATR) and Relative Strength Index (RSI), a technical indicator is a mathematical calculation. Perform on a variable like price or even other technical indicator. Active traders extensively use them in the market as they are primarily designed to analyze short-term price moments as defined by Bhandari et al. (2022)

**A) Moving Averages**

A popular technical analysis tool for smoothing out market activity is the moving average (MA), which removes "noise" from erratic price swings. Because it is based on historical pricing, it is a trend-following, or lagging, indicator. Simple moving averages for one, seven, and fifteen days were employed in our project as study Gurjar, M. et al. (2018)

### B) Relative Strength Index

One well-known technical indicator for forecasting stock prices is the RSI. It is an oscillating indicator designed to give both bullish and negative price signals by measuring the stock's velocity. This indicator is used by investors to determine if an investment is overbought or oversold. Finding possible entry and exit trading signals may also be aided by RSI. Additionally, because it compares the size of recent gains to recent losses, RSI is crucial for short-term stock price trend prediction.

## 5. EXPERIMENTAL WORK

### 5.1 Data set

Data set taken from yahoo finance where Yahoo Finance is based on its price index and price. It is a group of stock markets and encourages investors to compare the previous value and current value for performance calculation, remove the noise in the collected data, and pre-process the data. (Zhen et al., 2023) reviewpre-processed data is useful for stock market forecasting. Study make use of historical stock price data from Yahoo Finance, which can be accessed using Python's finance package. The information comprises trading volumes and daily adjusted closing prices for the main technology stocks: Apple Inc. (AAPL), from January 1, 2015, to January 1,2024.

Table 1: Apple Data set taken form yahoo finance

| Price | Adj Close | Close | High | Low | Open | Volume |
|---|---|---|---|---|---|---|
| Ticker | AAPL | AAPL | AAPL | AAPL | AAPL | AAPL |
| Date | | | | | | |
| 2015-01-02 00:00:00+00:00 | 24.373957 | 27.332500 | 27.860001 | 26.837500 | 27.847500 | 212818400 |
| 2015-01-05 00:00:00+00:00 | 23.687296 | 26.562500 | 27.162500 | 26.352501 | 27.072500 | 257142000 |
| 2015-01-06 00:00:00+00:00 | 23.689537 | 26.565001 | 26.857500 | 26.157499 | 26.635000 | 263188400 |
| 2015-01-07 00:00:00+00:00 | 24.021711 | 26.937500 | 27.049999 | 26.674999 | 26.799999 | 160423600 |
| 2015-01-08 00:00:00+00:00 | 24.944677 | 27.972500 | 28.037500 | 27.174999 | 27.307501 | 237458000 |
| ... | ... | ... | ... | ... | ... | ... |
| 2023-12-22 00:00:00+00:00 | 192.868134 | 193.600006 | 195.410004 | 192.970001 | 195.179993 | 37122800 |
| 2023-12-26 00:00:00+00:00 | 192.320221 | 193.050003 | 193.889999 | 192.830002 | 193.610001 | 28919300 |
| 2023-12-27 00:00:00+00:00 | 192.419830 | 193.149994 | 193.500000 | 191.089996 | 192.490005 | 48087700 |
| 2023-12-28 00:00:00+00:00 | 192.848221 | 193.580002 | 194.660004 | 193.169998 | 194.139999 | 34049900 |
| 2023-12-29 00:00:00+00:00 | 191.802185 | 192.529999 | 194.399994 | 191.729996 | 193.899994 | 42628800 |

2264 rows × 6 columns

### 5.2 Algorithm

The process of attempting to predict the future value of a stock or other financial instrument traded on a financial exchange is known as stock market forecasting. Python is the computer language used to make machine learning- based stock market predictions. Following are the steps of algorithm to forecast the trading in stock market.

- **DataCollection:**Thisisthefirststepofalgorithmwhere primary and secondarydatawillbe collected and verified for the process through mutual selection process.
- **ImportLibraries:**Thisisthefirststepofalgorithmtocollectanduploadthenecessarylibraries,suchas NumPy, Pandas, Matplotlib, etc.
- **Data Preprocessing:** You need to collect the historical data formodel training and testing, and you can obtain this data using APIs like Yahoo Finance, Bombay Stock Exchange, or National Stock Exchange.

- **SplitTrain-Test:**Inthisstepdataarecategorizedfortheirtrainingandtestingparts.
- **Training of Models:** According to the data, kernel will be picked and SVM may retain one of three kernel types: linear, polynomial, or RBF.
- **TheHyperparameterAdjustment:**Inthisstepsomestrategiesareused,tooptimizethepara meter.
- **Parameters of Performance:** In this part of the algorithm calculation of the Mean Absolute and Mean Squared errors take place to performance metrics. The following are some of the performance metrics that the chosen study uses to assess its performance:
    - **Mean Absolute Error (MAE):** Regression values are calculated using MAE. The sum of the differences between the expected and actual variables, divided by the total number of data points, is the error prediction in this scenario. The calculation of the difference between two continuous variables is known as MAE.

      MAEiscalculatedasfollows:

      MAE=mean(absolute(predictedvalue-actual value))
    - **Mean Square Error:** Minimal square regression is calculated using a loss function called the square average error,sometimesknownasmeansquarederror(MSE).Itisalsocomputedbytakin gthesumofthedifferences between the expected and actual variables and dividing it by the total number of data points.

  MSEiscalculatedas:

  MSE=mean(square(predictedvalue-actual value))
- **Comparison:** Comparing the expected value to the actual value for regression problems is one way to assess the model's performance.
- **Analysis:** In this step the summary of the overall implementation of proposed algorithm will took place in the form of analysis of proposed algorithm and other models.
- **Exit:**Assoonasanalysishasbeendoneabriefreporthasbeengeneratedattheendoftheimple mentation process of proposed algorithm.

## 6. DISCUSSION ABOUT RESULT

In this study, one data set Apple (APPL Inc.), and two classifiers Random Forest and SVM have been used for SMF because many classification algorithms and data extraction methods exist. It is difficult to compare the classifier built in this work with a similar system in the literature. The classification ranks from highest to lowest accuracy is as follows. It is clear from this result that Random Forest produces greater accuracy results. Since SVM has 97.36%.

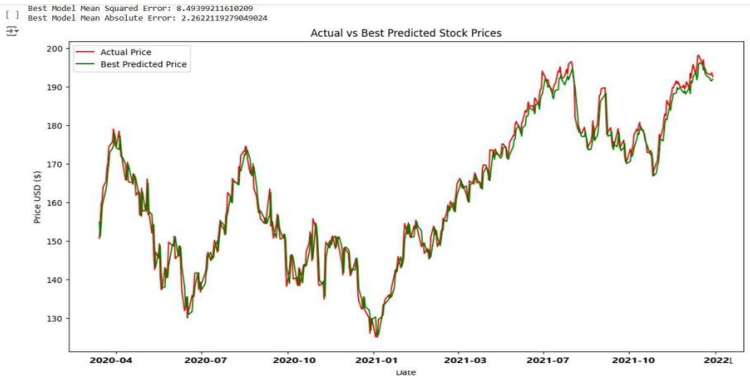


Figure 3: Graphical Output of Random Forest (Actual value vs Predicted value)

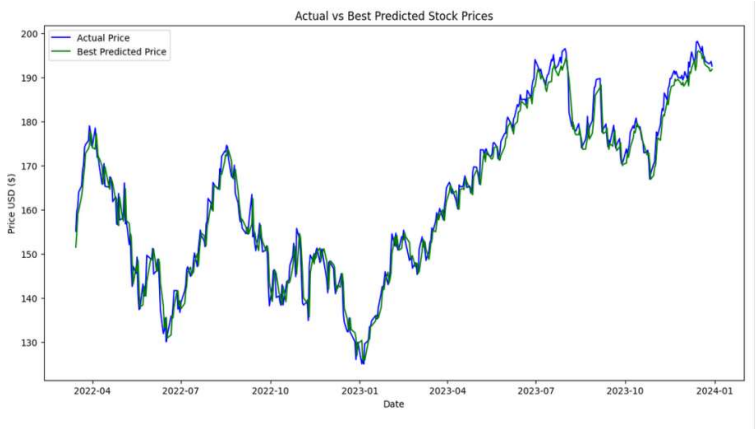


Figure 4: Graphical Output of SVM(Actual value vs Predicted value)

Table 2: Comparison of Model Performance metrics

| **Total No of errors** | **Random Forest** | **SVM** |
|---|---|---|
| MAE | 1.2025204104 | 2.3611476380 |
| MSE | 3.7106956165 | 8.9675521944 |
| IloR- Square | 99% | 97.36% |

## 7. CONCLUSION

Based on the evaluation metrics, Random Forest emerges as the best-performing model for stock price prediction. It has the lowest error values (MAE and MSE) and a very high R-Square value, which indicates that it explains most of the variance in the stock price data. While SVM also shows impressive results, and is considered the optimal model due to its simplicity, accuracy.

The main aim of our survey is to summarize the empirical evidence of stock market prediction based on ML models and forecasting the stock market with the highest accuracy. We can also try to enhance the accuracy of previous research done by the researcher. so the stock trader, investor, and researcher did perfect and accurate forecasting.

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# IOT-BASED AUTOMATIC WATER CONTROLLING SYSTEMS FOR GRAPES GARMING

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We have identified in this paper the development and implementation of an automatic water control system for grape farming using IOT. The main function is to maintain optimally the application of water by the grape vines for their best growth and development without wasting any water resource. This system makes use of the wireless sensor networks that monitor the soil moisture, temperature, and humidity in real time. The data received from sensors will be sent to a central IoT platform by devices like the ESP32 microcontroller. Further processing and analysis of the data are done on the cloud-based server to automate irrigation through solenoid valves, maintaining optimum soil condition. Field tests show significant water savings compared to
It does a good job compared to traditional irrigation methods in sustaining the desired soil moisture level. The smart irrigation system described in the following sections will not only promote sustainable farming for grapes but also bring forth better growth and higher yields of grapevines. Future work will include the integration of more advanced sensors and capabilities to expand towards broader agricultural uses.
**Keywords**: Internet of Things, Grape Farming, Water Management, Wireless Sensor Networks

## 1. INTRODUCTION

The following paper mainly focuses on how water level gardening can be controlled using IOT devices. For that, we need to know some concepts like what is IOT, what are the types of soil, and what the pH levels in soil are. The IoT may be defined as a network of interrelated and intercommunicating physical things or devices implanted with sensors, software, and other technologies over the Internet; these enable access to, and the exchange of, data by devices and systems. Things targeted can range from ordinary objects found in the household to complex industrial tools. IoT is basically the capability of devices to gather data, communicate that to a central system, and make decisions upon that data or perform an action with that data automatically. IoT Components: Sensors collect data from the environment, such as temperature, humidity, light, and motion. Actuators act upon data in this way: turn on a light, adjust the thermostat, and/or control machinery. Connectivity devices communicate with other devices and/or central systems using various network protocols like Wi-Fi, Bluetooth, Zigbee, and cellular networks. Data Processing and Analytics: The acquired data are processed and analyzed-often on a cloud computing or edge computing basis-to obtain insights into their meaningful processing and the triggering of the right actions. User Interfaces: Users of IoT systems rely on interfaces in the form of mobile applications, web dashboards, voice commands, or others, through which they can normally monitor and perform several control activities remotely over the devices. Viticulture is basically the cultivation of grapes, mainly for wine production, consumption in fresh form, juice, raisins, or other forms after further processing. Grape Production Based on Various Factors Site

Selection: This is a very critical decision in farming grapes. Climate, type of soil, slope, exposure to sunlight, and proximity to water sources are all essential factors when it comes to ascertaining the profitability of a vineyard. Variety Selection There are thousands of grape varieties grown all over the world, each serving different purposes. Growers will select a grape variety according to its intended use, suitability to the climate, resistance to disease, and for its demand in the market. Propagation Grapes are usually propagated through grafting, cuttings, and tissue culture. Propagation methods ensure that desirable characteristics of selected grape varieties are preserved and reproduced in new vines. Planting: Grapevines are normally planted in rows and at suitable spacing that allows adequate aeration, sunlight penetration, and management of the vineyard. The density of planting depends on several factors, including the variety, the type of trellis system used, and the general practice of vineyard management. Training and Pruning: The grapevine requires training and pruning to achieve good yields, quality fruits, and health of the vine. Trellising on vineyard properties could be anything from VSP to high-wire systems that support the growth of the vine and allow canopy management. Pest and Disease Management Grapevines are prone to a number of pests and diseases that range from fungal infections and insect infestations to viral diseases. Integrated pest management strategies, combining cultural, biological, and chemical controls, are used to reduce damage and lessen dependence on pesticides. Irrigation: Properly managed water is an important component of raisin grape production, particularly where rainfall is minimal or in areas subjected to drought. Methods of irrigation include drip irrigation, sprinkler systems, and other such ways to provide the vines with water without an over-supply that will encourage disease. Harvesting Grapes are picked at various stages of their ripeness depending on how they will be used. For wine, it is at the point when sugar, acidity, and flavor compounds are most favorably combined. It may be mechanically or manually harvested based on vineyard size and topography. b. Postharvest Handling: Grapes may either be processed into products or marketed fresh upon harvesting, depending on market demand. For wine production, for instance, grapes are first crushed before being pressed and fermented into wine. The grapes are sorted and cleaned for either fresh consumption or further processing into juice, raisins, or other products, then packaged accordingly. A great deal of planning is invested in grape farming, with detailed activities and continuous monitoring of conditions within the vineyard. Practices need to be flexible and adapt to the many changes occurring due to environmental factors as well as market demand to ensure the long-term sustainability and profitability of the vineyard. It is not possible for human beings to pay continuous attention to farming. Using IOT, now we can monitor or control farming from anywhere. All farming depends on soil and its water level maintained by pH level. Correct acidity of the soil can be one of the most important factors that differentiate the culture of grapes from others. Herein lies some information about soil pH for grapes:

1. Optimal pH Range: The optimal soil pH range for grapevines varies from 5.5 to 6.5. This slightly below neutral to neutral pH optimum ensures better intake of major nutrients such as nitrogen, phosphorus, and potassium, along with micronutrients like iron, zinc, and manganese.
2. Acidic Soil: The soil below 5.5 pH is considered too acidic and, therefore, could result in nutrient deficiencies, mainly calcium and magnesium deficiencies, and even aluminum toxicity. This may further lead to stunted vine growth because of its impact on the proper development and ripening of grapes.
3. High pH Soil- Alkaline Soil: On the other hand, very alkaline soil, with a pH above 6.5, reduces the availability of some nutrients in the soil, hence causing deficiencies and poor performance of the vine. In high pH soils, the uptake of iron might also be reduced, hence causing chlorosis-a yellowing of the leaves.

4. Testing and Adjustment: Testing the pH of the soil on which grapevines grow is an important periodic process. The usual modification of soil pH is by the addition of acids or bases; lime is added to increase the pH in acid soils, while sulfur is added to decrease the pH in alkaline soils. Applications of such amendments must, however, be judicious and based on recommendations from a recent soil test to avoid overcorrection.
5. Selection of Rootstock: Variants of rootstocks are more tolerant to certain conditions of soil pH compared to others. Application of an appropriate rootstock for the prevailing conditions in a vineyard site at establishment will help in reducing the problems of pH and improve health and productivity of vines.
6. Monitoring and Maintenance: These monitoring of soil pH, especially in established vineyards, needs to be very consistent. Several routine maintenance activities like mulching, cover cropping, and proper irrigation management would go a long way in keeping the soil pH stable within favorable limits for grapevine growth.
7. Local Factors: in carrying out the soil pH management as it relates to grape production, attention has to be given to the local environment as well as characteristics inherent in the soil. These variables-all of which include climate, pattern of rainfall, the soil type, and drainage- could have different effects on the soil pH and might require specific management practices.

## 2. LITERATURE REVIEWS

IoT-based farming is not any new idea, yet still, in our country, this technology is not fully flashed used. Muhammad Usman et al., 2019 They focus on smarter, better, and more efficient crop growing methodologies that would be required in order to meet the increasing world population's growing food demand in the face of the ever-shrinking arable land. The improvement of the crops and handling-new methods of which one sees being developed with indefatigable regularity-technology-weaned, innovative younger people taking to farming as a profession, agriculture as a means for independence from fossil fuels, tracking the growth of crops, their safety and nutrition labeling, partnerships between growers, suppliers, and retailers, and buyers. The presented paper emphasized the role of various technologies, but mostly IoT, in making agriculture smart and efficient for meeting future expectations. It provides in-detail discussions on wireless sensors, UAVs, cloud computing, and communication technologies. (Prem Rajak et al., 2023) suggested that IoT enabled smart farming has great perspectives for the future.
Advanced sensors can be employed to monitor environmental factors such as rainfall, moisture, and temperature for maximum agricultural yield. Water and Nitrogen contents in the soil could be measured using IoT-enabled devices. Evapotranspiration rates can be effectively monitored based on the CO2 level of the farm lands to have better vigilance on crop health. Moreover, IoT-enabled traps fitted with high-resolution cameras and other accessories can reduce pest attack by controlling pest population. Despite such advantages, major challenges in large-scale deployment of IoT-based smart sensors in agriculture include purchase and maintenance cost of sophisticated hardware and software. Apart from this, farmers residing in rural areas lack proper knowledge about IoT devices. Finally, cyber attackers might influence the automated smart farming by damaging the cloud servers where important data are stored. (Apurva A. Londheetal., 2020) discussed a work based on the concept of integrating agriculture with state-of-the-art technology. This can be done by embedding the technology in the heart of agriculture, that is, traditional and primitive techniques. The paper is supposed to provide, in totality, real-time and historical environment information to reach efficient management and exploitation of resources.
The proposed methodology utilizes received updated information, enabling farmers to cope with such changes and even benefit from them. Farming could be made more efficient &more

accurate by the implementation of IoT devices. IoT can be used in various domains of agriculture. This is designed to monitor the field parameters like Humidity, Soil moisture, Temperature, and Leaf Wetness remotely. The information can be collected by the farmers with the help of a cloud account and internet connection. The application of the latest innovations in technology, sensing, and communications shall enable substantial improvements in precision agriculture practices and management solutions. With the help of sensors in the crop field connected to the internet, an appropriate decision can be taken.

## 3. OBJECTIVE:

To design, with the application of IoT, an intelligent irrigation system, which can optimally manage the usage of water in gardening grapes.

**Implementation System Model Development**

**The development of the model of the system requires the following features:**

**1. System Architecture:**

a. The wireless sensor networks are proposed for the developed system to monitor the soil moisture, temperature, and other environmental variables.

b. Soil moisture sensors, temperature sensors, and humidity sensors are deployed at different places in the vineyard.

c. Collected data from these sensors are sent to the central IoT platform by devices such as ESP32 microcontrollers.

**2. processing and controlling:**

a. Realtime processing of data from sensors for making irrigation decisions

b. The system in turn uses a server cloud in which data storage and analysis are performed for automation of irrigation.

c. Blynk app may be used for monitoring and manual control .

**3. Automation and Optimization:**

a. Automatic opening/closing of solenoid valves based on soil moisture can be done to regulate the flow of water.

b. Irrigation time and volume will be dynamically altered based on sensor-reading changes and threshold levels as pre-set by the user.

c. This shall lead to an efficient application of water with no wastage, keeping the soil optimally moist for grape growth.

**4. Testing and Results:**

a. Field tests shall depict clearly how the system helps in maintaining an ideal level of soil moisture for the betterment of grapevine growth and yield.

b. The system is tested for its adaptability to various environmental conditions and its scope regarding water conservation.

**5. Advantages and Scope for Future Work:**

a. Water usage is very less as compared to conventional irrigation techniques.

b. Real-time monitoring of the system and its remote control.

components-

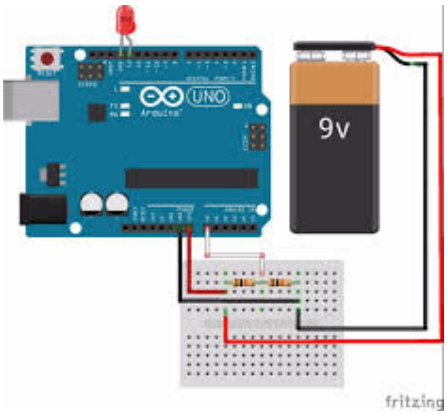
**16x2 LCD Display**: For real time display of soil moisture, status of the system and messages if any. LCD stands for liquid crystal display. It is one variety of the electronic display module used in a wide range of applications such as different circuits and devices. Such devices include mobile phones, calculators, computers, television sets, etc. These displays have their main preference for multi-segment light-emitting diodes and seven segments. The major advantages of this module are that it comes at a very low cost, can be programmed easily

along with animations too. Also, there isn't any limitation to showing custom special characters or animations etc.

**Water Pump Motor:** Supplies water to the plant upon instigation from the Arduino Uno. An Arduino-based microcontroller water pump is that kind of system where the function of a water pump is controlled by an Arduino. The Arduino could also be used for switching the pump on and off, including the regulation of flow rate and direction. Application areas where this system can be employed include irrigation, water treatment, and processes needing industrial control. To drive a water pump from an Arduino, the pump is connected with the Arduino's digital output pins. Normally, the pump would have two wires, one for power and the other for ground. These can then be connected to the 5V and GND pins, respectively, on the Arduino. You may then drive your pump through any digital output pin on the Arduino after these connections are made.
Use Arduino's digitalWrite function in order to vary the speed of the pump. Use one of the libraries, such as AccelStepper library, which allows control of the direction of the pump. Working with an Arduino and water pump should be guided by the pump's datasheet and operating instructions provided by the manufacturer. Also, keep in mind the use of a suitable relay in switching on and off the pump as they might require more current than what the Arduino can handle.
Additionally, it calls for an appropriate sealing of the system, preventing water damage, taking care of all precautions while working with water and electricity.

**Battery:** This powers the system so that the operation does not break in case there is no direct power source. Arduino Uno requires 5 volts power for running; hence, we will require at least 7.4 volts to 9 volts battery. As Arduino pins support only 5 volts maximum, we need to use a Voltage Divider. Voltage Divider basically consists of two resistors in series. It requires two resistors of the same value to divide to half voltage. 1K to 20K resistors can be

used, but the greater the resistance used, the lesser the power is consumed by the Voltage Divider.




It establishes IoT connectivity, hence the system can be monitored and controlled from a distance. Users can be present at any corner of the world and get real-time data on the parameters being measured and make necessary changes in their respective shares. The CPU performs the program logic and interacts with various components.

**Arduino UNO kit:** Arduino UNO is a standard board of Arduino. Here UNO means 'one' in Italian. It was named as UNO to label the first release of Arduino Software. It was also the first USB board that Arduino issued. It is considered to be the most powerful board utilized in many projects. Arduino.cc created an Arduino UNO board Arduino UNO is based on an ATmega328P microcontroller It is easy to use compare to other boards, such as Arduino Mega board etc. It comprises a digital and analog Input/Output pin, shields, and other circuits. Arduino UNO consists of 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP header. The programming is based on IDE, which implies Integrated Development Environment. It is capable of running on both online and offline platforms.

**ATmega328 Microcontroller**-It is an integrated chip Microcontroller of the ATmel family. It contains an 8-bit processor code inside it. The Memory combined with SRAM, EEPROM, and Flash, Analog to Digital Converter, SPI serial ports, I/O lines, registers, timer, external and internal interrupts, and oscillator.

**ICSP pin -In-**Circuit Serial Programming pin is used to get the facility of programming by the user using the firmware of the Arduino board.

**Power LED Indicator-** The ON status of LED shows the power is turned on. In case of power OFF condition, it will not glow.

**Digital I/O pins-** The Digital pin has the value HIGH or LOW. The digital pins are numbered from D0 to D13.

**TX and RX LED's-** The flowing of data successfully is indicated by lighting these LED's.

**AREF-** It is an Analog Reference which provides the facility of feeding a reference voltage to the Arduino UNO board from the external power supply.

**Reset button-** It is used to connect a Reset button.

**USB-** It allows the board to connect with the computer. This is necessary for the programming to the Arduino UNO board.

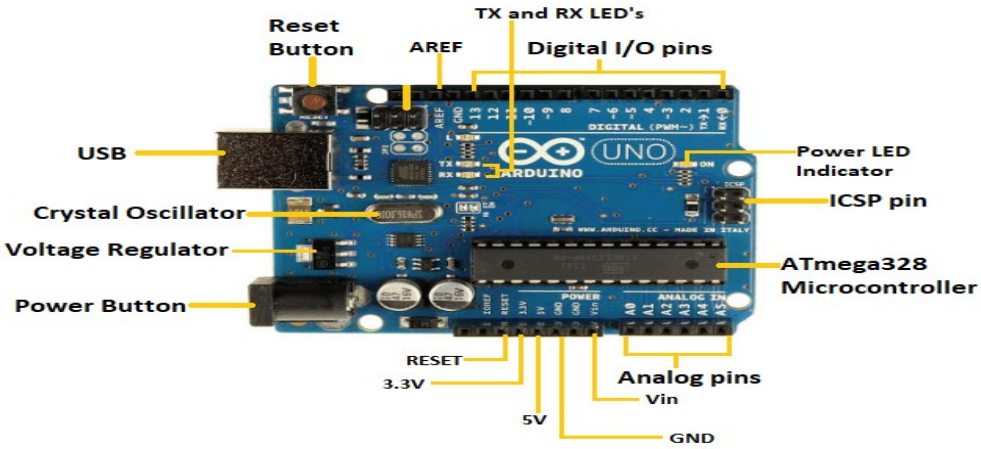
**Crystal Oscillator-** The Crystal oscillator has a frequency of 16MHz which gives power to the Arduino UNO being such a potent board.

**Voltage Regulator-** The voltage regulator converts the input voltage into 5V.

**GND-** Ground pins. The ground pin acts like a zero volt pin.

**Vin**- It is the input voltage.
**Analog Pins** - The pins numbered from A0 to A5 are considered analog pins. Analog pins read the analog sensor used in the connection. It also can be used as GPIO that is General Purpose Input Output pins.
The technical specifications of the Arduino UNO are listed below :

- There are 20 Input/Output pins present in the Arduino UNO board. These 20 pis include 6 PWM pins, 6 analog pins, and 8 digital I/O pins.
- The PWM pins are Pulse Width Modulation capable pins.
- The crystal oscillator present in Arduino UNO comes with a frequency of 16MHz.
- It also has an Arduino integrated WiFi module. Such Arduino UNO board is based on the Integrated WiFi ESP8266 Module and ATmega328P microcontroller.
- Of course, the voltage which is applied on UNO board varies from 7V to 20V.
- By Default, Arduino UNO draws power from an external power supply. While in some cases, it draws power from USB.




**Soil Moisture Sensor**
It shows how to measure the moisture content of the soil to determine whether there is any need for its watering. Usually, soil moisture sensors measure volumetric water content in soil. Since direct gravimetric measurement of free-soil moisture involves removal, drying and weighing of a sample, soil moisture sensors measure volumetric water content indirectly by utilizing some other property of the soil as proxy for moisture - electrical resistance, dielectric constant or interaction with neutrons. Soil moisture sensors usually refer to sensors that estimate volumetric water content. Another class of sensors measure another property of moisture in soils, referred to as water potential, and these sensors are usually referred to as soil water potential sensors, including tensiometers and gypsum blocks.

**Temperature and Humidity Sensor:** The sensor, which is usually in contact with the operational environment, can convert temperature and humidity into electrical signals that can easily measure both temperature and humidity. The general temperature humidity

transmitter on the market is usually applied to measure the quantity and relative humidity of the temperature in the air, transforming it into electrical signals or other types of signals according to certain regularity. Then, output the device to the instrument or software for the purpose of satisfying users' needs of the environment monitoring.

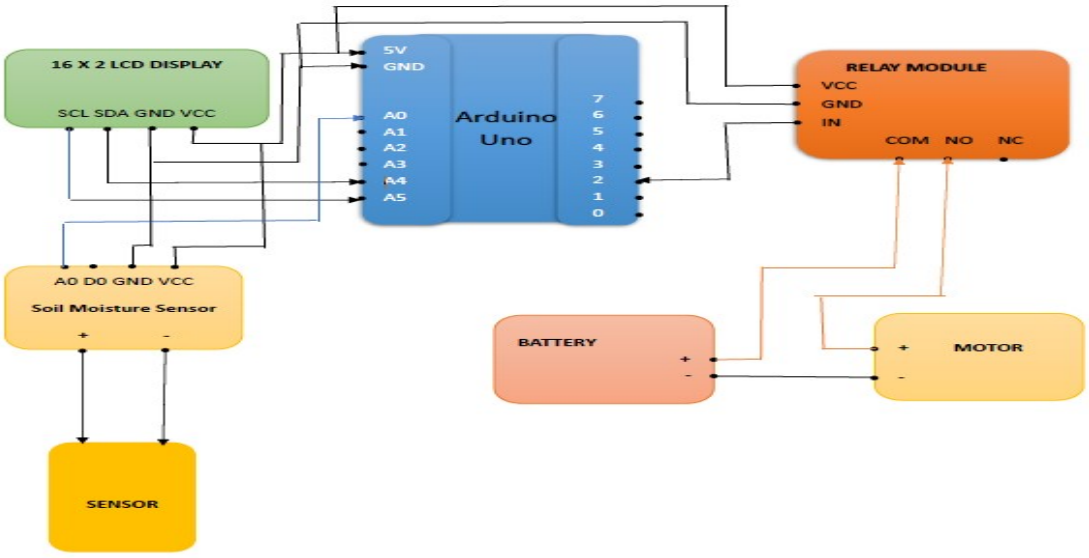
**Relay Module:** It activates the water pump motor for automatic water pumping based on a moisture sensor. A relay module is primarily employed for switching an electrical device or system on/off. They also provide isolation to the control circuitry so that a low voltage and current device such as a microcontroller may be used to safely control larger voltages and currents. The principle of the working of the relay module isn't that complex:. When a control signal is applied, the electromagnet inside the relay comes into play and closes the switch contacts. This opens the path and lets the current flow through the circuit. Conversely, when the control signal is removed, the action of the electromagnet ceases and the switch opens, thereby interrupting the flow of current.

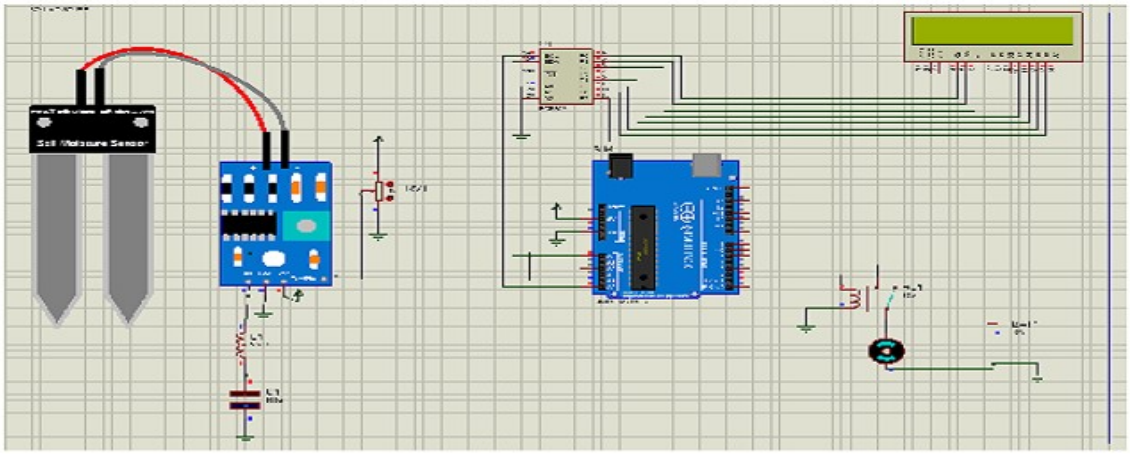
Each relay requires a control signal to turn on and off. These are low-power signals that decide when to energize the electromagnet. In general, these signals are sourced from a microcontroller or sensor and act as the trigger. Once the control signal is applied, the relay switches on, and when the signal is taken away, it automatically goes back to its default state. This thus enables precision control of the relay, allowing its operation in everything from switching on a light to firing a motor.

Relay modules can be made either with a normally open or normally closed switch configuration. NO switch configuration means an open switch in a state of rest of the electromagnet and closes when the latter is activated. In an NC configuration, it works just the other way.

Flyback diodes, among other elements, might be included on the relay module for protection and durability. These diodes prevent harmful flyback voltages when the electromagnet is turned off. Sometimes optocouplers are used to provide higher levels of isolation between the control and load circuits.

## Circuit diagram



**Functional**

1. In the IoT program, I controlled, using code in the C programming language, the water level in the soil in order to control the display via the I2C communication used by the LiquidCrystal_I2C.h file.
2. It initializes a LiquidCrystal_I2C class object by passing to its constructor the memory address that informs the I2C address of the LCD module and respective dimensions of 16 columns and 2 rows.
3. Then, it calls the setup() function once the program starts.
4. For Initializes serial communication at a baud rate of 9600 for debugging purposes.
5. For initializes the LCD display use init()function.
6. To turns on the backlight of the LCD used backlight() function.
7. For clears the display used clear() function.
8. It sets pin 2 to HIGH probably it controls some water pump, which in effect turns the water pump off at the very beginning.
9. For this code it sets the cursor to the first column of the first row.

10. It then reads the analog input value from pin A0, which seems to be connected with a moisture sensor.
11. Use the line Serial.println(value) for printing the analog value to serial monitor for debugging purposes.
12. Then it used some conditional statements to control the behavior of the water pump depending on the moisture level read from the sensor:

- If above 950, water pump = ON, and "Water Pump is ON" is displayed on the LCD.
- If it is less than 950, water pump = OFF; on LCD "Water Pump is OFF".

13. This is followed by another set of if-else statements for displaying quantity of moisture on LCD:

- If the moisture level is below 300, then "Moisture : HIGH" is displayed.
- When the moisture is within a range of 300 to 950, "Moisture : MID" is displayed.
- When the moisture level is above 950, "Moisture : LOW" is displayed.

**Results:**

These are some results which measured from this devices
Moisture: 950 Or Above (Moisture Low), Soil Dry - Water Pump On
Moisture: Between 950-300 (Moisture Medium), Soil wet - Water Pump On
Moisture: 300 Or Less (Moisture High), Soil Wet - Water Pump OFF

**Using IOT devices**

a. Water Conservation: Most of the smart irrigation system diminishes water usage, about 50 percent, as compared to other conventional irrigation systems.
b. Yield Improvement: Due to the optimization of water usage, the yields related to the grapes are much better.
c. Economical Operations: As a result of optimized water usage, the overall cost decreases due to a reduction in water consumption and labor cost for manual irrigation.

## 4. CONCLUSION:

The IoT-enabled irrigation is thereby effective in utilizing water resources for better production of grapes and can be used as a model for various other agricultural applications. The following program serves to trigger an irrigation system with input from a sensor of moisture levels, giving real-time feedback on an LCD display. When the MoistureLevel is 950 or above-this is representative of when the soil is somewhat dry-an Input would be sent to the water pump to turn on. "Soil Dry - Water Pump On" would appear when the value of MoistureLevel lies between 950 and 300: the system keeps the water pump on-for the soil median moisture values. "Soil Wet - Water Pump On". When it reaches a high level of moisture in the soil, at or below 300, the system will shut off the water pump. It generates a message: "Soil Wet - Water Pump Off". That gives an idea how the irrigation system acts on moisture levels-high or low-so as not to overwater or underwater the soil to keep the conditions right for plant growth.

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# A SOCIOLOGICAL REVIEW OF INNOVATIVE DISRUPTION TECHNOLOGIES AND CHANGING NATURE OF WORK IN CONTEMPORARY INDIAN SOCIETY

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Disruptive technologies like artificial intelligence (AI) and machine learning are driving major sectoral changes in the twenty-first century. Yet with e-governance facilitating extensive accessibility to data and rights-related concerns, India has to cope with the digital divide. There must be cooperation between citizens and technologists. Beyond simple adaptation, disruptive technologies can advance a sustainable, equitable, and interconnected society. The main Objectives of the paper are:

1. To know the perceptions and apprehensions of the student and teacher community about AI
2. To explore the perceptions and claims of experts about AI
3. To track newly produced opportunities becoming accessible with the application of AI
4. To analyze the trends of AI in the future on work and ethics.

A survey was conducted by using Google Forms. The responses of students and teachers in Bengaluru from the Humanities, Commerce, Science, Engineering, and Medicine streams were collected on awareness, apprehensions on innovations, job opportunities, besides chances for applications of AI. Supportive readings were collected from various search engines like EBSCO, Google Scholar, JSTOR, and manual search.

Keywords: Digitization, Digital revolution, Disruptive Technology, AI, Ethics, Work

## 1. INTRODUCTION

Scientists' initial efforts to explore, create, and advance in laboratories will result in the development of innovative products. Innovations are need-based and accelerators of social change. The twenty-first century is marked as an era of exceptional transformations in most sectors. The changes in these sectors are driven by innovations and disruptive technologies that challenge existing structures. These technologies are introduced and incorporated because of the assured efficiency. The digital revolution, digitization, widespread 5G connectivity, and the Internet of Things (IoT) have created a digital tapestry that seamlessly connects data, gadgets, and human behavior. Artificial Intelligence and machine learning have contributed to reshaping people's perception of the impact of disruptive technologies. Its role in the health sector specifically in the development of vaccines and treatment procedures is widely well-received and implemented. There are also hopes for offering solutions to problems ranging from climate change to genetic disorders with the help of AI. Augmented reality and Virtual Reality technology are used to reduce the boundaries between physical and digital worlds. Hence these trends are increasing the dependence of humans on AI. The circular economy and energy-efficient smart cities are two examples of sustainability breakthroughs that have gone away from particular technologies. Any technological innovations have both merits and demerits. AI is not an exception to this.

There are many paradoxes in Indian society, which is pluralistic. Even though there is a noteworthy digital divide, the public has access to a vast amount of data due to recent efforts towards a digital revolution that have enabled e-governance. This raises concerns about data security and the potential for stalkers to misuse the information. The disruptive nature of automation and AI creates ethical questions and employment market risks, calling for a paradigm change to strike a balance between economic advancement and human dignity. There are also sporadic instances of human rights, intellectual property, and copyright infringement. This calls for collaboration between technologists and citizens. Beyond simple adaptation, disruptive technologies can advance a sustainable, equitable, and interconnected society. In this paper the following are discussed: ( i ) the various studies on the uses of AI-based technologies, and policies of AI companies, ( ii ) peoples', and experts' apprehensions on the changing nature of work, and (iii) the necessity of developing more ethical and humane-based applications iv) The significance of innovations and disruptive technologies in the arena of AI ii) What type of job openings remain destined in all sectors and AI's influence of the work in Contemporary Indian Society by using AI to build a technologically driven society as portrayed by the scientists who are involved in promoting research and training.

The growth and progress within a country are pre-determined by technological advancements. In modern times, science and technological innovation strongly emphasize the formation of new opportunities and capabilities and are very future-focused. The imaginations, expectations, and visions that have formed the possibilities of new technologies and significant shifts in scientific theory (Borup et al., 2006). Innovations in the fields of computer science and information technology have had a great deal of influence on people's everyday lives. Easy access to the internet and its rapidity have an overwhelming application of its products almost everywhere, spanning from industries, offices, markets, and living spaces to the education sector. A requisite for these applications is created, plus a need for skilled professionals is also found. So, there exist boundless prospects for web designers, algorithm writers, and program developers. The process of Machine Learning and Deep Learning has created a lot of scope for the development of Artificial Intelligence. The cost of an Artificial Intelligence and Machine Learning course in IIT or IIM is around 2,00,000 INR for an annual program. There is some short-term online certificate courses offered for 2,500 to 10,000 INR. In the U.S., it starts from 1999$. Private organizations charge from 300,000 to 400,000 INR. Hence, these courses are highly expensive, and the affordability of such courses would be just a dream rather than a reality for middle-class and lower-middle-class students. These courses are anticipated to enhance the chances of job opportunities in the consequent arenas (Simplilearn, 2022). Among the major apprehensions is that these kinds of developments in AI will lead to the forfeiture of many conventional jobs. Additionally, they predict that it may create new job opportunities but demand for persons possessing different skill sets.

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## 2. Methodology

A survey was conducted by using Google Forms. The responses of students and teachers in Bengaluru from the Humanities, Commerce, Science, Engineering, and Medicine streams were collected on awareness, apprehensions on innovations, job opportunities, besides chances for applications of AI. Supportive readings were collected from search engines like EBSCO, Google Scholar, JSTOR, and manual search.

## 2. LITERATURE REVIEW

### Standpoints of Sociologists and other scholars on Technology

The sociology of artificial intelligence is a recently developing domain in which the effectiveness of this field on everyday life is very much discussed. There are two key approaches identified throughout the probe of artificial intelligence. The studies can be classified under 2 groups. Group one deals with the aftermath of social consequences to maintain social control, which creates social differentiation and prejudices based on culture. The second group of scholars has highlighted AI by applying an actor-network perspective. Sociologists have attempted to comprehend the idea of technology since the early 20$^{th}$ century. The development of any technology arises out of a need, sometimes for improvisation. Abstractideas or themes, creative processes, and the requirement for alternatives are the sources for new techniques in a given field. There are also chances of a new technique leading to the evolution of several other unexpected expansions. The term "praxeology" was coined by the French sociologist Alfred Espinas, to describe a brand-new field that could analyze the general philosophy of action, a framework with four parts—type task, techniques, technologies, and theory—that aids in deconstructing any human activity. He focused on the interaction between theory and practice, art and science, in executing planned and unplanned actions (González & Vázquez, 2017). Over time, the field of information technology and computing has changed. These areas have created opportunities for software engineers, program writers, and investors. Marx refers to Technik as a system of machines and characterizes it as a "means of production" that allows humans to exert divine control over nature through their will. According to Marx's scholarship, technology and ‘technical' are connected in the same manner that the general and specific are. This concept was used by scholars in the humanities field specifically by sociologists. The engineers have often used this concept, and they developed it for a clear grasp of technology from a cultural perspective (Schatzberg, 2018). The term "technology" entered the humanities in the second half of the 20th century and developed into a sophisticated metaphorical category. It later became the most crucial category in the activity-based conception of culture (Moisei Kagan, Eduard Markaryan), and sociology, culturology, art history, and archaeology all adopted it as their own. The ontological characteristics of human beings were linked with technology and culture. This usage of the term transformed "technology" into a change symbol, promising to reconsider the inferior status of the spiritual and intellectual spheres in the advancement of civilization.

Technology developed by scientists in their laboratories gains value only when its applications are widely understood and applied in different sectors. It is not just the concern of inventors or innovators but the concern of the nation and it looks forward to technology that will bring solutions to the problems and clear obstacles for the nation's economic progress**.** Values, attitudes, and beliefs do influence their acceptance of technology, and making it familiar is one of the important tasks. To break all these barriers it has to effectively communicate. Hence there should be a preparedness right from policymakers and implementers to business tycoons. Beckmann explains that technology is not just a mathematical discipline growing out of physics, mechanics, or chemistry but an incorporating

science of political economy, finance, and management. The technology initiated by craftsmen or engineers ultimately familiarizes administrators, civil servants, and tradesmen with glitches arising in the exercising of it in their respective fields (Natalia Nikiforova, 2015).

**Reliance and claims on equal accessibility to Computer Applications and Information Technology**

The Information, Communication, and Technology revolution that occurred in India has brought in tremendous structural and functional changes in several sectors. This industry is dynamic and continually evolving, so there have been additional advancements since then. A major force behind national economic growth is the ICT revolution, which is being driven by the phenomenal progress of semiconductor innovation and the quickening pace of globalization (Jorgenson Vu, 2016). The acquisition, recording, and processing of data, which is finally retrieved as information via electronic signals for usage, are the traits of Information, Communication, and Technology. This revolution has changed the way people function and communicate. Businesses have benefited profoundly by applying ICT tools. ICT corresponds to the integration of computer networks, telecommunications networks, and multimedia networks. The technology is used for a variety of tasks, from processing data in organizations to managing and regulating robotic machines remotely (Mohammed & Sadiq, 2015). This revolution has also created opportunities for several other scientists and innovators to upgrade existing knowledge for future generations. Information technology resources are essential for encouraging innovation and enhancing performance in higher education institutions, especially in terms of product development, according to research findings based on responses from respondents working in higher education institutions in Garut, Indonesia (Maulani et al., 2021). It has promoted teamwork and creativity in the classroom and organizations wherever it is applied. The demands, attitudes, expectations, perceptions, and values around the use of technology in education are shaped by large firms that are involved in the field of educational technology. It is also essential to critically examine how these companies display and market their goods (Marone &Heinsfeld, 2023). AI (Artificial Intelligence) and ICT (Information and Communication Technology) are closely interconnected fields that often complement each other to enhance various aspects of technology, business, and society. ICT supporting AI development has been possible due to computational power with aids in the development and training of sophisticated AI models. ICT systems play a crucial role in processing large volumes of data which is essential for AI models and effective communication.

Social change is evident due to technological interventions. Computing historians have attempted to gauge the particular changes in society since the adoption of technologies. J. Cortada (2013), has brought out the prominence of the micro and macro analysis of the studies done on computing technologies. The spontaneous, and universal computer applications, information technology, and the digital revolution have changed the nature of work in both the public and private sectors. For example, the research carried out by many of the professors and students is highly impossible owing to the computers. Computer technology is a bargain with a high-tech devil. This technology of writing has destroyed people's ability to write, think, and interpret and it has reduced the self-confidence of people about their ability to think and write. The reliance on search engines has increased due to the availability of facts-based knowledge on mobile phones. The information that is available now on digital platforms is constantly refined both with human and AI interventions. But once it is done at the machine learning phase it may end up routing to certain searches only. What is uploaded for people to access digitally depends upon the actors including the

program developers, researchers, and information seekers. Paul Sagan remarked that the digital age has produced an information and communication resurgence, and it has neither reached many nor everyone has equal opportunity to be part of this renaissance (Darnton et al., 2011).

**ICT, Mobile Applications, Education, and Research**

Different types of mobile applications and computers have influenced and transformed different facets of Indian society. Learning and acquiring skills are instant due to these applications. The young generation of learners is referred to as digital natives by Prensky. They grow up by playing video games, surfing the internet, and they are multitasking. In the field of education, the Net Generation is driving a shift in pedagogy from a teacher-focused, instruction-based model to a student-focused, collaboration-based paradigm.According to Tapscott (1998), this trend has been set in the field of education. Students typically spend more time engaging in entertainment than in academic pursuits, according to a study conducted in Malaysia, and the researchers have advocated to enrich the learning process through the usage of new emerging technological tools (Yong & Gates, 2014). The introduction of ICT has enhanced both the teaching and learning experience, specifically with slow learners and kids with special needs. The learners have access to multimedia for quality learning. The outcomes of a study entitled “Everyone pursuing their dreams Google's and Microsoft's discourse on educational technology” indicate that the narrative advanced by these businesses portrays technology as a revolutionary force capable of bringing life to an ailing institution of learning (Marone &Heinsfeld, 2023). The Speech-to-text (STT) Dragon study sheds light on how technology can assist children in overcoming literacy obstacles. It has successfully enhanced the children's handwritten text and generated remarkable results for screen-written text at the post-test, providing them with lifelong independent communication skills (Kambouri et al., 2023). The findings of a study exploring the relationship between educational ICT resources, student engagement, and academic performance highlight that curriculum-based, non-curricular, and cognitive-motivational engagement all have a good correlation with educational ICT tools. Governments are advised to use various measures to realize the potential benefits of educational ICT resources, by the research findings (Wang & Wang, 2023). A superior cost-performance ratio over old labor-intensive manual systems is one benefit of utilizing IT in business processes (Abdel Raheem et al., 2021). The study conducted by Dierckx and others (1999), observed in an automobile disassembly enterprise that there is a relationship between information technology and innovation in SMEs because of standardized operations, expertise, distinction, and both horizontal and vertical integration created feasible development with IT application. It opened up several job opportunities for people in many domains, including the software field, and is also responsible for a huge shift for many middle-class software engineers in Indian society. Nations that are developing are obligated to provide all the resources wanted by youth to obtain ICT management training (Mohammed & Sadiq, 2015).

**Cloud Computing and Artificial Intelligence**

Some of the imperative traits of the Internet revolution are cloud computing, artificial intelligence, continuous integration and continuous deployment, open source software, blockchain, distributed ledger technology, the Internet of things, low code or no code development cyber security, and remote collaboration tools. Alan Turing, one of the leading British mathematicians and logicians, claimed that the human brain by and large is like a computer machine and machines can think on their own shortly in 1950. The term "artificial intelligence" was subsequently formally introduced approximately six years later, in 1956, when computer scientist John McCarthy and Stanford's Marvin Minsky sponsored the

roughly eight-week-long Dartmouth Summer Research Programme (Haenlein & Kaplan, 2019). Artificial intelligence (AI) is the concept and technique for creating computer systems that can do functions like recognizing words, making decisions, and pattern recognition that traditionally needed human intelligence. Natural language processing, machine learning, deep learning, and other technologies are all included under the broad term artificial intelligence. Therefore, AI is all about engineering intelligent machines to perform all the actions. Strong (or general) AI and weak (or narrow) AI have been distinguished from one another. Weak AI is limited to doing activities like that of humans, while strong AI, also known as artificial general intelligence (AGI), is found in computers capable of executing any intellectual and cognitive tasks that a human can perform. Put differently, the question of "whether machines can be truly intelligent or simply able to act 'as if' they are intelligent" determines the distinction (Kaplan, 2016). Squibb claimed that intelligence is an abstraction derived from socially acceptable behavioral patterns from a sociological perspective (Squibb 1973), Russell and Norvig (2020), provide another attempt to characterize the behavioral traits that render a machine intelligent. The bounded rationality of humans served as the authors' point of reference. They maintained that a computer must exhibit human-like, rational, or human-like behavior to be classified as intelligent. Russell and Norvig (2020) have said that artificial intelligence (AI) cannot replace human "knowledge workers" in their capacity to apply tacit knowledge to evaluate and solve problems. In the era of robots and artificial intelligence, McClure (2018), investigates how employees' agency impacts their job security. Because they are more willing to accept and adjust to the new AI-present workplace order, he contends that employees with a more favorable attitude towards AI typically have higher job stability and enhanced employability. It would be pointless to bring up the Kantian objection that the near-future AIs have no moral standing and are only being employed as means to an end (Fröding& Peterson, 2021). Artificial intelligence (AI) can create synthetic faces that can speak and express any desired language (Zakharov, Shysheya, Burkov, &Lempitsky, 2019).An AI system is ultimately a tool that will endeavor to do any task that it has been assigned. The issue arises from the fact that people, who are rarely as exact as they ought to be, provide those opinions. Therefore, for AI systems to properly read ambiguous commands, they need to be equipped with a knowledge of human values.

**Digital Revolution and Artificial Intelligence**

In the 21st century research, the digital revolution and consequent innovations have encompassed socioeconomic and political aspects. The transition that started in the 1980s and is still going on today from mechanical and analog gadgets to digital technology is commonly referred to as the "digital revolution." The Internet, cell phones, VoIP services, digital ecosystems, and computers have collectively become frequently utilized in the past few years, allowing us to embed digital tools and web-based communication into our everyday lives. (www.techopedia.com).The government, academic institutions, research establishments, and business sectors have to endorse the digital shift for this to be implemented successfully (Verlagsgesellschaft et al., 2021). Every crucial domain is digitalized to provide efficient services. For example, agriculture, banking, classrooms, defence, energy, and hospitals. This has resulted in profound and systemic structural changes at a faster scale inside the organizations. To enable the transfer of offline transactions to the online sphere, offline analog data must be converted into digital values through the process of digitization. This move essentially refers to the organization's conversion of its various resources and assets into online formats rather than requiring significant changes to process enhancement or the creation of new business models within the company (Veldhoven &Vanthienen, 2023). Florence and others have noted that the pandemic accelerated digital adoption, particularly in remote work and online operations. This shift has had long-lasting effects on productivity and labor markets, helping firms adapt to lockdowns and maintain

operations (IMF). The research conducted in these areas utilizes maximum resources. Across the globe, the state is inclined to invest in the Research and Development sector gaining dominance in knowledge. According to the World Bank report it is estimated that by 2030, over $400 billion will be needed to provide everyone with broadband access. This is conceivable with the private sector lowering expenses and risks while boosting productivity and innovation, and governments must implement drastic changes. (World Bank, 2024). Digitization is an inevitable process, it has enhanced the investments in digital needs of organizations. In 2022, 31% of digital spending was devoted to developing know-how, while 69% of disbursements shifted towards operating (EY 2022). This is driven by the need to bring tech-enabled products to market and enhance operational efficiencies quickly. Digitalization has had a direct and beneficial influence on profit for the last two years, according to 79% of organizations (Bite Stream 2024). Research indicates that aligning technology with strategic goals is crucial for maximizing the value derived from digital investments. Companies that clearly articulate their digital strategy tend to see a positive impact on their market valuation (Deloitte 2023). Due to the increase in profits, and visibility of the business, there is a steadfast move towards investment in digital transformation from the leaders in their respective domains at the global level.

In the early stages of the Industrial Revolution, industries applied the technology evolved by the then scientists in their laboratories. The patenting of technology, innovations, and knowledge has given a business dimension to the Research and Development sector. So it was driven by the knowledge generated in laboratories. In India, the Anusandhan National Research Foundation is anticipated to receive seventy-two percent of funding from the private sector. The Finance minister has stressed that ANRF will maneuver basic research and prototype development (Rajendran. C.P. 2024).

During the fourth industrial revolution, technological parks offered high-quality space and facilities along with other value-added services that encourage and regulate the flow of knowledge and technology between universities, R&D centers, businesses, and markets. It also helps to create and grow innovative companies through incubation and spin-off processes (Marciniec, 2007). In the present scenario, industries are investing in the research and development sector to fulfill industry-specific motives. The industry sectors driven by the digital revolution have designed and established their own Research & Development wing wherein the state and public have very minimum participation. Science parks are the global hubs for the development of new technologies. They are located in knowledge-based economies, and the effect of these parks boosts the inventiveness and competitiveness of small and medium-sized businesses Marciniec, B. M. (2007).

Prominent consequences of data gathering and data-based projections mark the digital revolution. The data pooling is done on massive scales by the industrial sectors to track consumer choices and behavior from nook and corner of the world. Today's consumers are well-informed, and the majority of their needs are met by many service providers who are globally connected.

**Digital Revolution and AI**

The Digital Revolution has led to an exceptional outburst of information, often referred to as "Big Data." Massive datasets required for training complex models, especially in machine learning and deep learning, were generated and accessible to AI systems by the broad digitization of material, which ranges from social media posts, online transactions, and sensor data from IOT devices, to enormous databases of online material (Mayer-Schönberger& Cukier, 2013). Because there is a wealth of data available, AI systems can continuously learn, adapt, and perform better.

Data management and the usage of digital devices for multiple purposes have accelerated digital capacities for many people. But accentuating it for the poor systemic backwardness is

one of the reasons. Without access to the internet, billions of people have been kept out of the modern world. 2.6 billion people, or almost one-third of the global population, did not have access to the internet in 2023.2.6 billion people, or almost one-third of the global population, did not have access to the internet in 2023 (World Bank).

**Intelligence, Human Intelligence, and Artificial Intelligence**

It is observed that in both animals and plants, intelligence is most frequently researched concerning humans. The capacities for abstract cognition, comprehension, communication, reasoning, learning, planning, emotional intelligence, and problem-solving are some of how intelligence has been defined and understood. Leg and Hunter (2006) have expressed that Intelligence measures an agent's ability to achieve goals across an extensive array of environments. Human Intelligence is all about the capability of humans to think, act, and react in a given condition. It also helps in having better clarity over the prevailing uncertainties. Psychologists explain that there is something known as general intelligence and specific intelligence. Most IQ is acknowledged to be genetic. According to sociologists, social environment, education, and other social factors contribute to human intelligence. Learning a language and acquiring knowledge through the same languages happens in primary institutions of society. British Scholar Len Scott says that intelligence studies have highlighted the way knowledge is accepted, generated, and used (Warner. M 2008)

Artificial intelligence is a branch of science and engineering. It's a science that studies how to build intelligent machines and intelligent computer programs. Alan Turing, a mathematician, gave his first lecture on AI in 1947. He was also of the opinion that machines will compete with men in every intellectual area. Here's one of the core areas and the problem that is dealt with by the researchers in the field of AI. For other experts, this is one of the major apprehensions will AI replace human intelligence, or whether the reliance on AI is greater in the future? (Kurzweil, 1985).

Traditional artificial intelligence has used reasoning to solve problems since the 1950s. Deductive reasoning is used to implement the majority of expert systems. Data mining and machine learning both use inductive reasoning. Artificial neural networks are dynamic, adaptive, incredibly concurrent structures that comprise based on the fundamental characteristics of biological networks. The network educatesitself on how to perform the task through trial and error. Based on situations, embodiment, intelligence, and emergency behavior, more potent independently moving robotics are created. Combining symbolic, connectionist, and behavioral mechanisms to create intelligent structures is a terrific notion.

The capacity to reason, communicate, and make reasonable decisions in the actual world of imprecision, uncertainty, and incomplete information is just one of the unique abilities that humans possess (Shi, 2011). Allan Turing's main argument was that the human brain must be organized for intelligence and the same organization can serve as a base for building discrete-state machines. He also has expressed that by developing a thinking machine the covert process of human thinking can be traced. AI is not a terminated mission rather there is the reception of its outcomes despite major criticisms and intimidation (Castelfranchi, C 2013).

**Types of AI, theoretical interpretations, opportunities, and apprehensions about AI**

Two varieties of artificial intelligence are still operational. a. Artificial General Intelligence and b. Artificial Narrow Intelligence. Stephen Hawking, Elon Musk, and other well-known scientists and technology commentators have maintained that intelligent systems (AI) are a technological advancement able to transform society, classifying it as high risk" along with nuclear technology (Holley, 2016; D 'Orazio, 2014), as have some industry experts like Stuart Russell (Bohannon, 2015). There are just three fundamental methods for constructing AI:

symbolic-computational, connectional, and neuromimetic, with several subgroups of each and even hybrids. The symbolic-computational approach, or "good old fashioned AI" (GOFAI), often ignores the human brain in favor of using algorithmic tools to describe and construct a rational agent, which serves as a counterpoint to the rational actor in the literature on economic and related legal theory (Finkelstein, 2004). The connectional technique comes next; it is modeled after how the human brain connects artificial neurons to create neural networks. The neurokinetic approach, frequently referred such as a subset of the connectional approach, looks directly at the human brain and makes attempts to replicate certain aspects of it or the entire thing, including whole-brain simulation. In a deep learning neural network, datasets' vague information becomes representations by layers of artificial neurons subsequently there were reservations voiced that the network may learn from them. This learning is frequently semi-supervised or even unsupervised (Schmidhuber, 2015). Mosco refers to technological myths, a myth neither factual nor wrong, technological myths are quite drastically found to be having an in-depth result ((Mosco, 2004). Initially, when Allan Turing mentioned thinking machines, there were reservations expressed about whether it was accepted to be a reality. This is consistent with how information scientist Hamid Ekbia described the AI myth as the "embodiment of a dream kind of dream that is not just an illusion or mere imaginary, but one that stimulates analysis motivates action, and inspires commitment.

**Actor-Network Theory and Artificial Intelligence**

Numerous facets of society unite people and form a social network between them. Additionally, some associations may not be made up of people but serve as actors in bringing people together. According to Bruno Latour's Actor-Network Theory (ANT), a network is not a thing, but its actors frequently are. The fusion tendency is referred to by Latour as the "sociology of the social," and he states early on that "the social cannot be conceived as a form of material or domain" because "the social cannot be construed as anything static and extensive enough to be called social context." For instance, "social environment" is regularly cited as a crucial independent variable impacting outcomes in studies on change and innovation, whether in business or government. The social environment is based on culture. Culture involves approved and accepted ways of life. However, the transmission is inevitable, uniform, and spontaneous. The spaces, methods, and channels vary according to the accepted ways decided by the government, market forces, and scientific innovations. The role of things and the shape of practices are virtually always present when we observe attempts at operational specificity. Maximum users are using the available knowledge since it is available and ignorant about the technical know-how of this. Hence the awareness of AI and its application is quite low. Expectations from technological innovations are quite common amongst the stakeholders. Brown and Michael have examined how expectations are distributed about the divergent roles played by various actors (scientists, regulators, the general public, etc.) in the innovation process. Expectations and future orientation have been examined in both traditional and modern social theory, particularly in the works of Weber, Mead, Schutz, and others. They are a crucial component of human agency (Borup et al., 2006). If any information gets changed at an individualistic stage, it might affect the whole community and users of the information. Also, there is lagging in collective conscience and a shortfall of democracy in handling many concerns at the community level in the real world due to attempts being made to find the answers in the virtual world. There are apprehensions about the notion of access to information, and doubts are raised on the authenticity and reliability of such information in the future (Darnton et al., 2011).

**Opportunities in the area of artificial intelligence**

“Google at its best would be powered by artificial intelligence. The perfect search engine would know all there is to know about the internet, know exactly what you were looking for, and provide the information you needed. We're a long way from accomplishing that right now. But we may approach that gradually, and that's essentially what we strive towards." Larry Page. Google has come up with a Gemini AI-based chatbot.
According to simplilearn.com job opportunities with an M.S. degree in AI will enhance the chances in the digital tech sector. The projected job opportunities are 45% for the IT sector and for others, it is only 10%. From this graph, it can be inferred that though AI is applied in all sectors, career opportunities are lopsided. It also shows that these kinds of developments are creating exclusive careers in the IT sector.

**Artificial Intelligence and Ethics.**

One of the major concerns is how far Artificial Intelligence can be ethical. Many of the researchers have raised their comments on to what extent ethical principles can be applied. Social values, moral and ethical issues, and the relative importance of values held should all be taken into account by AI thinking by many stakeholders in diverse ethnic settings; provide an explanation of its logic; and ensure transparency (Dignum, 2018). Ethics in artificial intelligence: Introduction to the special issue. The nature of AI is such that a lot of AI creates epistemic weaknesses for the experts who build it. The development of machine learning introduces an epistemological "black box" vulnerability, meaning that its designers may know very little, if anything, about what is happening inside the black box (Liu, 2021) Towards a code of ethics In addition to governmental agents, commercial companies are also becoming more and more affected by this rise. Companies like Google, Microsoft, and Facebook, for example, have very total access to both individual and network data. Companies and people also exchange data from other sources with the police and other parties who are willing to pay for it.(Kraemer et al., 2011) Even if AI is capable of amazing discoveries that humans are not capable of, including identifying third- or higher-order connections in complicated biological networks—where three or more variables must interact for an effect to occur—it lacks common sense and reasoning abilities. AI algorithms may take on social roles, requiring new design specifications like predictability and openness. It's possible that sufficiently general AI algorithms won't work in predictable environments, necessitating the development of artificial ethical considerations and new forms of safety assurance (Kraemer et al., 2011)

**Artificial Intelligence in India**

The process of globalization has opened up opportunities in trade and technological knowledge across the globe for India. In India, information technology services and outsourcing companies such as TCS Infosys and Wipro have played a crucial role in providing software solutions and services to clients across the world. Some of the Indian industries have started using artificial intelligence, including banking and finance and supply chain management. Indian IT firms, such as TCS and Infosys, are working on creating a range of AI-based fixes for their issues. For instance, the "National Programme on Perception Engineering" is an Indian government-funded research program toward the development of AI. The establishment of software companies gave a facelift to the cities and it has given global recognition to these cities. The development of these cities has far-reaching consequences, including the expansion of the cities and amenities of international standard. It has also contributed to the start-up ecosystem and cities like Bengaluru Hyderabad and Pune are recognized as the cities of start-ups the start-ups include synthetic and agri-tech contributing to innovation and technology. A report by Zinnov Global Management Consulting states that over US$36 million has been invested in about 170

businesses(Srivastava, 2018). It has also transformed the country into a digitally empowered society. AI research for both military and commercial use has been funded by DRDO at the Centre for Artificial Intelligence and Robotics (CAIR) (Srivastava, 2018). Online shopping is one of the recent developments in the field of trade and commerce, it has changed the whole dimension of purchasing and selling of the commodities. People who are busy and don't find sufficient time for shopping end by buying products through online applications. Retailers have adopted a range of technologies to interact with their customers during their online buying experience in response to the growing popularity of online shopping. One field that definitely makes this easier is artificial intelligence. The Concepts of machine learning, neural networks, big data and artificial intelligence (AI) are shaping new digital consumer worldwide. India is also one of the newest and largest growing markets for Digital Marketing (Umesh and IJARSCT, September 2020). The innumerable projects and programs focus on a government digital infrastructure and the adoption of technology across sectors have contributed towards the digitalisation of many sectors. A study on Artificial intelligence for governance in India was conducted and the findings suggest that deploying AI assisted governance is hampered by issues with data protection, acquisition, and storage. Concerns about the improper use of data and a lack of trust are further ethical issues that could prevent AI from being widely used in governance(Gupta, 2019).

## 3. EXPERIENTIAL WORK

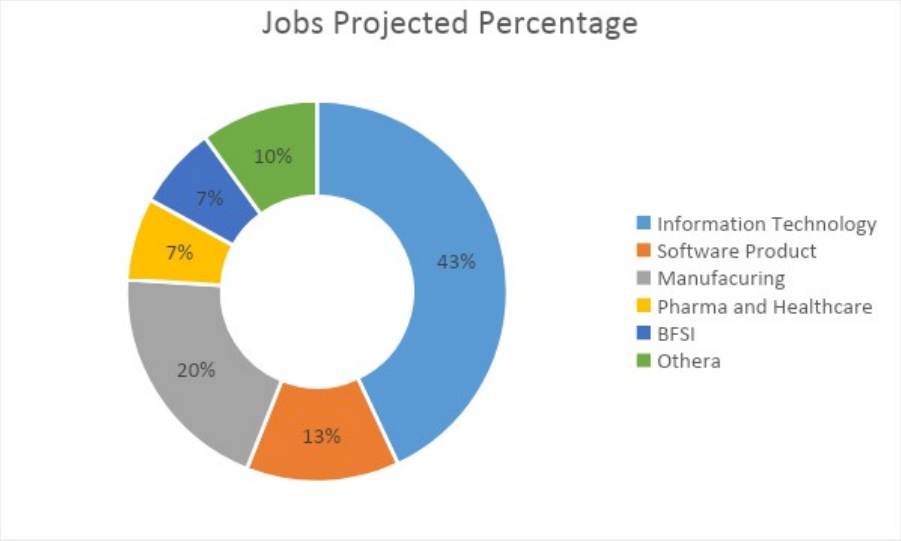


Figure 1: Jobs Projected Percentage Source: simplilearn.com

A survey was carried out to explore the awareness, apprehensions, and opportunities with AI among students and teachers in Bengaluru city. Two different schedule forms were made for teachers and students. The link for forms was shared amongst the students and teachers and data were collected.

**Responses of the students**

The vast majority of respondents (80.3%) are undergraduates. A small portion of respondents (8.5%) have a 12th Standard qualification. Another small segment (7%) consists of post-graduates. A very small percentage (approximately 4.2%) are Ph.D. holders. The majority of the respondents are students pursuing UG, PG, and Ph.d from the fields of commerce, science, engineering, and medicine and have participated in this study.

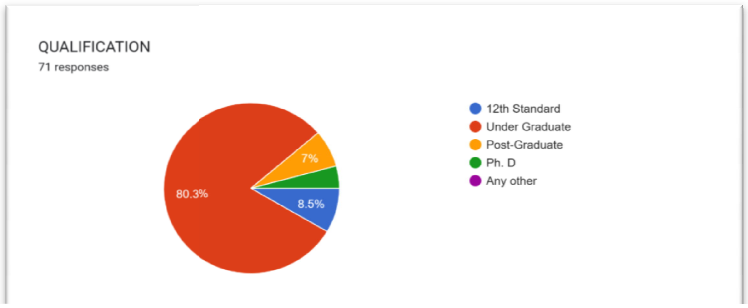


Figure 2: **Percentage of Students from various streams**

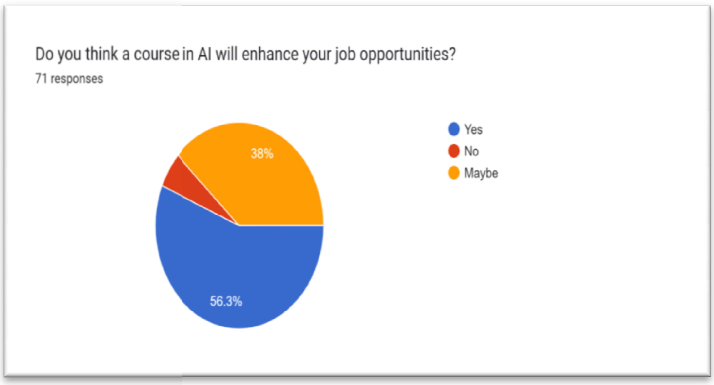


Figure 3: Course in AI and Enhancement in Job Opportunities

The majority of the students feel that a course in AI will enhance job opportunities for AI. This demonstrates the students are aware about the importance of AI. Though universities across the country are attempting to catch up and prepare students of all the streams to provide a foundation in AI, there is lot of ambiguity amongst the teachers to what extent AI tools can be used.

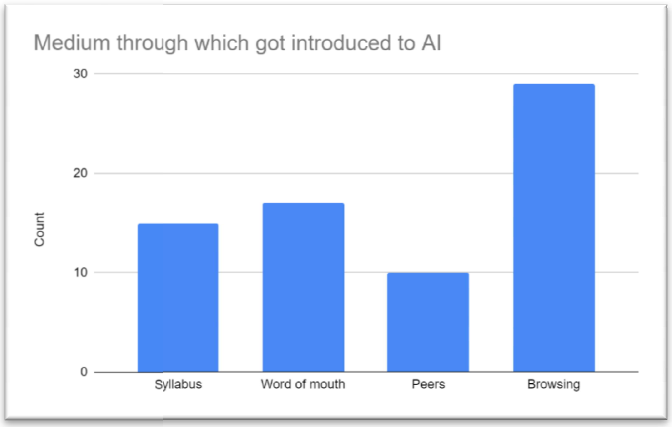


Figure: 4 Medium of AI Introduction

Based on the display, it can be inferred that the largest proportion of pupils have discovered AI while browsing and only 21.1% know it through the syllabus and 23.9% through

interactions. Browsing is a significantly popular method for people to learn about artificial intelligence, suggesting that online resources or personal exploration play a crucial role in AI awareness. Word of mouth and Syllabus are also significant, but not as much as browsing. Peers have the least influence in spreading information about AI, which might indicate either fewer peer discussions on the topic or less effective dissemination through peers. The universities at Texas, MIT, reputed institutes such as IIT, and IIM, and many other websites have produced promotional videos and advertisements about these courses. Automated and profound learning are two key components of computational intelligence. This happens during the browsing. The browsing history is linked to one's email id. Machine learning happens during the browsing hints to the agencies about the details of who is browsing the information and, the type of the information, and based on that students devise info regarding AI and related concepts during browsing compared to other modes.

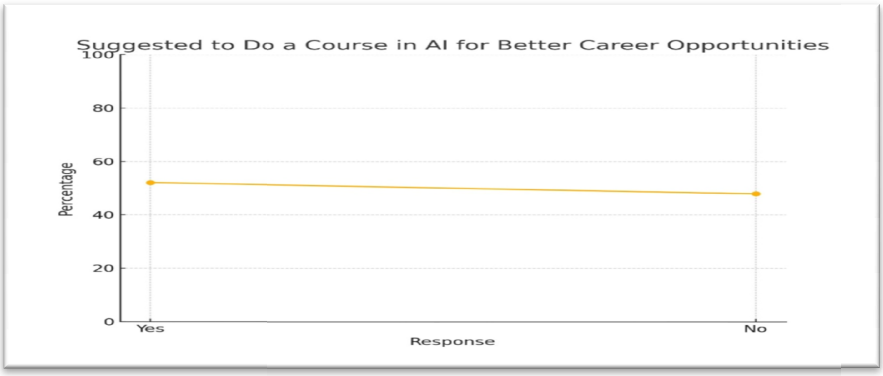


Figure 5: Suggestion for a Course in AI

52.1% of them have agreed that they were suggested to do a course in AI to boost their likelihood of good job opportunities. A majority of the respondents believe there is a lack of training in AI that could lead to job loss. 47.9% of students have stated that they do not think that a course in AI will deprive them of better career opportunities. Hence these students are confident about getting a job by pursuing the current course. The products of the AI field, AI knowledge, and practices are socially constructed and shaped by power relations between agents and groups of agents that exist and act in this field (Bourdieu, 1975).

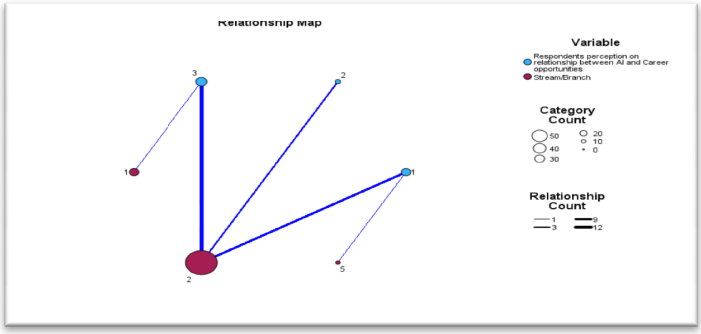


Figure: 6 Relationship Map on AI and Job Opportunities

Node 2 (red) is the most central node with the largest size, indicating it has the highest category count. It is heavily connected with both blue nodes (1, 3) and a red node (2), signifying it is a critical stream/branch with strong connections to respondents' perceptions.

The blue node 3 has strong connections with nodes 1 and 2, suggesting a significant perception of AI and career opportunities related to these branches or streams. The thin connection between nodes 3 and 1 indicates a weaker relationship compared to others. Node 5 (red) is somewhat isolated, having only one thin connection, indicating a minimal relationship with other entities. Node 1 (blue) also has limited connections, suggesting fewer respondents perceive a relationship between AI and career opportunities in that branch or stream. However, the role played by data analysts in collecting readily available data due to AI has unassuming both advantageous and unfavorable effects.

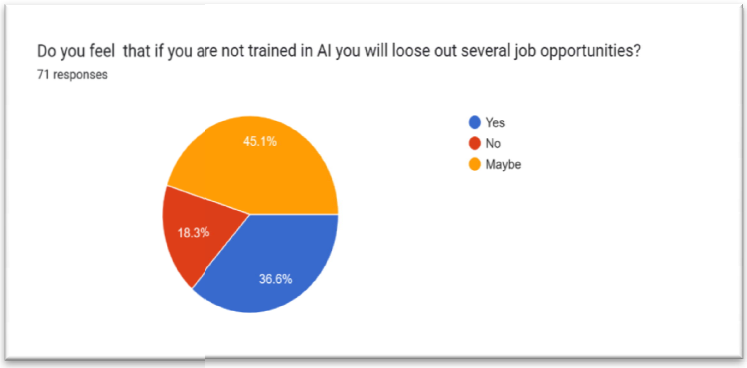


Figure 7: Fear of Losing Job Opportunities

Statistical analysis, data mining, cloud and distributed computing, web architecture and development framework, middleware and integration software, user interface design, and network and information security are the most sought-after skills in the global job market. The well-known job-seeker networking site LinkedIn lists one of the top ten desired technologically focused careers. Pupils are not fully aware of the fact that technologically orientated jobs are gradually being replaced by technological assistance. Technology takes the role of the working population. Concerns about losing their work due to AI training are shared by 36.6% of respondents. Most of those 45.1% are unsure if they will be impacted.

**Table: 1** Correlations AI tool use, tracking of Search History and Frequency of using AI tools

| **Correlations** | | AI tool use and tracking of Search History | Frequency of using AI tools |
|---|---|---|---|
| AI tool use and tracking of Search History | Pearson Correlation | 1 | .380 |
| | Sig. (2-tailed) | | .001 |
| | N | 71 | 71 |
| Frequency of History using AI tools | Pearson Correlation | .380 | 1 |
| | Sig. (2-tailed) | .001 | |
| | N | 71 | 71 |
| Correlation is significant at the 0.01 level (2-tailed). | | | |

The correlation coefficient between AI tool use and tracking of Search history and Frequency of using AI tools is 0.387. This coefficient is a measure of the strength and direction of the association between the two variables. A value of 0.387 indicates a moderate positive correlation. This suggests that as the use of AI tools involving search history tracking increases, the frequency of using AI tools also tends to increase, and vice versa.
Significance (Sig. 2-tailed): 0.001 the p-value (0.001) is less than the standard significance level of 0.01, indicating that the correlation is statistically significant.
This means there is strong evidence against the null hypothesis (that there is no correlation), and it is unlikely that the observed correlation is due to random chance.
The analysis shows a significant moderate positive correlation between the use of AI tools involving the tracking of search history and the frequency of using AI tools. This implies that there is a meaningful relationship where higher engagement with AI tools is associated with an increased likelihood of these tools tracking search history, and frequent users of AI tools tend to use those that track their search history more often.

**Responses of the teachers:**

The teachers who teach higher education students have responded to the questions via the Google form and their responses are of due importance in this study. 50% have expressed that AI will replace human intelligence. They have expressed that they suggest AI products like chatbots, Google Scholar, connected papers, and virtual travel booking agents. There is less awareness about the tools. For example, Google Scholar is not the only one such search engine for students. Google, Yahoo, Baidu, Yandex, Duck Duck Go, Ask.com, Yahoo, Baidu, Yandex, Duck Duck Go, Ask.com Ecosia, Aol.com, Internet Archive.

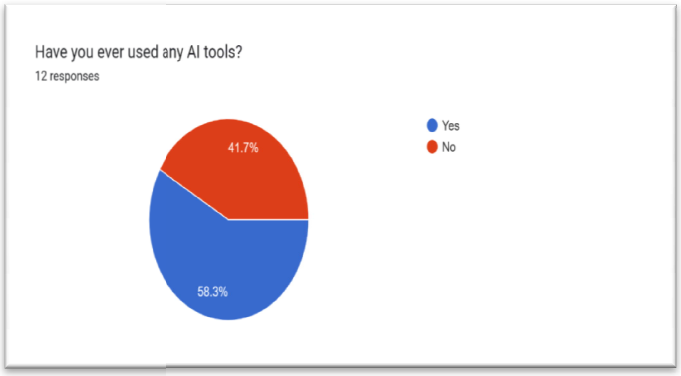


Figure 8: Percentage of Teachers Usage of AI tools

41.7% have accepted that they have not used AI tools at all and this indicates that they are apprehensive about using AI tools

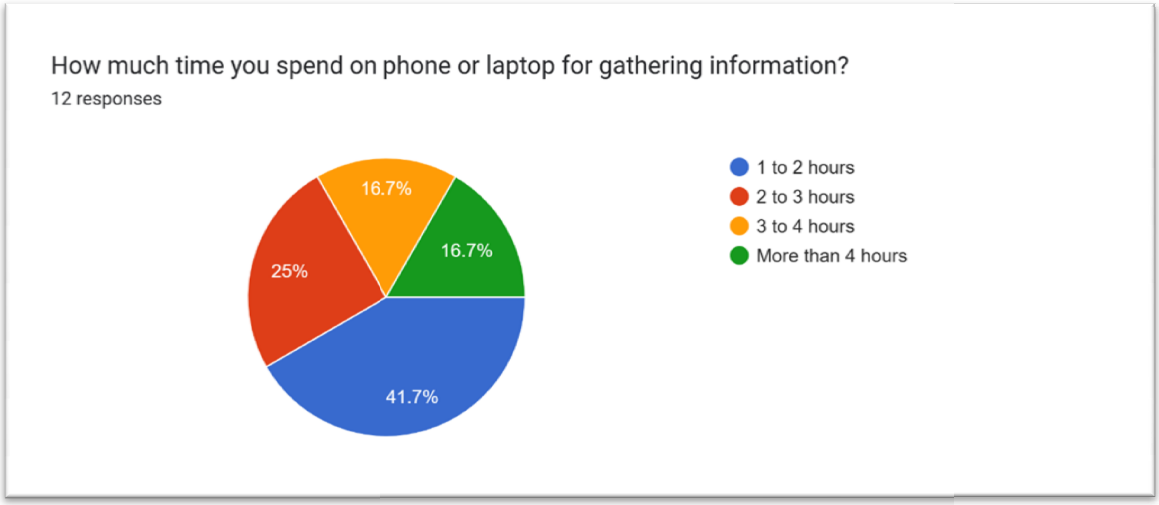


Figure 9: No. of Hours Spent on Laptop

32.14% have agreed that spend close to 4 and more than 4 hours on a laptop. This kind of time spent enhances the scope for deep learning and machine learning. Teachers are directly providing the details to the websites and the kind of information sought is tracked by the AI professionals and companies

The responses of the teachers for the job opportunities to students are, that students might get jobs in Airports restaurants, Financial analysts, no idea, I don't think so, Not, Apps with better, personalized diet plans, development of tailored food products, the potential for better research writing, In mental health analysis therapies, Counselling and research, majority of the present jobs need AI, every equipment can be automated, any stream of students can enter the business world. Few professors are unaware of the job opportunities and few have attempted to point out the opportunities from their respective subjects. Most of the jobs created in the future would be to code and decode the information for big business firms on the preferences of the consumers, and stakeholders.

The responses to the question, what is the role of AI in building a technologically driven society? Are as follows:

- Make work and storage of information easier, Moulds in making things accessible.
- The effective utilization of talents and less waste of time.
- Huge data analysis & makes tasks easy
- Quick solutions to problems, and makes living with ease possible.
- A major important role, Automation, is essential in the robotic world.

The above responses give mixed opinions about it and some of them do not have clarity on it. They have not understood the consequences, specifically, the amount of damage it may cause due to the intrusion into one's privacy. Every move whether about health, travel, investment, borrowing, lending, or your opinion, tastes, and preferences is observed, tracked, and utilized for brand building. Hence people are under the threat of continued surveillance.

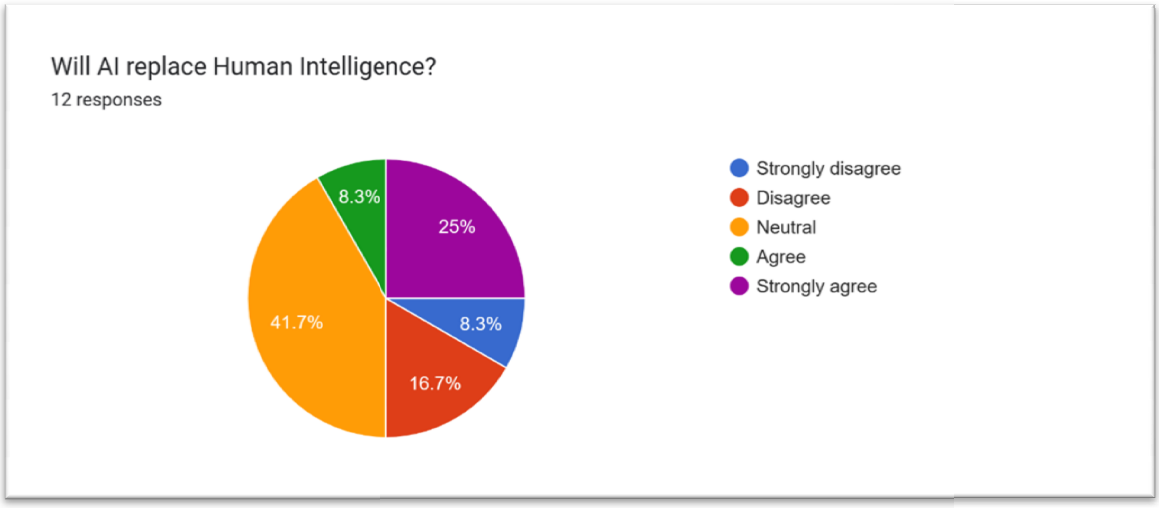


Figure 10: Replacement of Human Intelligence by AI

Will AI take over humans? This question is posed on various platforms. Allan Turing who is the father of computation and artificial intelligence had given a call that by building an artificial thinking machine one can understand the functioning of the human mind better. 25% of teachers have said, they strongly agree that AI will replace human intelligence, and 16.7% and 8.3% have disagreed and strongly disagreed with the replacement of human intelligence by AI. Human intelligence is not just genetic, and psychological but also social. What is fed as data, statistics, is learned by the machine which is known as narrow AI. Beyond this, there are no path-breaking developments, decision-making, or risk management performed through machine and deep learning.

**Conclusion:**

People have many outstanding aptitudes: foremost, the proficiency to reason, interact, and take rational decisions. The first is the ability to accomplish a wide range of mental and physical tasks; the second is the concrete domain of indistinctness, confidentiality, and incompleteness of information, which humans possess in many astonishing ways. For machine intelligence to accomplish a wide range of mental and physical tasks, it needs to learn from natural intelligence. Science and Technology no longer remain as a domain meant for the well-being of humankind. The research carried out in this field is sponsored by gigantic companies that have massive profit motives. All these sponsors for example IBM, Reliance, and Google, have entered the fields from education, health, insurance, banking, and finance services retail to research and development. How much ever AI works for us it is ultimately artificial and not original/natural. It is created with fixed programming, algorithms. When humans only are not perfect can human-made machines be perfect? From 2000 onwards society is witnessing the fourth stage of the industrial revolution known as the revolution in the digital domain. This stage is witnessing the application of technology to analyze the human mind, skills, and behavior. The Internet of Things influences everyday life. Hence the application of AI and its products are going to bring evident structural and functional changes in all these fields.

Digital technologies have enabled sociologists to better understand the relationship between them and society, but present issues pertaining to inequality, inequality of power, rules of conduct, and security.

Today, we are living in a society where Information is shared for free. This free access to information has given people to get into various types of networking platforms and also has been advantageous and in some instances risky due to stalkers. Any technological innovations have both merits and demerits. AI is not an exception to this. There are many paradoxes in Indian society, which is pluralistic. Even though there is a significant digital divide, the public has access to a vast amount of data due to recent efforts towards a digital revolution that have enabled e-governance. AI has a great deal of potential in the Indian market since it can leverage domestic talent and create a thriving IT sector there. AI can support key government initiatives in India, such as Made in India, Digital India, and Skill India. To become a powerful force in the sector, India must use AI in applications and infrastructure, policy and regulations, research and development, and human resource development.(Srivastava, 2018). This raises concerns about data security and the potential for stalkers to misuse the information. India can no longer afford to fall behind. For political reasons, it did not reap the gains of the first and second industrial revolutions. But by using the talent that exists in the nation, information technology may help it reap the rewards of the transformation. In addition to making money from software exports, it has the potential to employ millions of educated individuals. Most of the companies are automating the processes using AI technology, and India might lose on it (Srivastava, 2018). Human rights violations do occur occasionally as well. As much as possible, authors suggest that algorithm designers leave ethical decisions to users; if this isn't feasible, then the ethical presumptions made by the algorithm should at the very least be clear and simple for users to understand (Wang & Wang, 2023). For developers to get access to government-owned data, policies are required. Similar to other nations, the government must fund basic research as well as long-term research projects in the area of AI and technological interventions. If India is involved in taking up initiatives to look into ethical violations and constant checks on the replacement of the Human workforce due to AI, it can champion the fourth phase of the Industrial Revolution in the same manner as it was possible through the IT revolution. To give people in Indian society a more moral, just, sustainable, and successful future, there is a dire need to develop more ethical and humane-based applications.

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# ANALYSIS OF LONGITUDINAL DROUGHT PATTERNS AND VARIABILITY IN LALITPUR DISTRICT, UTTAR PRADESH, INDIA, USING SPI, SPEI INDICESAND MACHINE LEARNING TECHNIQUES

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Drought, a hydrological extremity, exacerbates adverse impacts on the environment, society and livelihoods. The frequency and severity of droughts globally are being augmented by both natural and anthropogenic factors. This investigation delves into the escalating patterns and impacts of drought within Lalitpur District in India, scrutinizing a 33-year dataset through the lenses of the Standardized Precipitation Index (SPI) then Standardized Precipitation Evapotranspiration Index (SPEI) along with3months, 6 months, 9 months, 12 months' time scale. The application of the Mann-Kendall test elucidates the trends, while future projections shed light on potential drought scenarios. The findings pinpoint significant drought years, attributing the intensification to modest rainfall variations, imprudent groundwater usage, agricultural practice shifts and drastic changes in land utilization. This phenomenon has notably hampered agricultural productivity across numerous sectors of Lalitpur, with water shortages becoming pronounced in the aftermath of the monsoon season. Predictive analyses forecast a spectrum of drought conditions: approximately 46% mild, 12% moderate, 32% severe and 7% extreme droughts according to the SPI and a 75% likelihood of mild droughts with a 22% chance of severe conditions as per the SPEI. This comprehensive study advocates for holistic watershed management strategies, offering valuable insights for regional planning and water resource sustainability, particularly in India's semi-arid regions.
**Keyword:** SPEI, SPI, Mann-Kendal Test, Predictive Analysis, Correlation Analysis.

## 1. INTRODUCTION

Drought represents an extended episode of aridity and water paucity across various domains (atmospheric, lithospheric and hydrospheric) within the Earth's system, categorizing it as one of the most severe climatic phenomena(Gulbranson & Tabor, 2023). Episodes of extreme drought have been a natural adversity throughout human history, predominantly occurring when various hydro-meteorological variables fall below their typical thresholds(Kusangaya et al., 2021).Numerous regions globally, including those known for their tropical wet and humid climates, have experienced prolonged drought conditions(Zhu et al., 2021). However, arid zones are particularly susceptible to drought due to their reliance on limited periods of precipitation throughout the year for moisture replenishment(Cheng et al., 2021).Drought is typically categorized into four distinct types(Van Loon & Van Lanen, 2012): hydrological drought, characterized by a significant reduction in water availability(Hisdal et al., 2024); agricultural drought, marked by adverse impacts on crop production due to insufficient soil moisture(Al-Kaisi et al., 2013); meteorological drought,

identified through prolonged periods of below-average precipitation; and socio-economic drought, which entails the consequences of water scarcity on socio-economic systems(Bhunia et al., 2020; Haile et al., 2020).Among the spectrum of drought phenomena, the meteorological drought is deemed notably critical due to its extended duration and continuity (F. Wang et al., 2020). Such conditions precipitate a sequence of consequential impacts including groundwater scarcity(Parisi et al., 2018), diminished agricultural yields(Al-Kaisi et al., 2013), a decrease in soil moisture levels(Berg & Sheffield, 2018) and a reduction in surface water availability(Furtak & Wolińska, 2023). These environmental changes, in turn, precipitate a diminution in socio-economic resources, culminating in socio-economic drought conditions (Adaawen, 2021; Serkendiz et al., 2023).Presently, the management, planningand development of water resources have become imperative due to global climate change(Mall et al., 2006). As a result, mitigating drought events has emerged as a crucial challenge in combating hydrological extremes(Kumar et al., 2021).The Indian Meteorological Department defines meteorological drought as a condition wherein the rainfall during a year, or specifically during the south-west monsoon time, falls below 25% of its normal level for an area(Gautam & Bana, 2014; Parida & Oinam, 2015; Vishwakarma & Goswami, 2022). This necessitates thorough scientific investigation and research to ascertain the frequency, intensity, likely recurrence periods and intervals of severe and extreme drought events, which are essential for the effective management and strategic planning of water resources (Bhunia et al., 2020).Different drought indices are the important tool to quantify the severity of drought hazard(Bera et al., 2021). Various drought indices have been proposed by the many researchers worldwide to determine drought magnitude, severity and occurrence rate through SPI (Standardized Precipitation Index) (McKee et al., 1993), SPEI (Standardized Precipitation Evapotranspiration Index) (Vicente-Serrano et al., 2011) , PDSI (Palmer Drought Severe Index)(Palmer, 1965), SWSI (Surface Water Supply Index) by Shafer and Dezman in 1982(X. Liu et al., 2016), EDI (Effective Drought Index) (Byun & Wilhite, 1999), RDI (Reclamation Drought Index)(Weghorst, 1996) etc. Various important agricultural drought monitoring indices are Moisture Adequacy Index (MAI)(Jadhav et al., 2015), Crop Water Stress Index (CWSI)(Alderfasi & Nielsen, 2001) and Crop Moisture Index (CMI) etc. Similarly, hydrological drought indices such as Surface Water Supply Index (SWSI)(Shafer & Dezman, 1982), Standardized Hydrological Index (SHI)(Y. Wang et al., 2020), Standardized Water Level Index (SWLI)(Sharma & Panu, 2014) etc. have been applied to identify the drought frequency and magnitude(Bera et al., 2021).In recent decades, the Standardized Precipitation Index (SPI) and the Standardized Precipitation Evapotranspiration Index (SPEI) have evolved into foundational drought assessment tools, as endorsed by the World Meteorological Organization (WMO)(Tirivarombo et al., 2018), enabling the quantification of drought extent, intensity and duration (Nedealcov et al., 2015).The SPI and SPEI offer a distinct advantage by incorporating the temporal influence of previous values on the current index, utilizing antecedent cumulative climatic conditions, thereby yielding more accurate results(Kamruzzaman et al., 2022). While the SPI relies solely on precipitation data, the SPEI integrates both precipitation and evaporation data (Tirivarombo et al., 2018) . As a result, these two drought indicators hold significant importance in assessing agricultural productivity, wildfire occurrence, water level fluctuations and precipitation accumulation, among other parameters (Zargar et al., 2011).The exponential smoothing method, known for its empirical nature(Gardner Jr, 2006), demonstrates efficacy in simulating and forecasting meteorological drought, exhibiting a high level of accuracy (Djerbouai & Souag-Gamane, 2016).The exponential smoothing function has been innovatively applied to predict drought occurrences over the Bankura district(Raha & Gayen, 2020).The exponential smoothing technique exhibits a remarkable capability for seasonal adjustment and outperforms other statistical models in forecasting accuracy (Rabbani et al., 2021).SPEI stands as another

crucial drought indicator(Wan et al., 2023), discerning drought occurrences by assessing the water balance status and distinguishing between precipitation and potential evapotranspiration (Yao et al., 2022).While the theoretical basis of SPI and SPEI is similar, the calculation steps differ(Ojha et al., 2021). SPI relies solely on precipitation data(Docheshmeh Gorgij et al., 2022), whereas SPEI takes into account the variance between evapotranspiration and precipitation amounts (Soh et al., 2018).The rising trend in evaporation due to global warming holds significant importance in drought assessment(Vicente-Serrano et al., 2020). Therefore, SPEI is relatively superior for drought monitoring compared to SPI, as it considers the impact of changing evaporation patterns alongside precipitation variability (Beguería et al., 2014).However, in arid regions, the utility of SPEI is considerably constrained compared to SPI(Rehana & Naidu, 2021). Therefore, conducting a comparative analysis of the regional suitability of these indices is imperative for their appropriate application and effective water resource management(Bhaga et al., 2020; Herndon et al., 2020). India, being one of the most drought-prone countries globally(Bhunia et al., 2020; Todmal, 2023), experiences its highest rainfall during the southeast monsoon season (June to September)(Barde et al., 2020). Insufficient rainfall during this period can lead to drought conditions in various regions (Kumar et al., 2013).In the drought-sensitive area of Lalitpur(Nair et al.), there's a significant lack of comparative analysis between the two main drought indices, SPI and SPEI. Bridging this gap is essential for improving agricultural output and managing water scarcity effectively, particularly in semi-arid regions.Water serves as the pivotal resource in semi arid and arid climatic regions(Morante-Carballo et al., 2022; Singh & Chudasama, 2021). However, in recent years, substantial water resources have been allocated for the cultivation of rabi and kharif crops, leading to slight modifications in cropping patterns within these regions(Garg et al., 2023). Consequently, crops with higher water requirements have been introduced, exacerbating water scarcity and recurrent drought incidents(Jatav, 2024). The innovation of this research lies in its identification of trends, spatial patternsand prediction of drought occurrences. Furthermore, the study proposes mitigation measures such as the cultivation of high-temperature-tolerant crops and modifications in land use. The primary goal of this study is to assess the status, trend, severity, and predictive capabilities of drought using SPI and SPEI indices at different temporal scales.

## 2. DATABASE AND METHODOLOGY

### 2.1.Study Area

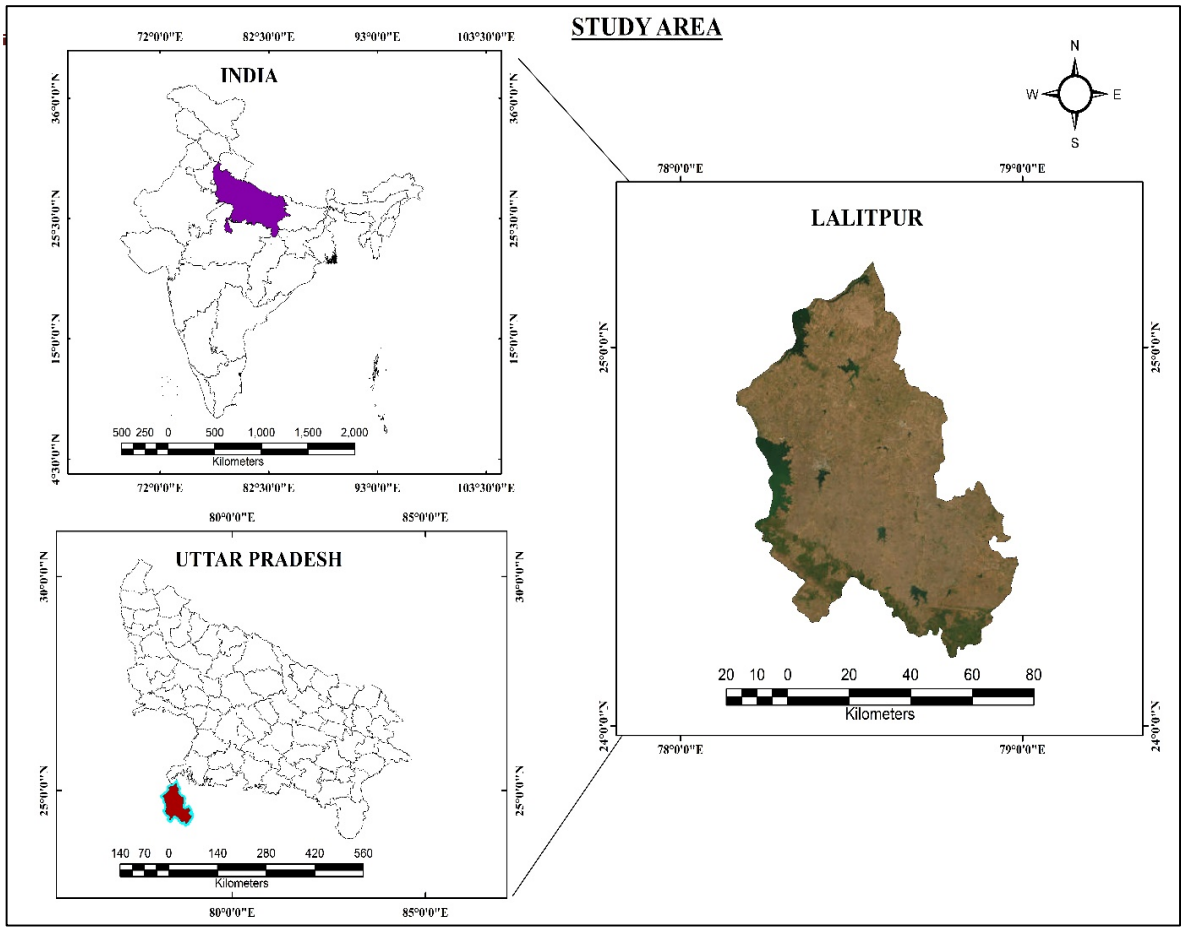


**Figure 1**: Geographical Location of the study area

The current research focuses on an extensive region of the Bundelkhand plateau, specifically Lalitpur district, situated between latitude 24°11' and 25°14' N and longitude 78°10' and 79°0' E (Mishra, 2014)(Figure 1). This district is bordered by Jhansi district to the north, Sagar and Tikamgarh districts of Madhya Pradesh to the east and Guna district of Madhya Pradesh(Pant et al., 2021), separated by the Betwa River, to the west. It spans an area of 5,039 square kilometres(Gupta et al., 2020).The district is renowned for its rich culture, serene ambiance and natural splendour, boasting the highest number of dams in the state(Khatoon & Javed, 2022). It encompasses six blocks: Bar, Talbehat, Jakhaura, Birdha, Mahraoni and Mandawara(Khan et al., 2012). With an average annual rainfall of 1044.3 mm, the district experiences a sub-humid climate characterized by hot, dry summers and cold winters(Gupta & Nair, 2012). Around 91% of the rainfall typically occurs from June to September(Khatoon & Javed, 2022).The region features three main types of soil distinguished by colour and topography: red soil, black soil and alluvial soil(Singh, 1999). Red soil, resulting from the weathering of granite and gneisses, is further categorized into two local types known as raker and parwa soil(Gupta & Nair, 2012). Black soil originates from limestone and granite parent materials and is subdivided into Black kabar and Mar soil based on texture(Adhikary et al., 2014). Alluvial soil, prevalent along river valleys, comprises coarse sand containing quartz and feldspars(Joshi et al., 2022).According to the 2011 census, Lalitpur district has a population of 1,218,002, with a population density of 242 inhabitants per square kilometre(Gupta et al., 2020). The population growth rate between 2001 and 2011 was 24.57%. The district exhibits a sex ratio of 905 females for every 1000 males(Gupta & Nair, 2012). The region experiences severe water crises, especially during the months of February to June(Shrestha, 2013). According to the Department of Land Resources, the major drought-affected blocks are Bar, Talbehat, Jakhaura,Bridha and Mahrani.

**2.2.Data Availability**

In this research, a total of 33 years of temperature and rainfall data were utilized to evaluate the Standardized Precipitation Evapotranspiration Index (SPEI) and Standardized Precipitation Index (SPI). Monthly mean rainfall data from 1990 to 2022 was collected from the India-Water Resources Information Systemswebsite, Government of India. Similarly, daily and monthly temperature data were obtained from the NASA Power Access Viewer website. It is noteworthy that drought indices such as SPI and SPEI typically require a minimum of 20 years of rainfall datasets for calculation, although researchers commonly utilize 30 years of data sets for more robust analysis. In this study, a 33-year time series dataset was used for determining SPI and SPEI. The efficacy of various drought indices was compared in an agrarian semi-arid river basin in Maharashtra, with a focus on selecting the most suitable drought index and timeframe based on a 25-year dataset spanning from 1985 to 2009 (Wable et al., 2019). Additionally, SPI has been successfully employed to provide a satisfactory explanation for intensive floods in the south Cordoba province of Argentina within the timeframe of 1974 to 1999 (Seiler et al., 2002),

**2.3.Standardized Precipitation Index (SPI)**

Calculation of the Standardized Precipitation Index (SPI) over any given region relies on long-term precipitation records(Türkeş & Tatlı, 2009). Developed by McKee and his colleagues, the SPI serves as a tool to assess rainfall deficits and the severity of drought conditions (Hayes et al., 2011)(Table 1). (McKee et al., 1993) was designed SPI index to comprehend the fact of shortage of rainfall. The Standardized Precipitation Index (SPI) is globally recognized and has been endorsed by the World Meteorological Organization (WMO) as a primary index for determining drought conditions (Hayes et al., 2011).Datasets related to the Standardized Precipitation Index (SPI) have been routinely modelled using a Gamma distribution.Gamma distribution used to assess precipitation probabilities(Sharma & Singh, 2010). The analysis of SPI metrics has been conducted using the R programming language.Danandeh Mehr et al. (2020) applied the same methodology in Ankara, Turkey(Danandeh Mehr et al., 2020).An equation can be utilized to ascertain the probability function characteristic of the Gamma distribution; this methodology enables the calculation of probabilities associated with various outcomes within the distribution's context(Shiau, 2020).

**Table 1**. Categories of climatic moisture based on SPI and SPEI values

| Category | SPI/SPEI Value |
|---|---|
| Extremely Wet | ≥ 2.00 |
| Very Wet | 1.50 to 1.99 |
| Moderately Wet | 1.00 to 1.49 |
| Near Normal | -0.99 to 0.99 |
| Moderately Dry | -1.00 to -1.49 |
| Very Dry | -1.50 to -1.99 |
| Extremely Dry | ≤ -2.00 |

The evaluation of SPI (Standardized Precipitation Index) values to assess precipitation probabilities has been conducted through the use of the R programming language(Zhang & Li, 2020).The equation is utilized to calculate the likelihood function for the Gamma distribution's parameters(Gupta & Kundu, 1999). $g(x) = \frac{1}{\beta \propto \Gamma} x^{a-1} e^{-x/\beta}$ **(1)**

In this context, $\alpha$ denotes the shape parameter, $\beta$ signifies the scale parameter, and $x$ refers to the precipitation quantity. The Standardized Precipitation Index (SPI) adheres to the principles similar to those of the Z-score(Naresh Kumar et al., 2009).

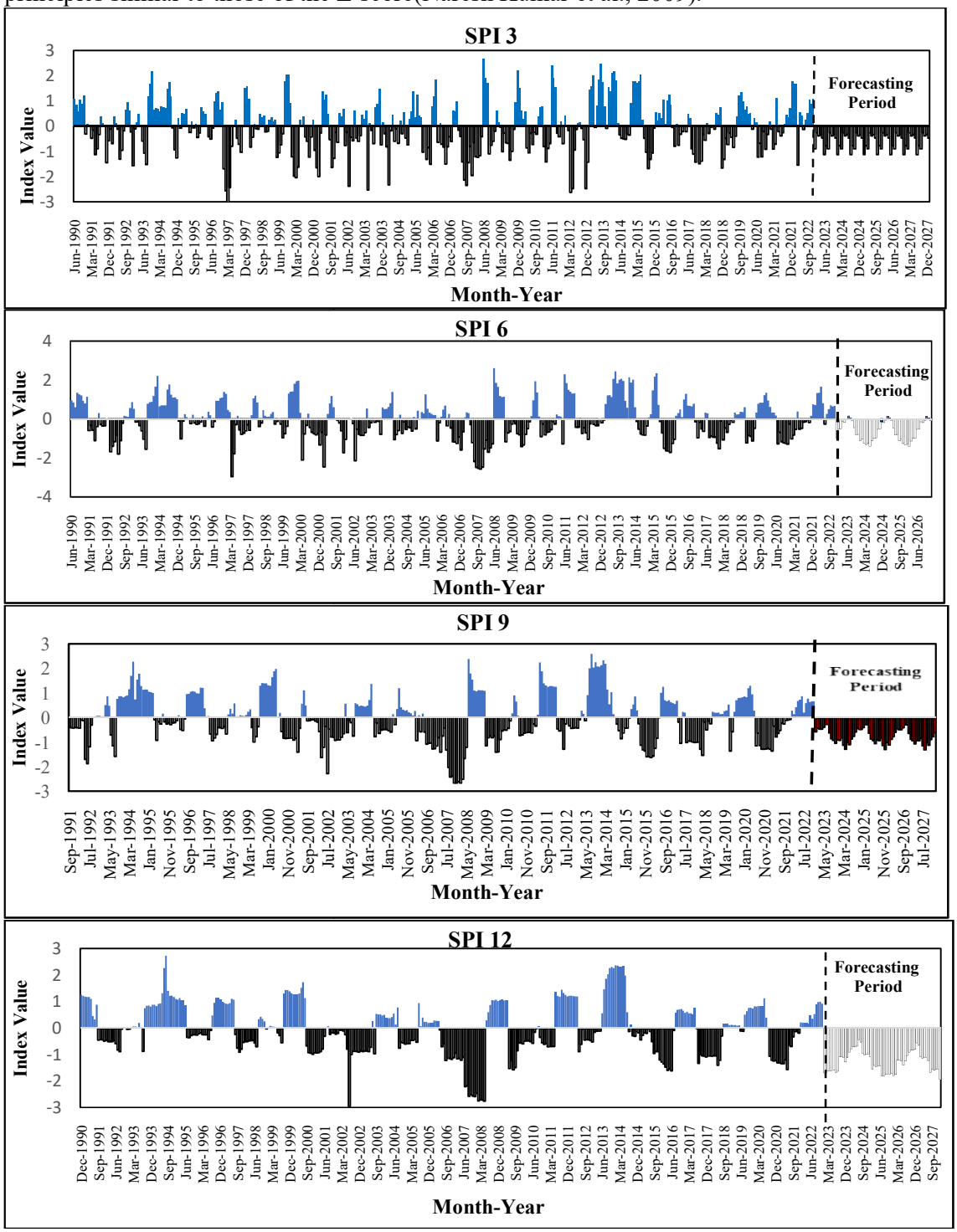


**Figure 2**Assessing drought severity using the Standardized Precipitation Index (SPI) from 1990 to 2022, including a projection period, involves analysing data over various intervals: 3month.6 month,9 month and 12 month

$$SPI = \frac{x - \mu}{\sigma} \textbf{(2)}$$

In this context, X denotes the measured precipitation., The mean level of precipitation is symbolized by $\mu$, The symbol $\sigma$ is used to represent the standard deviation of the precipitation data (Patel et al., 2007).

**2.4. StandardizedPrecipitation Evapotranspiration Index (SPEI)**

The calculation of SPEI is akin with SPI, but for SPEI, Initial step involves calculating the disparity between precipitation and potential evapotranspiration (PET)(Stagge et al., 2014). Vicente-Serrano et al propounded the Standardized Precipitation Evapotranspiration Index (SPEI) (Bera et al., 2021)SPEI is utilized to discern the aquaticequilibrium and assess the drought conditions across various time scales(Wable et al., 2019).Potential Evapotranspiration(PET) is estimated using the Penman-Monteith technique(Westerhoff, 2015). This technique integrates a range of climatic factors including temperature, rainfall, wind speed, solar radiation, and others (Vicente-Serrano et al., 2012).The log-logistic distribution is commonly employed for SPEI across different time scales, typically assessed using the Kolmogorov-Smirnov test(Vicente-Serrano et al., 2011).

$$D_i = P - PET \textbf{(3)}$$

here, P indicates the precipitation in a specific time series and PET means evapotranspiration rate on the same time. The distribution function in question adheres to the specified formula (Vicente-Serrano et al., 2011).

$$F(x) = \left[1 + \left(\frac{1}{x - y}\right)\right] \textbf{(4)}$$

The calculated value $F(x)$ is converted into a Z-score, a standardized value. Following this transformation, the Standardized Precipitation-Evapotranspiration Index (SPEI) can be determined using a specific formula. $SPEI = W - \frac{C_0 + C_w + C_2 W^2}{1 + d_1 w + d_2 w^2 + d_3 w^3}$ **(5)**

where, $C0$=2.5155, $C1$=0.8082, $C2$=0.0103, $d1$=1.4327, $d2$=0.1892 and $d3$=0.0013(Zhang & Li, 2020)

**2.5. Evaluation Using Mann-Kendall Test and Sen's Slope Value**

The Mann-Kendall trend statistic serves as a non-parametric analytical tool, proficient in detecting trends across dataset(Sharma et al., 2019). Being non-parametric, it eschews the necessity for data to conform to a normal distribution(Ghahramani, 2013). Predominantly employed for discerning significant upward or downward tendencies in meteorological variables, this statistical approach is endorsed by the World Meteorological Organization (WMO) for the examination of diverse hydro-meteorological parameters(Liu et al., 2020).In the Mann-Kendall statistical test, two primary hypotheses are contemplated: the null hypothesis and the alternative hypothesis(Totaro et al., 2020). This analysis employs the Mann-Kendall test on the resultant values of SPI & SPEI across various temporal scales. The execution of this procedure is facilitated through the R-Studio programming environment, with the trend determination process governed by the Mann-Kendall test formula(Table-2).

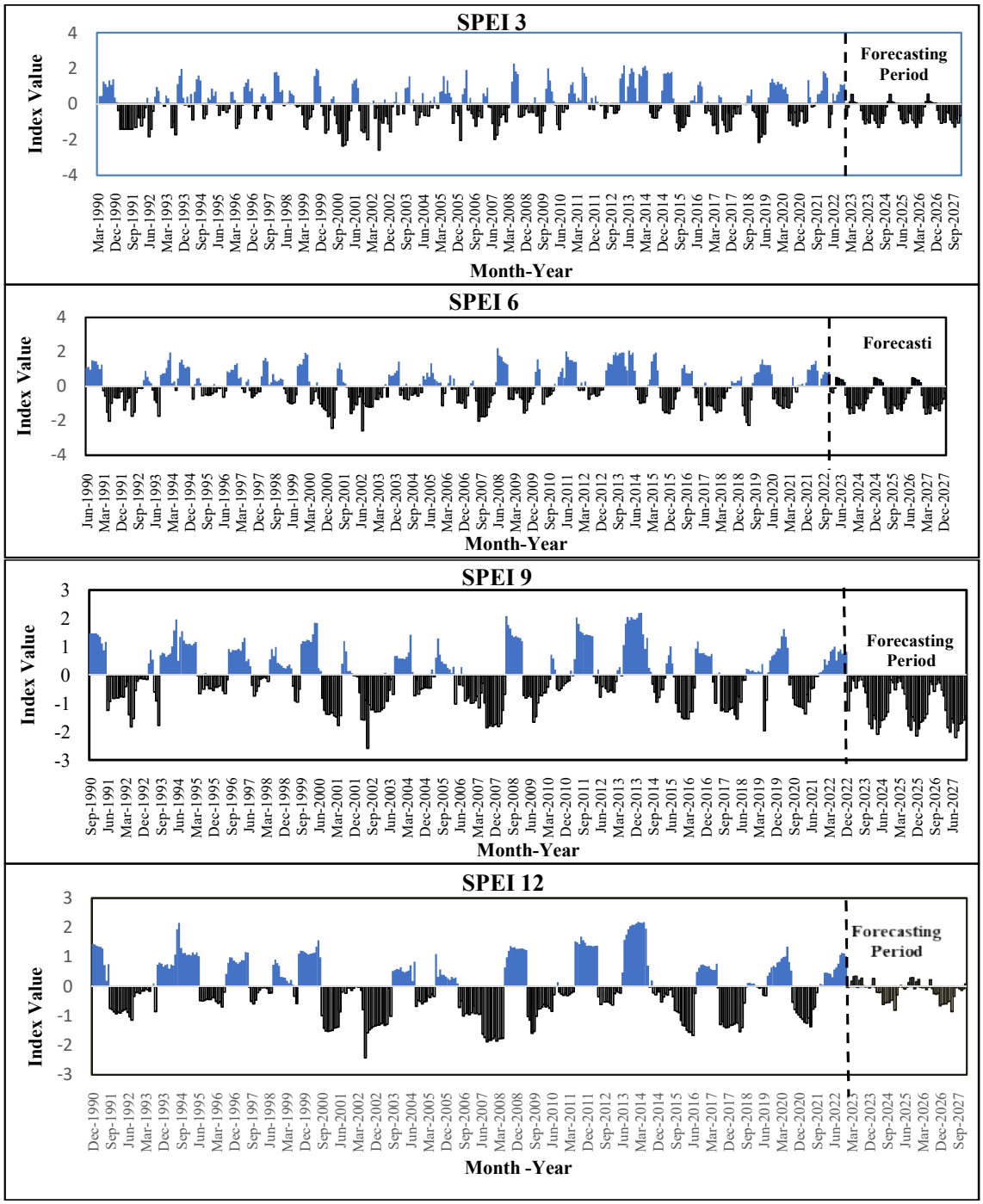


**Figure 3**. Assessing drought severity using the Standardized Precipitation Index (SPI) from 1990 to 2022, including a projection period, involves analysing data over various intervals: 3month.6 month,9 month and 12 month

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} \operatorname{sgn}(x_j - x_k) \quad \textbf{(6)}$$

In this context, S stands for the Mann-Kendall statistic, n denotes the sample size, and the term 'sign' refers to the signum function, which determines the sign of a given value(Frimpong et al., 2022).

.where, $sign\ (xj - xk) = 1\ if xj - xk > 0$ **(7)**

$= 0\ if xj - xk = 0$

$= -1\ if xj - xk < 0$

If n more than 10 then variance can be formulated by the below formula(Frimpong et al., 2022),

$$Var(S) = \frac{n(n-1)(2n+5)\sum_{i=1}^{m} t_1(i)(i-1)(2i+5)}{18} \quad \textbf{(8)}$$

Sen's slope estimator is employed to meticulously ascertain the quantum of the trend within the dataset (Sen, 1968).The Statistical tool Sen's slope measurement is utilized here to ascertain the extent of the resulting numbers from the drought indices, providing a measure of the trend's strength or rate of change within the data. (Table 2).It follows,

$$(Q_i) = \frac{x_j - x_k}{j-k} i = 1,2.....N \quad \textbf{(9)}$$

here, $x_j$ & $x_k$ also refers to the Quantitiesof the dataset

**2.6. Evaluation of Drought Patterns and Future Projections**

To analyse the drought dynamics in Lalitpur district, various statistical approaches, including the SPI & SPEI indices over different time spans, have been utilized. Drought severity has been categorized into four distinct levels: mild, moderate, severeand extreme, according to the SPI and SPEI values.Bera et al. (2021) employed the identical methodological approach in the Purulia district(Bera et al., 2021). The cumulative number of drought months within each category has been calculated to illustrate the representative drought conditions observed between 1990 and 2022.Forecasting delineates the anticipated values for a stochastic distribution. Projections for the forthcoming five years have been conducted using the exponential smoothing function, specifically the Holt-Winters exponential smoothing model, facilitating the calculation of drought months across various categories to derive effective drought management strategies. This study encompasses a five-year forecast to delineate short-term future drought trends accurately, thereby enabling timely interventions in the affected regions. The quintessential challenge in forecasting a stochastic variable lies in determining the probability density function of future values based on past observations. In this investigation, the exponential smoothing technique, particularly the Holt-Winters method, has been employed for precise prediction of SPI and SPEI at 3, 6, 9and 12-month intervals.

$$L_t = \alpha(Y_t - S_{t-m}) + (1-\alpha)(L_{t-1} + b_{t-1}) \quad \textbf{(10)}$$

**3. Result**

In this study, the outcomes have been categorized into distinct sections, including the evaluation of drought severity, the assessment of drought magnitude spanning from 1990 to 2022and the examination of drought forecasting trends. These divisions aim to facilitate appropriate management strategies for the near future.

**3.1 Drought Severity Assessment**

Drought intensity evaluation has been appraised via various statistical methodologies for measuring drought.

### 3.1.1Assessing Drought Through SPI Involves Using the Standardized Precipitation Index.

The Standardized Precipitation Index, SPI, is a method extensively used as the principal index for drought analysis over diverse time scales such as 3, 6, 9and 12 months(Bazrafshan et al., 2014) (Figure 2).In this method, drought is categorized into four division: mild, moderate, severeand extreme drought.Between the years 1990 and 2022, SPI3 identified a total of 141, 34, 13and 13 drought months as mild, moderate, severeand extreme drought, respectively. Similarly, SPI6 identified 145, 34, 13and 9 drought months; SPI9 identified 141, 38, 10and 9 drought months; and SPI12 identified 149, 35, 6and 12 drought months as mild, moderate, severeand extreme drought, respectively, within the same time scale.

### 3.1.1Assessing Drought Through SPEI Involves Using the Standardized Precipitation Evapotranspiration Index.

SPEI (Standardized Precipitation Evapotranspiration Index) is another statistical method utilized here across various time periods (3, 6, 9, 12 months). In this method, drought is categorized into four classes: mild, moderate, severeand extreme drought. Between 1990 and 2022, a total of 140, 42, 17and 6 drought months were identified by SPEI3; 147, 39, 16and 6 drought months by SPEI6; 138, 40, 21and 1 drought months by SPEI9; and 141, 43, 21and 1 drought months by SPEI12, respectively, falling into the categories of mild, moderate, severeand extreme drought(Figure 3).

### 3.2 Assessing Trend and Severity of Drought

The Mann-Kendall test has been utilized to discern the statistical tendency in Lalitpur spanning from 1990 to 2022. Analysis of SPI and SPEI indices revealed an increasing trend in dry months or dry spells across all time scales (3, 6, 9, 12 months), accompanied by a simultaneous rise in the intensity of dry season while wet periods are diminishing over Lalitpur. The Mann-Kendall test, employing Sen's slope estimator, likewise identified a hiking trend in dry months and drought situations across various periods for both SPI and SPEI, with a high level of statistical significance ($p<0.05$)Kamruzzaman et al. (2022) conducted a spatiotemporal drought analysis in Bangladesh employing the Standardized Precipitation Index (SPI) as well as the Standardized Precipitation Evapotranspiration Index (SPEI). Their investigation yielded consistent results across the region.(Kamruzzaman et al., 2022). It has been observed that SPI values across varioustemporal intervals (3, 6, 9 and12 months) display this increasing trend.The analysis shows a downward trend in SPI3, SPI6, SPI9, and SPI12 at a 5% significance level, with decreases of -0.00078, -0.00167, -0.0019, and -0.0026 /month, respectively (see Table 2). Similarly, SPEI also shows a declining trend over different time scales (3, 6, 9, and 12 months) at a high significance level, with a decrease of -0.00018/month

**Table 2**.The result combines the Mann-Kendall test for trend analysis with Sen's slope to quantify changes, especially in drought trends.

| Index | Class | Z | P Value | S | Vars | Kendall Tau | Sens Slope |
|---|---|---|---|---|---|---|---|
| SPI | SPI3 | -1.051 | 0.019 | -1.74 | 2.6857 | -4.158 | -0.00078 |
| | SPI6 | -1.8710 | 0.0682 | -3.121 | -2.6757 | -7.4855 | -0.00167 |
| | SPI9 | -2.3456 | 0.0188 | -4.297 | 2.69657 | -1.0222 | -0.0019 |
| | SPI12 | -3.2354 | 0.000395 | -5.83 | 2.6947 | -1.3995 | -0.0026 |
| SPEI | SPEI3 | -0.38687 | 0.0775 | -4.74 | 2.6257 | -1.1351 | -0.00018 |
| | SPEI6 | -0.9581 | 0.3808 | -1.43 | 2.6557 | -3.3991 | -0.00067 |
| | SPEI9 | -2.3224 | 0.03625 | -3.66 | 2.5957 | -8.8706 | -0.0018 |
| | SPEI12 | -4.3395 | 0.00093 | -5.584 | 2.6857 | -1.2177 | -0.00228 |

Source: Self Computed by Author

-0.0006/month, -0.0018/monthand -0.00228/month for SPEI3, SPEI6, SPEI9and SPEI12, respectively (Table 2).In 2021, Bera et al. discovered results in Purulia that aligned with previous findings.

**3.3 Prediction of Drought Occurrences:**

Prediction entails predicting future trends utilizing historical data of the same parameter. In this investigation, a future forecast of drought has been conducted to analyse forthcoming trends and facilitate appropriate management strategies. Forecasting from January 2023 to December 2027 has been accomplished through simulated SPI and SPEI data.A statistical functionnamed by Holt-Winter exponential smoothing, has been utilized for effective future forecasting. The smoothing constants.$\alpha$, $\beta and \gamma$adjust the level, trend and seasonal index over time. A total of five years of forecasting has been conducted from January 2023 to December 2027 utilizing SPI and SPEI indices across various time scales. Over the subsequent five years, SPI3 has projected 29 mild drought and 15moderate months. Additionally, SPI6 has anticipated 19, 21, 6 and 0 drought months, categorized as mild, moderate, severe and extreme drought, respectively. SPI9 has predicted 27, 10, 20 and 4 drought months, while SPI12 has forecasted 42, 0, 0 and 0 drought months for the same categories. Similarly, SPEI3 has forecasted around 53, 7, 0 and 0 drought months, SPEI6 has predicted 30, 13, 0 and 0 drought months, SPEI9 has anticipated 46, 14, 0 and 0 drought months and SPEI12 has shown 35, 14, 0and 0 drought months, categorized as mild, moderate, severe and extreme drought, respectively (Table 4) (Figure 2 and 3).

**Table 3**.Exploratory Review of Different Temporal Dimensions for SPI and SPEI

| Statistical Analysis | SPI3 | SPI6 | SPI9 | SPI12 | SPEI3 | SPEI6 | SPEI9 | SPEI12 |
|---|---|---|---|---|---|---|---|---|
| Mean | -0.0130 | 0.0132 | 0.0060 | 0.0140 | 0.0073 | 0.0073 | -0.0073 | -0.0073 |
| Median | 0.0342 | 0.0306 | 0.0714 | 0.0778 | -0.0266 | -0.0266 | -0.0266 | -0.0266 |
| Standard Error | 0.0507 | 0.0492 | 0.0498 | 0.0505 | 0.0501 | 0.0501 | 0.0501 | 0.0501 |
| SD | 1.0080 | 0.9790 | 0.9800 | 0.9939 | 0.9949 | 0.9949 | 0.9949 | 0.9949 |
| Variance | 1.0161 | 0.9584 | 0.9605 | 0.9878 | 0.9899 | 0.9899 | 0.9899 | 0.9899 |
| Skewness | -0.0538 | -0.0390 | 0.0358 | -0.0853 | -0.0757 | 0.0757 | -0.0757 | -0.0757 |
| Kurtosis | 0.1008 | 0.0112 | 0.0493 | 0.2436 | -0.5241 | -0.5241 | -0.5241 | -0.5241 |
| Maximum | 2.6800 | 2.6100 | 2.5932 | 2.7313 | 2.2591 | 2.2591 | 2.2591 | 2.2591 |
| Minimum | -3.1300 | -2.9680 | -2.6677 | -2.9609 | -2.5924 | -2.5924 | -2.5924 | -2.5924 |
| Range | 5.8100 | 5.5780 | 5.2608 | 5.6922 | 4.8514 | 4.8514 | 4.8514 | 4.8514 |

Source: Self Computed by Author from SPSS

**Table 4**Summary Statistics for Prediction Accuracy Across Various Time Scales of SPI and SPEI

| Statistics | SPI3 | SPI6 | SPI9 | SPI12 | SPEI3 | SPEI6 | SPEI9 | SPEI12 |
|---|---|---|---|---|---|---|---|---|
| Alpha | 0.90 | 0.25 | 0.90 | 0.50 | 0.25 | 0.75 | 0.75 | 1.00 |
| Beta | 0.0015 | 0. 0015 | 0.0012 | 0.0015 | 0.0011 | 0.0012 | 0.0011 | 0.0012 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Gamma | 0.10 | 0.25 | 0.10 | 0.00 | 0.25 | 0.25 | 0.25 | 0.25 |
| SMAPE | 1.04 | 1.08 | 0.78 | 0.62 | 1.10 | 0.87 | 0.89 | 0.50 |
| RMSE | 0.72 | 0.83 | 0.59 | 0.54 | 0.92 | 0.65 | 0.56 | 0.62 |
| MAE | 0.57 | 0.68 | 0.43 | 0.36 | 0.78 | 0.50 | 0.45 | 0.39 |
| MASE | 0.80 | 1.35 | 1.17 | 1.50 | 1.29 | 1.11 | 1.29 | 1.68 |

Source: Self computed by author from ARIMA model

**Table 5**.Descriptive Analysis of Various Time Scales of SPI and SPEI

| Date Type | Drought Classification | SPI 3 | SPI 6 | SPI 9 | SPI12 | SPEI 3 | SPEI 6 | SPEI 9 | SPEI 12 |
|---|---|---|---|---|---|---|---|---|---|
| Drought Indices | Mild drought | 141 | 145 | 141 | 149 | 140 | 147 | 138 | 141 |
| | Moderate drought | 34 | 34 | 38 | 35 | 42 | 39 | 40 | 43 |
| | Severe drought | 13 | 13 | 10 | 6 | 17 | 16 | 21 | 21 |
| | Extreme drought | 13 | 9 | 9 | 12 | 6 | 6 | 1 | 1 |
| Forecasting | Mild drought | 29 | 19 | 27 | 42 | 53 | 30 | 46 | 35 |
| | Moderate drought | 15 | 21 | 10 | - | 7 | 13 | 14 | 14 |
| | Severe drought | - | 6 | 20 | - | - | - | - | - |
| | Extreme drought | - | - | 4 | - | - | - | - | - |

Source: Self calculated by author from time series analysis

$$b_t = \beta(L_t - L_{t-1}) + (1-\beta)b_{t-1} \textbf{(11)}$$

$$s_t = \gamma(Y_t - L_t) + (1-\gamma)S_{t-m} \textbf{(12)}$$

### 3.4 Study Assessing the Relationship Between SPI and SPEI

Pearson's correlation is utilized herein to classify the level of correlation among the Standardized Precipitation Index (SPI) and Standardized Precipitation Evapotranspiration Index (SPEI) across various temporal scales(Figure 4).It has been demonstrated that SPI12 and SPEI12 exhibit the strongest positive association (0.96), succeeded by time scales of 9, 6 and 3 months.SPI and SPEI demonstrate a pronounced positive correlation, as evidenced by the mounting trending outline observed in the correlation matrix across various temporal scales.The SPI exclusively utilizes past rainfall records as its input parameter(Bazrafshan et al., 2014). Consequently, SPEI exhibits strong predictive potential due to its inclusion of both precipitation and evapotranspiration data, providing an additional input compared to SPI(Zhang et al., 2009).Incorporating potential evapotranspiration enhances the reliability of establishing any drought index(Joetzjer et al., 2013).Various descriptive statistical analyses and a range of indices, spanning varied time periods, have been measured. Which is summarised in Table 3.The efficacy of future prediction across different time periods has been evaluated, revealing that SPEI12 demonstrates high accuracy in upcomingforecastgrounded on Root Mean Square Error (RMSE) andMean Absolute Error(MAE)values, with SPI6and SPEI6 following outfit(Table 4).

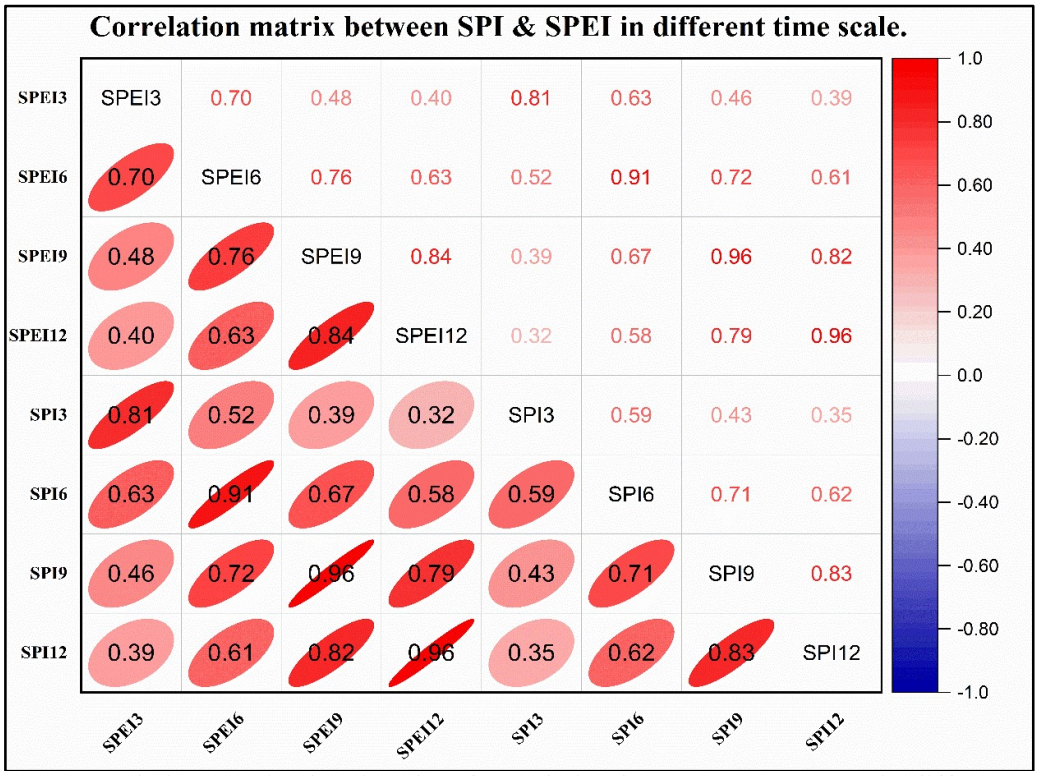


**Figure 4.** Correlation matrix showing the of correlation between SPI & SPEI in different time scale

Numerous past researchers have assessed the impact of extreme events on agriculture or food production(Z. Liu et al., 2016).Drought spells or events can significantly diminish crop production by exerting adverse effects on physiology, productivity, phenology, growth and other crucial aspects(Anjum et al., 2017). In Europe, the impact of drought on agricultural productivity and economic losses has emerged as a major concern, with an average annual loss of 6.2 billion euros over the past decade(Vicente-Serrano et al., 2012).In India, particularly in the year 2000, the most severely affected drought-prone states were Bundelkhand region, Rajasthan, Gujarat, Odisha, Andhra Pradesh and Maharashtra(Samra, 2004). These states collectively incurred a total loss of 588 million USD. Furthermore, in 2002, the overall economic loss due to drought reached 910.72 million USD(Bahinipati, 2020).

**4.Discussion**

The ongoing research revolves around estimating the drought situation utilizing SPI and SPEI indices, incorporating diverse statistical methodologies. Additionally, future predictions for the next five years, specifically focusing on the drought-prone Lalitpur district of Uttar Pradesh, are being analysed (Table 5).The SPI analysis is conducted based on rainfall collected data, while the SPEI assessment relies on both potential evapotranspiration andprecipitation data. Tirivarombo et al. (2018) carried out a study utilizing this data for the purposes of drought monitoring and analysis, focusing on the Standardised Precipitation Evapotranspiration Index (SPEI) and the Standardised Precipitation Index (SPI)(Tirivarombo et al., 2018).The evaluation of these two indices have been calculated. Typically, the Lalitpur district under the Bundelkhand region experiences the highest rainfall during the monsoonal months, such as June, July and August(Ahmed et al., 2019; Aslam & Parveen, 2024; Donthu et al., 2021; Srivastava, 2019).However, it is important to note that rainfall distribution is not uniform across all seasons and years, indicating variability in precipitation patterns that can

impact drought assessments and water resource management strategies(Mpelasoka et al., 2008).Drought is not an unforeseen environmental occurrence; rather, it is a recurrent phenomenon or hydrological extreme(Van Loon, 2015). Predicting the occurrence, intensity and magnitude of drought is of utmost importance for devising appropriate mitigation strategies(Panu & Sharma, 2002). Analysing trends and forecasting drought in dry regions serves as a critical tool for effective planning of water resource management(Rad et al., 2017).The trend of drought occurrence has been effectively estimated here, providing a clear illustration of the severity and intensity of drought across the region. Determining the degree of drought using various drought indices is another crucial aspect of climate extreme studies(Mukherjee et al., 2018). Different levels or degrees of drought indicate impacts on crop growth, fire risk, water deficit levels and more(Zargar et al., 2011). This study primarily emphasizes the characteristics of drought, its severity, trend magnitude and forecasting. The research suggests that the region will experience moderate to extreme hydrological drought conditions in the near future.Various statistical methods for drought determination indicate that the region has encountered a range of mild to extreme drought situationsover the period from 1990 to 2022.A noticeable extreme drought event occurred over the span from July 2007 and persisted until May 2008.Simultaneously, the Standardized Precipitation Evapotranspiration Index (SPEI) has also recognized the Identical period as experiencing extreme and severe drought conditions. Severe drought conditions were observed in various months across different years, including 1993, 1997, 2000, 2001, 2006, 2007, 2009, 2015, 2016, 2018, 2021 and 2022.Extreme drought conditions have been meticulously documented across various time periods and months according to different SPI indices. Notably, SPI3 highlighted severe drought episodes spanning from February to April and December 1997, March 2000, March 2001, July 2002, May 2003, April 2004, August and September 2007, along with April, May and December 2012. Moreover, SPI6 identified additional extreme drought months such as April 1997, April 2000, March 2001, July 2002 and the prolonged drought period from August to December 2007. Similarly, SPI9 revealed intense drought occurrences from March to September 1990, March and September 1991, as well as January 1994. Furthermore, SPI12 highlighted July 2002, the extended drought period from June to December 2007 and February to May 2008 as significant periods of extreme drought. Crystalline rocks, predominantly comprising granite, gneisses, schists, quartz reefs and mafic rocks, constitute approximately 80% of the district's land area(Dinkar et al., 2019; Meert & Pandit, 2015), whereas sedimentary rocks, primarily consisting of sandstone, shales and carbonate rocks, occupy 18%. The remaining 2% of the area is characterized by unconsolidated alluvial valley fills formations(Dinkar et al., 2019). In crystalline rocks, the presence of groundwater is predominantly influenced by topographical conditions and the degree of weathering(Lachassagne et al., 2021). The movement of groundwater is contingent upon the interconnectedness of fracture zones and similar factors(Waters et al., 1990). Topographically elevated features such as inselbergs, buttes and kopjes typically exhibit limited groundwater occurrence, whereas pediments and low-lying areas (pediplains) offer promising prospects for groundwater presence(Etuk et al., 2023). In these crystalline rocks, groundwater is found either within the sub-aerial weathered mantle or along joints, fractures and other zones of weakness under conditions where the water table is established(Anand & De Broekert, 2005). In the southern peripheral region of the district, sedimentary rocks are prominently present, primarily composed of sandstone and shale formations(Saraf & Jain, 1996). Groundwater within this sandstone-shale sequence predominantly occupies the fine interstices of weathered zones and aligns along joint planes and bedding planes within unaltered rock structures(Saraf & Jain, 1996). Within carbonate rocks, groundwater is typically found either within the weathered mantle or within cavities and caverns formed because of karstification processes(Ford & Williams, 2007). The accessibility of groundwater

is contingent upon the abundance of such cavities and other saturated weak planes within these rock formations(Klimchouk, 2017). In Lalitpur district, the Central Ground Water Board (CGWB) has constructed 15 exploratory wells ranging in depth from 15.71 to 33.90 meters below ground level (mbgl), with discharge rates ranging from 26 to 408 Liters per minute (lpm)(Book, 2019; Saha & Ray, 2019) Additionally, CGWB has also erected 8 exploratory wells during the 2001-02 period as part of the Accelerated Exploration of Groundwater Resources Program (AECP)(Pant et al., 2021). The discharge rates from these wells vary from negligible amounts to 500 litters per minute(Book, 2019). According to the depth to water level data collected from 14 groundwater monitoring stations in 2007, the pre-monsoon water levels range from 0.77 meters below ground level (mbgl) in Talbehat to 11.85 mbgl in Madawara(Mishra, 2014). In the post-monsoon period, the depth to water level varies from 0.70 to 10.38 mbgl(Sinha, 2021). The fluctuation in water levels ranges from 0.07 meters in Talbehat to 2.60 meters in Lalitpur(Tripathi et al.). Shallow water levels are observed in areas under canal commands, while deeper water levels are noticed mainly in the southeastern part of the district, particularly in the Madawara block(Saraf & Jain, 1996). Shallow water levels (ranging from 0.00 to 3.00 mbgl) occur sporadically in the form of small pockets along surface water bodies in the Talbehat areas(Tripathi et al.). Over the ten-year period from 1997 to 2006, the long-term water level trend observed in 14 groundwater monitoring wells indicates that only three stations demonstrate a rising trend, while the remaining 11 exhibit a declining trend(Hasim, 2020). Among these, the wells at Amjhaza Ghati, Bansi and Jakhlaun are showing a rising trend at rates ranging from 0.0499 to 0.1524 meters per year(Tripathi et al., 2021). Conversely, the declining trend in the eleven other wells varies from 0.0169 meters per year in Lalitpur to 0.4659 meters per year in Madaura(Book, 2019). According to the report on dynamic groundwater resources of Uttar Pradesh as of March 31, 2004, the annual groundwater revitalize in the district is predictable to be 67,813.67 hectares per annum (ham). The net yearly groundwater availability is calculated at 62,274.29 ham. The existing gross groundwater draft for all uses is 32,195.90 ham(Sinha et al., 2016). For future irrigation development, the net groundwater availability is projected to be 28,824.87 ham. The stage of groundwater development is currently at 51.70%.Based on these estimates, it is determined that four blocks are categorized as safe in terms of groundwater availability, while the remaining two blocks, Bar and Talbehat, are classified as semi-critical(Mishra, 2014). Groundwater in shallow aquifers within the area is characterized as colorless and odorless, with a specific electrical conductance ranging from 570 to 960 µs/cm at 25°C.). In all blocks of the district, groundwater development is facilitated through various means, including dug wells, borewells and state tubewells. These resources play a crucial role in providing access to water for domestic and agricultural purposes across the region. With a substantial number of 25,838 dug wells dispersed throughout the district, ranging in depth from 5.50 meters below ground level to deeper depths and yielding between 50 to 200 litters per minute, local communities benefit from reliable sources of groundwater. Additionally, the presence of 3,593 Rahat structures, with depths varying from 10 to 25 meters below ground level and yields ranging from 100 to 200 litters per minute, further enhances water accessibility. Complementing these traditional methods, the installation of a single state tubewell, boasting a yield of 400 litters per minute, contributes significantly to groundwater availability (Groundwater Brochure of Lalitpur District, U.P." 2008-2009 by Gautam, J.P).The Government of India has developed integrated drought management policies, drawing from international drought management strategies(Samra, 2004). These policies are built on three fundamental pillars: monitoring and early warning systems, susceptibility and influence assessment and mitigation and response(Kumar et al., 2021). This comprehensive

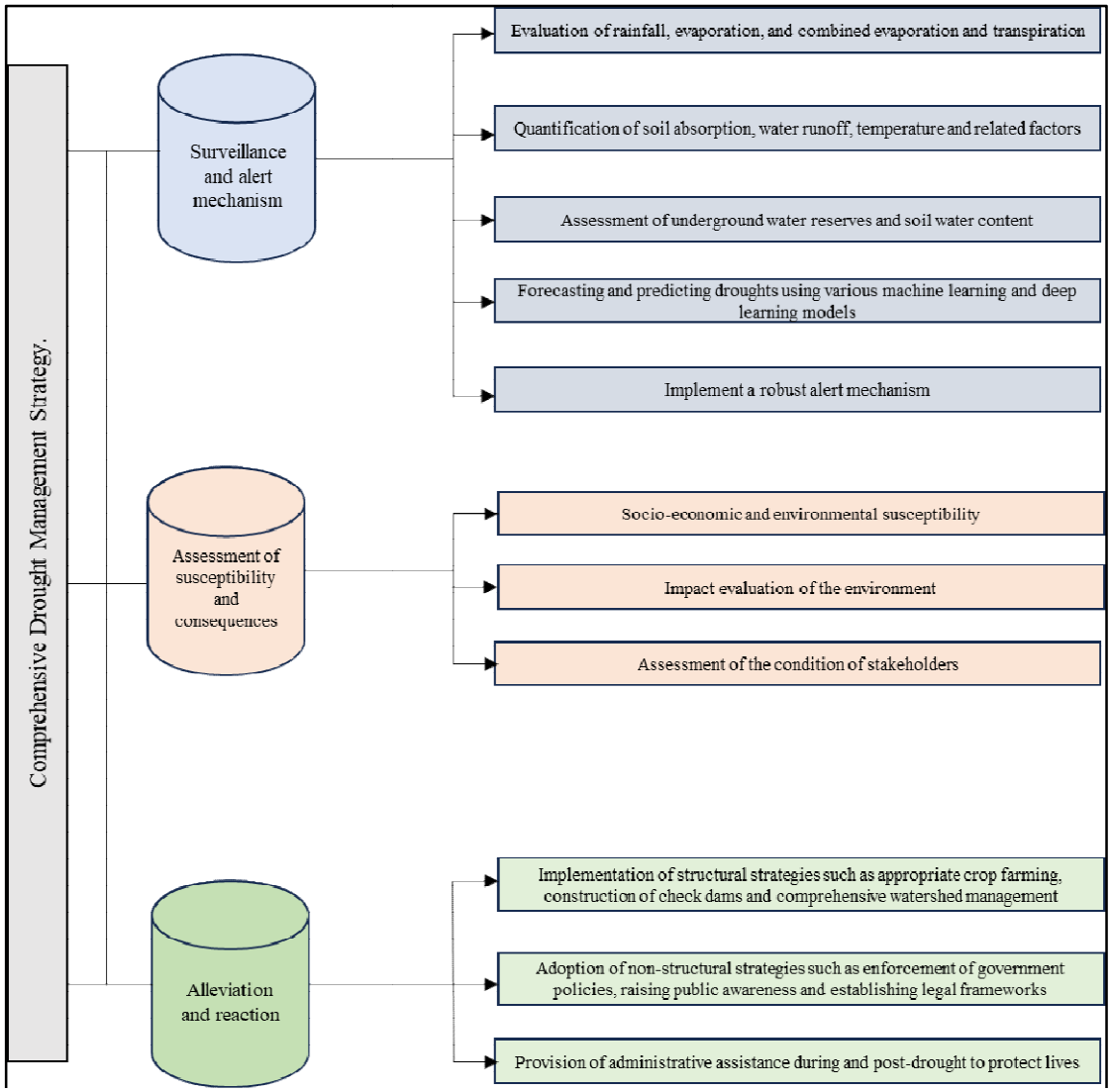


**Figure 5**.Flow chart that outlines the key components of integrated drought management programs.

**Source**: Computed by Author

approach aims to address the challenges posed by hazardous environmental conditions promptly and effectively. By implementing this integrated approach, the government seeks to enhance preparedness and resilience in combating drought-related issues. Monitoring and early warning systems play a crucial role in providing timely information to anticipate and respond to drought events. Vulnerability and impact assessments help identify at-risk areas and populations, enabling targeted interventions and resource allocation(Downing et al., 2005). Additionally, mitigation and response measures are essential for minimizing the adverse effects of drought and supporting affected communities. It is imperative that these integrated drought management policies be implemented promptly to safeguard against the detrimental impacts of drought and ensure the well-being of the populace and the environment (Figure 5).

## 5. Conclusion

Using statistical methods, it has been determined that the wholedistrict is prone to drought and has experienced several significant drought events through its past. Drought assessmentandmonitoring are crucial initial steps for ensuring sustainable water resource

management, especially in the study area. By systematically monitoring and assessing drought conditions, stakeholders can better understand the dynamics of drought occurrences, identify vulnerable areas and implement targeted measures to mitigate the impacts of drought on water resources and the community. This proactive approach is essential for promoting resilience and ensuring the long-term sustainability of water resources in the region.The systematic study above reveals that several principal factors contribute to drought events in the region.Moderate precipitation levels, very high rates of evaporation and evapotranspiration, as well as significant runoff and rapid land use modifications, are identified as regulating factors influencing drought occurrences. These findings underscore the complex interplay of geological, climatic and anthropogenic factors in shaping drought events in the area.Monitoring various drought indicators such as evaporation, Rainfall, temperature, soil moisture, permeation, runoff, vegetation cover and groundwater storage is critical on both aannually and long-term basis. Modern research into drought prediction and foretelling should leverage machine learning as well as deep learning models to improve accuracy and timeliness. Additionally, village-wise drought vulnerability assessments are essential, particularly for those residing in drought-prone areas. These assessments can help identify vulnerable populations and inform targeted interventions to enhance resilience and reduce the impacts of drought on communities.Ground-level studies and data are crucial for the survival of marginal peasant and local peoples. Conducting methodicalecological impact assessments can provide an accurate understanding of drought intensity and the socioeconomic status of stakeholders. Local administrators should take proactive measures such as providing high-temperature-tolerant plants and seeds and encouraging farmers to cultivate these crops. By promoting resilient agricultural practices and providing necessary support, authorities can help mitigate the adverse effects of drought on vulnerable communities and enhance their resilience to future drought events.Similarly, integrated watershed management practices should be implemented in semi-arid regions to effectively manage water resources and mitigate the impacts of drought. Non-structural measures such as administration policies, public consciousness campaigns and legal frameworks should be efficientlyimplemented in various area of drought-prone regions to enhance resilience and preparedness. Additionally, there is a need for more research and development efforts at the regional or local scale to better understand and address the challenges posed by severe environmental calamities like drought. By taking a comprehensive approach that combines watershed management, non-structural measures and ongoing research, stakeholders can work towards building more resilient communities and ecosystems in drought-prone areas.

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# MICROWAVE-ASSISTED GREEN SYNTHESIS OF TETRAHYDROBENZO [B] PYRANS VIA ONE-POT MULTI-COMPONENT REACTIONS UNDER CATALYST AND SOLVENT-FREE CONDITIONS

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The development of an environmentally friendly protocol for synthesizing tetrahydrobenzo[b]pyrans is currently a priority, given their significance as versatile intermediates. In this regard, employing Microwave (MW) irradiation without catalysts or solvents can serve as an eco-friendly and efficient method. We have successfully demonstrated the production of tetrahydrobenzo[b]pyran derivatives via multi-component reactions of aldehydes, dimedone and malononitrile using MW irradiation under catalyst-free and solvent-free conditions. The resulting products were purified through recrystallization in ethanol. The synthesis of tetrahydrobenzo[b]pyran derivatives was achieved with high isolated yields (70-80%) in short reaction times, as confirmed by melting point determination and $^{1}H$ NMR spectroscopic analysis. This transformation likely involves sequential Knoevenagel condensation, Michael addition, and intramolecular cyclization steps. The MW irradiation-based protocol for synthesizing tetrahydrobenzo[b]pyran derivatives offers several advantages: operational simplicity, absence of catalysts, solvents, bases, and additives, compatibility with various functional groups, straightforward purification, rapid reaction times, and cost-effectiveness. Additionally, it provides high isolated yields in short reaction times without generating byproducts.
**Keywords:** MW-Assisted, Solvent-Free, Catalyst-Free, MCRs, Benzo[b]pyranes.

## 1. INTRODUCTION

In recent years, there has been a growing demand for environmentally friendly synthetic methods in organic chemistry (Ramon, 2005; Simon, 2012; Gawande, 2012; Gu, 2012). Multicomponent reactions (MCRs) have emerged as powerful tools for creating biologically significant structures within the framework of green chemistry (Anastas, 1998; Poliakoff 2001; DeSimone 2002; Gross 2002). One-pot MCRs have gained significant attention due to their efficiency, ease of implementation, and typically high product yields (Zhu, 2005; Domling, 2006; Weber, 1999; Armstrong, 1926). The concepts of environmental factor (E-factor) and atom economy have gradually been incorporated into traditional organic synthesis across both industrial and academic spheres. Solvents are the primary contributors to poor E-factors, particularly in the production of fine chemicals and pharmaceuticals (Sheldon, 2008; Sheldon, 2012). Consequently, developing catalyst- and solvent-free MCRs has become crucial in both academia and industry, as these processes are rendered environmentally friendly by minimizing waste, time, labor, and expenses (Je˘selnik, 2001; Singh, 2012; Tanaka, 2000; Cave, 2001; Chakraborti, 2007; Chankeshwara, 2006). Recently, microwave (MW)-assisted chemistry has become a valuable technique for various applications in organic synthesis and transformations (Roberts, 2005; Kappe, 2004; Dallinger, 2007; Yadav, 2008). MW-promoted MCRs have attracted researchers' interest due to their unique or unexpected reactivities and their significant contributions to green chemistry (Gawande, 2013; Polshettiwar, 2008).

4H-Benzo[b]pyrans are prevalent in many biologically active molecules and have demonstrated a wide range of pharmacological activities and biological properties, including spasmolytic, diuretic, anticoagulant, anticancer, and anti-anaphylactic effects (Andreani, 1960; Bonsignore, 1993). Over the past decade, numerous methods have been developed for synthesizing 4H-benzo[b]pyrans [9-19]. These methods have employed various toxic nitrogen-containing bases (Zheng, 2011; Khoobi, 2012; Dekamin, 2013), hazardous and volatile organic solvents (Wang, 2003; Heravi, 2009), and different types of metal catalysts, particularly ionic liuid (Kumar, 2007) biocatalysts (Pradhan, 2012), MgO (Heravi, 2009), $SiO_2$ NPs (Banerjee, 2011), ZnO NPs (Bhattacharyya, 2012; Banerjee, 2013), and mesoporous materials (Mondal, 2012). More recently, $Fe_3O_4$ NPs (Fallah-Shojaei, 2014), $Co_3O_4$ (2022), and $ZnFe_2O_4$ (Das, 2014), have been used to synthesize these compounds. Although effective and reliable, most of these methodologies do not align well with green chemistry principles due to their use of large amounts of volatile solvents, toxic and hard-to-obtain catalysts, extended reaction times, and lower yields. To address these limitations, there is a need for a straightforward, efficient, and cost-effective "green protocol" for synthesizing 4H-benzo[b]pyran derivatives under environmentally benign conditions.

In continuation of our research, we have reported few MW-assisted reactions in various chemical transformations for the synthesis of useful organic Scaffolds (Patel, 2024; Kumari, 2024, Patel, 2021; Patel, 2019). In this research paper we have report microwave-assisted synthesis of tetrahydrobenzo[b]pyrans through one-pot multi-component reactions under catalyst and solvent-free conditions.

## 2. MATERIAL AND METHODS

Chemicals and solvents were obtained from Sd-Fine, Sigma Aldrich, and HIMEDIA (India) and utilized without additional purification throughout the experiments. All glassware was dried in an oven before use. Reactions were conducted using a scientific microwave reactor (Cem Discover Model No. 908010). A digital auto melting point apparatus (Decibel Model DB 1672) was employed to determine melting points. $^1$H NMR spectra were recorded on a Bruker 400 MHz instrument using $CDCl_3$ as the solvent.

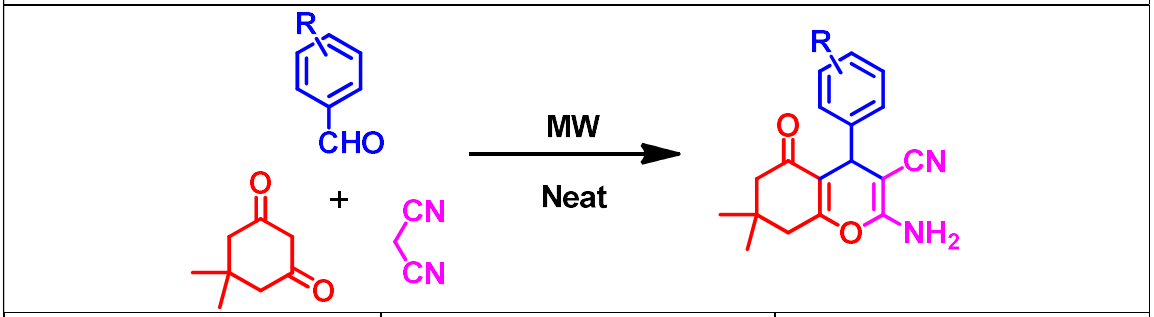
## 3. GENERAL EXPERIMENTAL PROCEDURE

Equal molar amounts of dimedone (1 mmol), aldehyde (1 mmol), and malononitrile (1 mmol) were combined in a microwave vessel. The mixture was subjected to microwave irradiation at 80 $^oC$ (60 Watts) for 5 min. to complete the reaction. Subsequently, the reaction mixture was rinsed with ethanol (10 mL), yielding a solid crude product. This was then recrystallized from EtOH to obtain the analytically pure product.

## 4. RESULT AND DISCUSSION

We began by conducting a one-pot condensation reaction using benzaldehyde (1 mmol), malonitrile (1 mmol), and dimedone (1 mmol) under microwave irradiation. This process, involving benzaldehyde, malonitrile, and dimedone (1 mmol each), yielded the desired product with 80% efficiency in just 5 minutes at room temperature. The results are presented in Table 1. Aromatic aldehydes with both electron-donating groups (such as -Me and -Cl) and electron-withdrawing groups (like $–NO_2$) participated in the condensation reactions, with no notable electronic effects observed. Following the reaction, products were solidified, dissolved in heated ethanol, recrystallized, and thoroughly dried in an oven. Initial product verification was conducted through melting point analysis (Table 1), with further characterization by $^1$H NMR spectroscopy. All synthesized tetrahydrobenzo[b]pyran derivatives are are previously reported compounds, with observed melting points closely matching literature values. The corresponding references for these compounds are provided in Table 1. Representative $^1$H NMR spectra of some of the compounds are included.

**Table 1.** Substrate scope for the synthesis of tetrahydrobenzo[b]pyrans[a].

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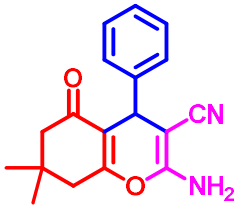
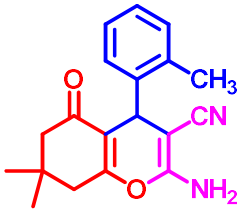
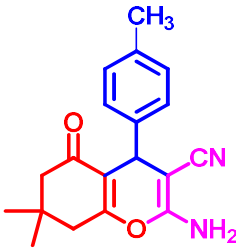
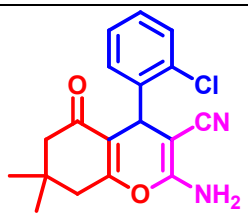
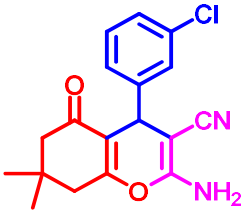
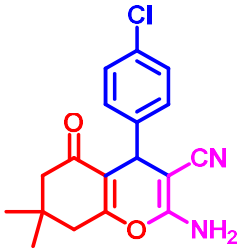
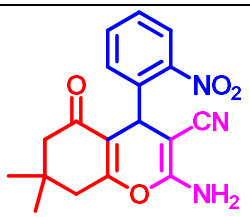
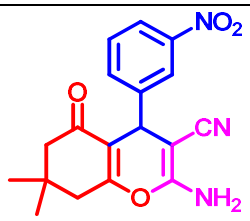
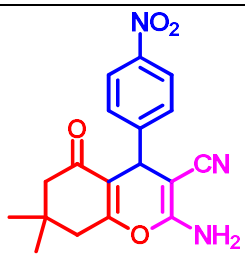
|---|---|---|
|  Yield: 80%, MP: 228-230 °C Rep. MP: 231 °C [Ref. 21] |  76%, MP: 213-215 °C Rep. MP: 216 °C [Ref. 23] |  76%, MP: 208-210 °C Rep. MP: 211 °C [Ref. 21] |

| | | |
|---|---|---|
|  72%, MP: 210-215 °C Rep. MP: 216 °C [Ref. 21] |  74%, MP: 228-230 °C Rep. MP: 233 °C[Ref. 22] |  75%, MP: 205-207 °C Rep. MP: 208 °C [Ref. 21] |
|  70%, MP: 178-180 °C Rep. MP: 182 °C [Ref. 21] |  70%, MP: 205-207 °C Rep. MP: 209 °C [Ref. 21] |  72%, MP: 174-177 °C Rep. MP: 178 °C [Ref. 22] |
| [a]**Reaction conditions:** 1.0 mmol of aromatic aldehyde, 1.0 mmol of dimedone, and 1.0 mmol of malononitrile under microwave irradiation (60 Watts) at 80 °C for 5 min. | | |

## 5. Conclusions

In conclusion, we have demonstrated a microwave-assisted, one-pot multicomponent synthesis of tetrahydrobenzo[b]pyran derivatives under environmentally friendly conditions. This approach yielded high-quality tetrahydrobenzo[b]pyran products (70–80%) in a brief reaction period using microwave irradiation. Notably, the electronic effect had minimal impact on this synthetic method.

**Conflict of interest:** We have no conflict of interest to declare.

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**NMR Spectra**

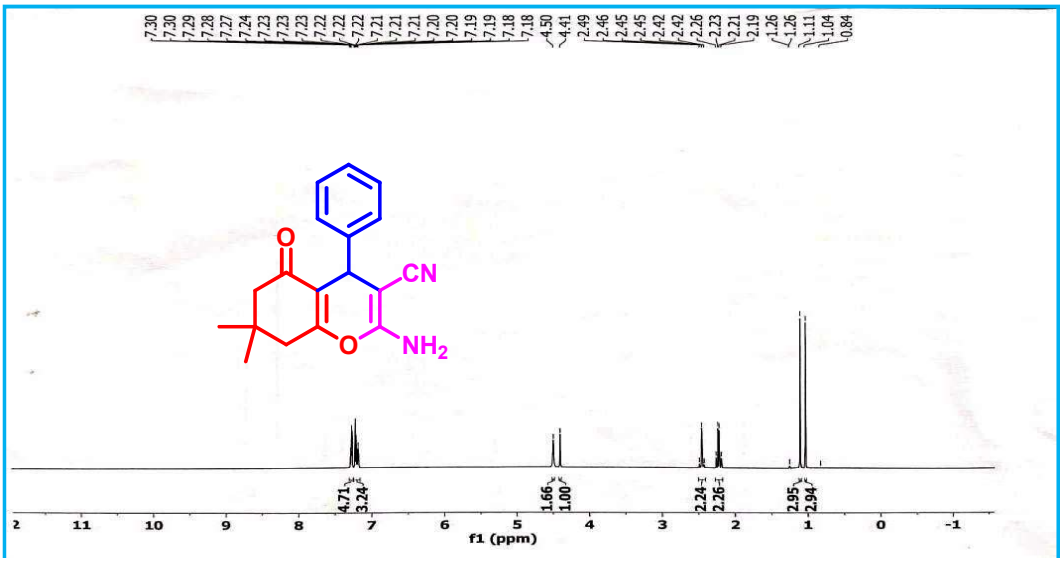

**Figure 1:** 1H NMR spectra of 2-Amino-3-cyano-4-(phenyl)-7,7-dimethyl-5-oxo-4H-5,6,7,8-tetrahydrobenzo[b]pyran

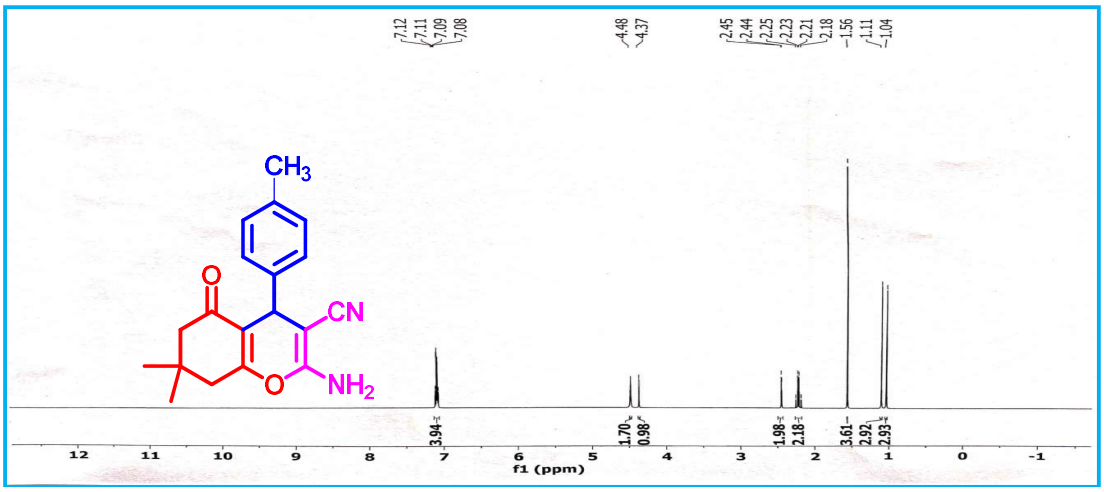


**Figure 2:** 1H NMR spectra of 2-Amino-3-cyano-4-(4-methylphenyl)-7,7-dimethyl-5-oxo-4H-5,6,7,8-tetrahydrobenzo[b]pyran

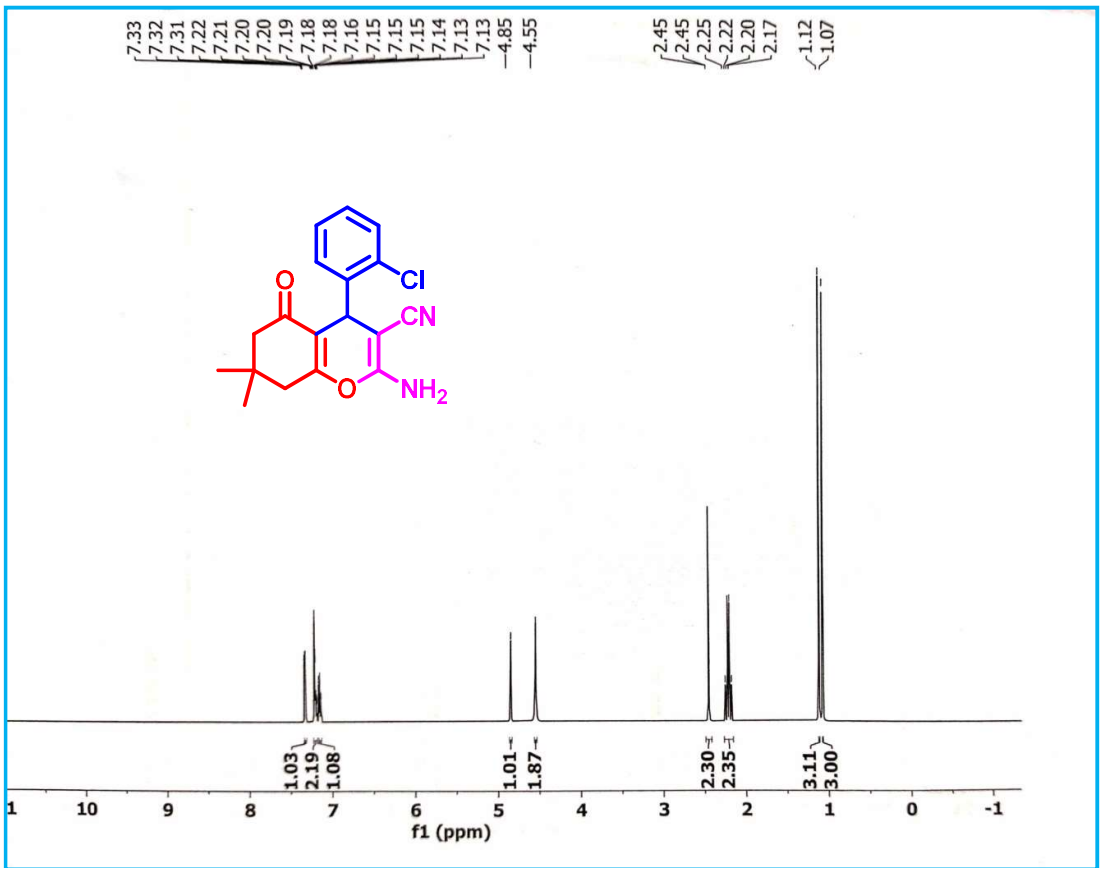


**Figure 3:** 1H NMR spectra of 2-Amino-3-cyano-4-(2-chlorophenyl)-7,7-dimethyl-5-oxo-4H-5,6,7,8-tetrahydrobenzo[b]pyran

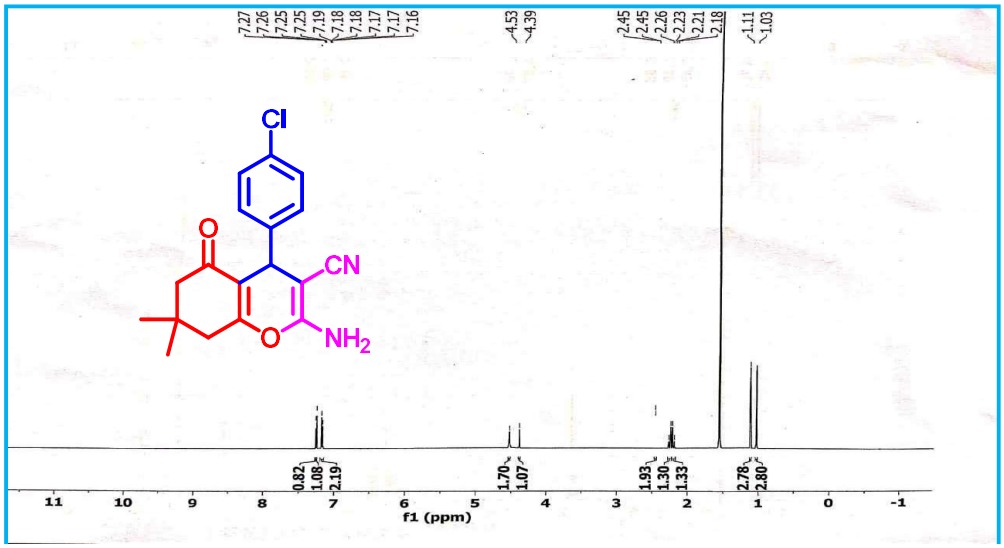


**Figure 4:** 1H NMR spectra of 2-Amino-3-cyano-4-(4-chlorophenyl)-7,7-dimethyl-5-oxo-4H-5,6,7,8-tetrahydrobenzo[b]pyran

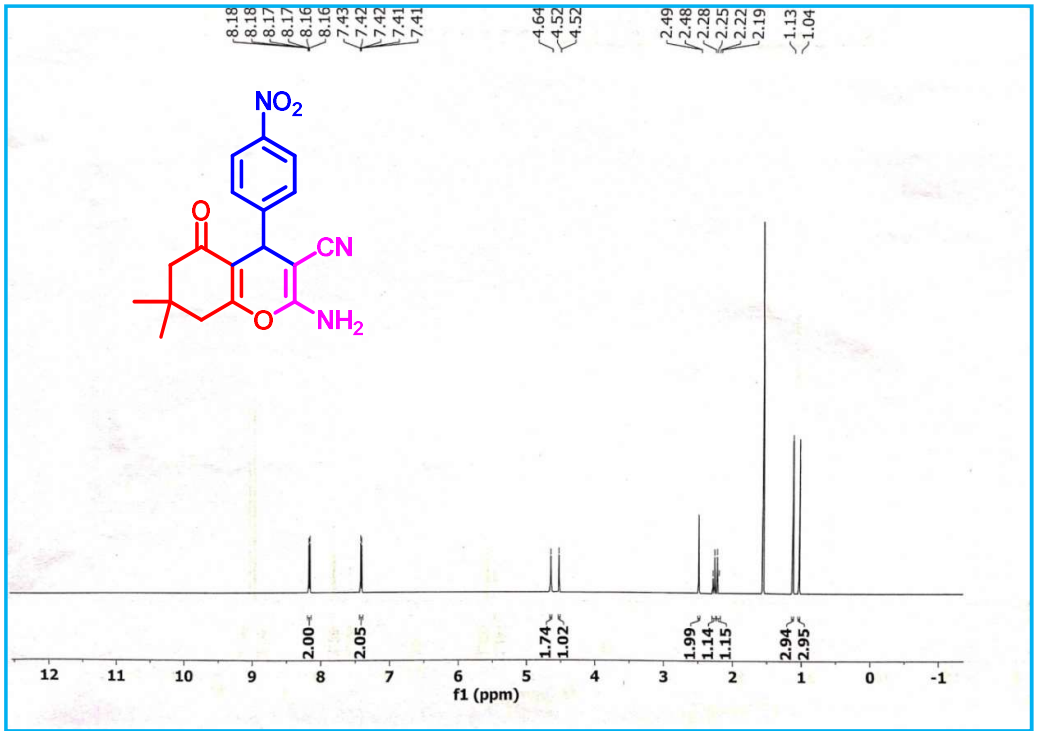


**Figure 5:** 1H NMR spectra of 2-Amino-3-cyano-4-(4-nitrophenyl)-7,7-dimethyl-5-oxo-4H-5,6,7,8-tetrahydrobenzo[b]pyran

# VALIDATION OF DFT RESULTS BY EXPERIMENTAL DATA: OPTICAL PROPERTIES OF CDSE THIN FILMS

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Optical properties CdSe (cadmium selenide) semiconductor on cubic structure determined by the Density Function Theory (DFT) and Chemical Bath Deposition (CBD) method. using The absorption coefficient, optical conductivity, optical constant, analyzed by optical data using siesta and optical absorbance spectra were captured byCBD, the experimental band gap of CdSe is 1.74 eV our experimental finding shown 1.94 eV is larger while theoretical data reported 1.29 eV is smaller then both experimental results, because of GGA underestimate band gap. Structural image is also compared in the report Avogadro and GDIS plotted primitive cell image and FE-SEM image shows soft boll type crystal structure of CdSe thin films.
**Keywords:** DFT, Band Gap, Siesta, CBD, FE-SEM**.**

## 1. INTRODUCTION

A variety of deposition techniques such as electrode deposition, vacuum evaporation and chemical bath deposition (CBD) have been used to deposit CdSe thin films[1]. Because of it's ease of use, low costs, and capacity to deposit solid solutions without the need for complex equipment, the CBD method is the most appropriate for thin film deposition among them[2]. This technique has helped us produce homogenous, highly adherent, almost stoichiometric CdSe films with fewer flaws[1]. In addition to their applied interest, thin films play an important role in the development and study of materials with new and unique properties. Examples include multiferroic materials, and super lattices that allow the study of quantum phenomena[3]. The thin film properties can be controlled by the thickness parameter that makes their use in modern technologies[4]. A thin film is prepared by condensing the matter in atomic/molecular/ionic form onto a substrate. Thin films are deposited by either physical or chemical methods[5-7]. Crystalline and nonc-rystalline thin films have remarkableimportance inhigh technologylike solarcells, polarizer, magnetic sensors, magnetic thinfilms inrecording devices, interferencefilters, microelectronicdevices[15]. The CdSe nano-material contributes to the advancement of photo detectors, emittingdiodes, electronics, photoelectrochemical devices, light electrically driven lasers[8], optoelectronicsand fieldeffect transistors[10] etc.The CdSe nano-materials has high surface-to-volume ratio and showed an enhanced photo catalytic activity. The uniform 40-50nm size CdSe nano-crystals havebeen preparedby γ-ray irradiationat roomtemperature[14]. Using sodium selenosulfatethe porousCdSe materialswere preparedby spraypyrolysis depositionmethod[16].

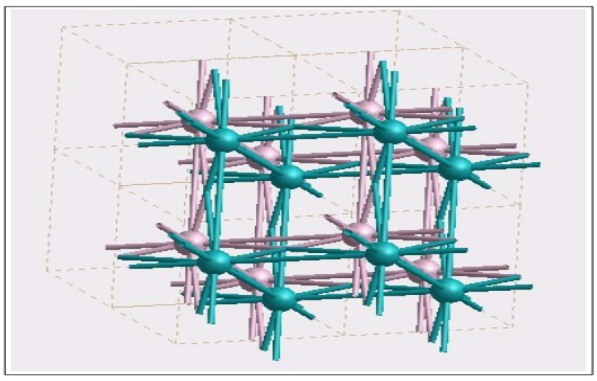

Fig : 1 crystal structure of CdSe by DFT

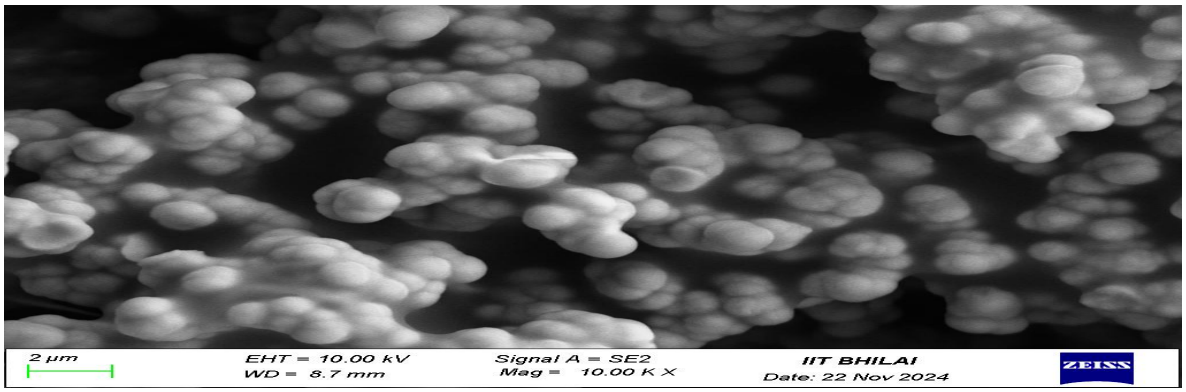


Fig :2 FE-SEM image of CdSe at 10k magnification

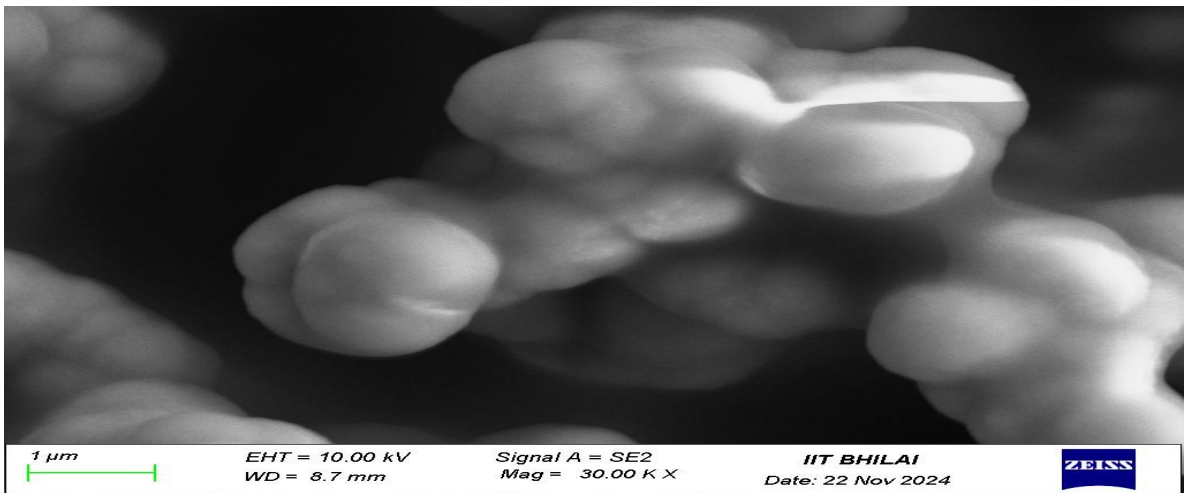


Fig :3 FE-SEM image of CdSe at 30k magnification

## 2. METHODS

The CBD method was used first time in 1884 and it was limited for PbS and PbSe. In the 20 th century the CBD method for thin film preparation mainly focusedon thesolar energyapplication andare widelyused todevelop the solar absorber coatings. The depositionof filmcan be controlled by deposition parameters like deposition temperature, deposition time, pH value etc[2]. DFT is a computer quantum mechanical modelling technique used to uncover the electronic and nuclear composition of many-body systems, particularly atoms, molecules, and other small-scale entities. According to this

theory, functions can be used to determine a many-electron system's attributes[4]. In condensed-matter physics, computational physics, and computational chemistry, DFT is one of the most well-liked and useful techniques. Investigations into the structural and electrical characteristics of cubic and hexagonal CdSe systems have been conducted using first principles total energy calculations[5]. The DFT-based SIESTA code handles all optimizations and computations. The exchange and correlation energies are handled within the GGA according to the PBE parameterization, and the pseudo potential approach has been employed in this code to solve the Kohn Sham (K-S) equations[9].

## 3. RESULT AND DISCUSSION

Optical properties

Optical absorbance spectra in UV-visible were captured between 450 and 750 nm in wavelength, absorbance is recorded in 594 nm. It is evident from Fig.4 that absorbance values as the optical absorbance rose with wavelength. This indicates that CdSe have a greater capacity to absorb light.

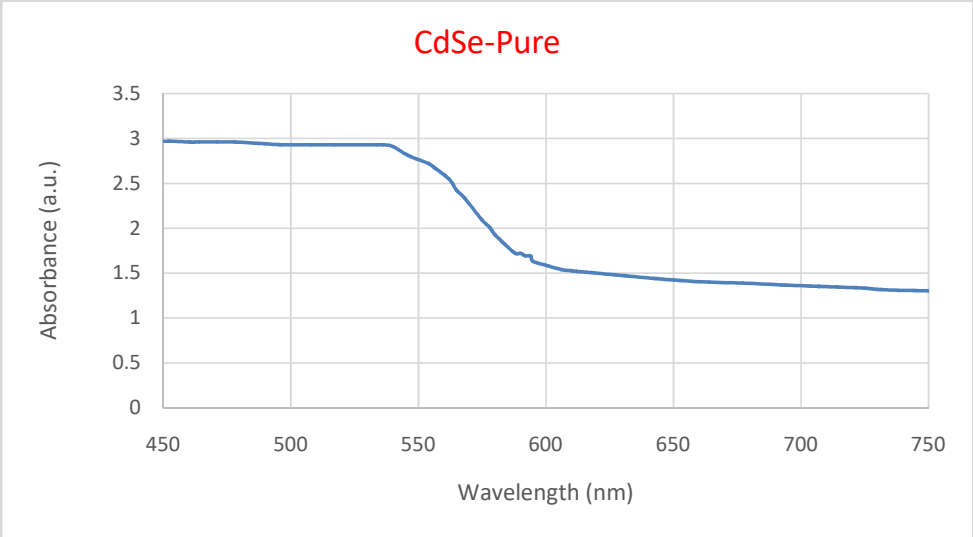


Fig : 4 optical absorbance of CdSe

Here fig 5 (a) denoted the absorption coefficient and optical conductivity of CdSe in cubic fom by DFT calculation and (b) is hexagonal form. In general, we discovered that when an electromagnetic wave strikes crystals, electronic excitation results in optical features of semiconductors. DFT analysis of the CdSe compound in both configurations reveals that the hexagonal structure is not fully isotopic, whereas the CdSe-cubic structure is isotropic. The figure illustrates the variation of absorbance as a function of wavelength. The radiation's hv propagation in the x and z directions stays constant in the CdSe-Cubic system. It has a considerable absorption in the ultraviolet spectrum and drops off significantly after 600 nm. CdSe has a low absorption and is significantly lower than the UV in the visible light spectrum, which spans from 380 to 600 nm. CdSe-hexagonal radiation propagation differs from DFT in directions xx and zz, particularly in the 200–300 nm region.

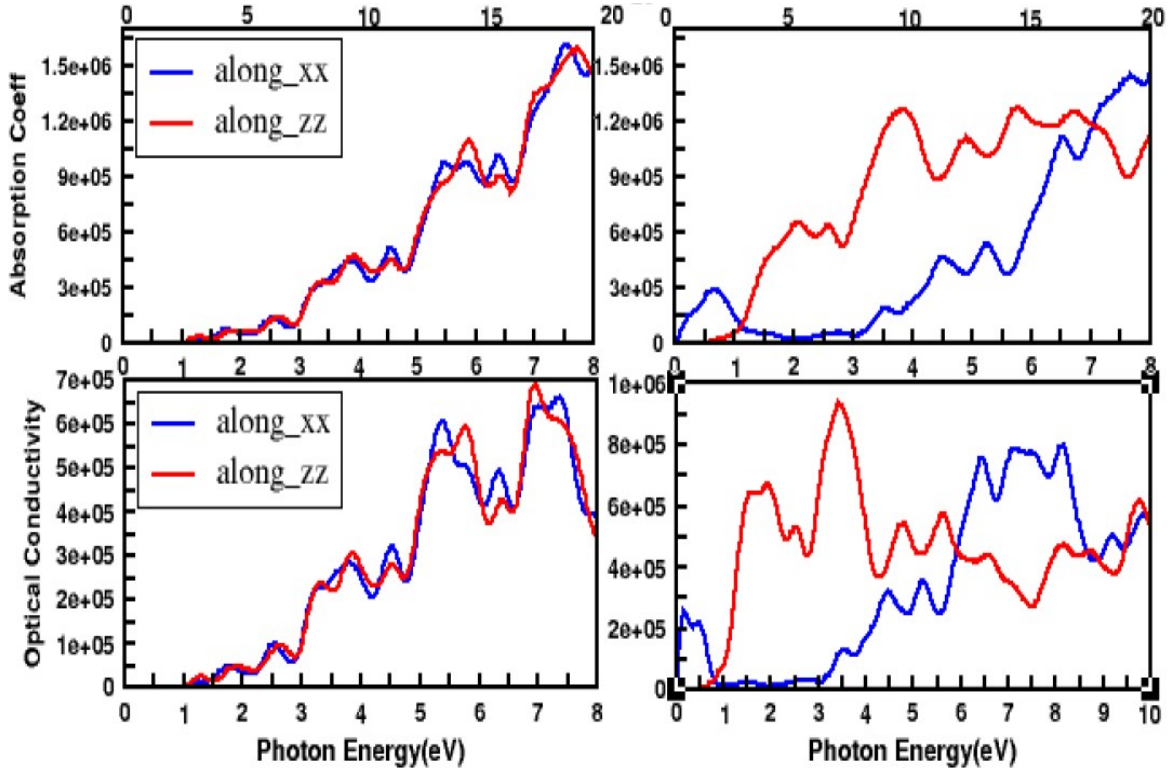


Fig : 5 (a) CdSe Cubic Structure (b) CdSe Hexagonal Structure

## 4. CONCLUSION

CdSe thin films were examined for their optical characteristics by DFT and CBD, here the cubic structure system is present in both methods. The absorbance of the CdSe thin film was altered by DFT study; since the optical absorbance increased with both results. Cubic and hexagonal bulk structure CdSe optical properties have been investigated and the results are in good agreement with experiments. Chemical BathDeposition techniquecan beconsidered asone ofthe mostviable method for large area uniform deposition. Because of its high absorption coefficient, high photosensitivity, and technical applications such as gamma-ray detectors, infrared windows for solar cells, LEDs, and sensors, it is considered a promising material.

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# ROLE OF NANOTECHNOLOGY IN CHEMICAL AND BIOLOGICAL SCIENCE AND SYNTHESIS OF NANOPARTICLES FROM WASTE BATTERIES

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Bio-nanotechnology is a multidisciplinary field that requires knowledge of chemistry, biology to manipulate and generate nonmaterial's for desired applications. Disposable batteries are the primary source of E- waste and industrial waste. Increased Production of waste from industries have persuaded in sustainable and naturally stable methods to reuse the waste as emerging industrial waste is creating concern regarding environmental and health issues. This Review reports the detail study and synthesis of zinc oxide (ZnO) nanoparticles from waste batteries and its applications. A thermal treatment at 900˚ centigrade under an inert atmosphere of argon and Hydrometallurgical was used to synthesize ZnO nanoparticles and its applications as energy storage, as catalyst, in medicine, in microelectronics, as contrast agents and a basis for Drug delivery system.This review provides an overview of the current status and challenges and future aspects for the utilization of industrial waste that is large batteries, printed circuit boards, electronic equipment's as suitable inputs for the production of nanoparticles. In this review we study about researches on the mechanism used for recovery of valuable metals from waste batteries. Our research interests are in the areas of design, synthesis, assembly, and engineering of nanoparticles for chemical and biomedical applications.
**Keywords**: E-Waste, Nanoparticles, Biological and Chemical Science, Waste-Batteries.

## 1. INTRODUCTION:

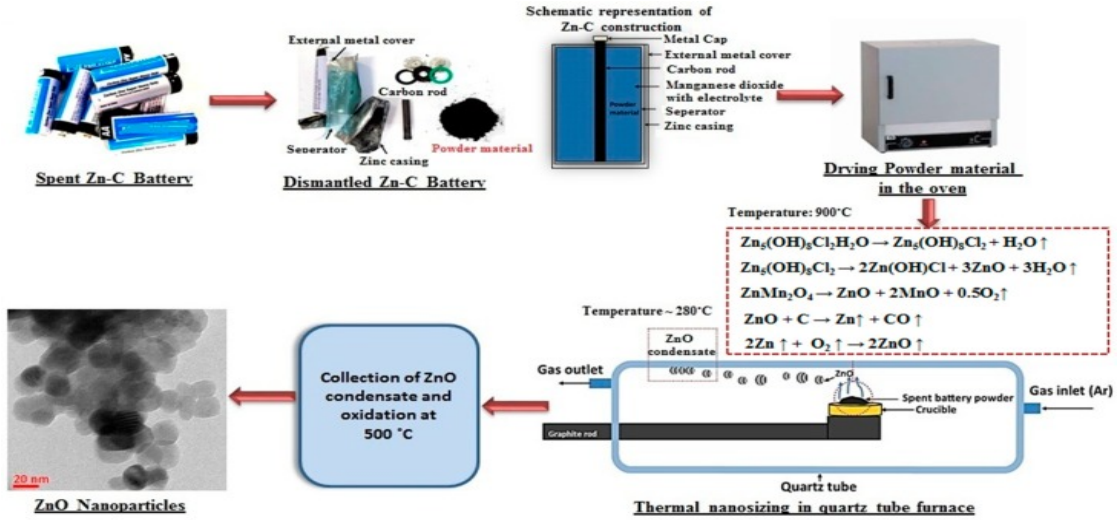
Nano chemistry is an emerging subdiscipline of chemical and material science that deals with the development of new methods. It deals with the material which are smaller than 100 nm or $10^{-9}$ m. Waste acts as a starting material for nanoparticles. From industries large batteries wastes acts as a source of Zinc, Carbon, Cobalt, Copper, Lead, Lithium etc. E-waste can act as a significant source of recovering precious metals. Industrial waste such as lead batteries, zinc-magnesium batteries etc. have been identified as rich source of valuable metals and metal oxides. For the past few decades, there has been steady increase in the development of efficient recycling technique for the e-waste with regard to the recovery of metallic components. The e-waste recycling is further challenging because electronic devices are made up of complex mixtures of various metals, newly engineered nanomaterials. Despite of practical difficulties the high economic value of precious metals such as gold, silver and palladium continue to drive e-waste. Zinc Oxide is a material of special interest due to its wide band gap of 3.3ev, unique optical behavior and excellent chemical and thermal stability. Zinc Oxide has variety of applications such as electronics, optoelectronics, sensors, lasers, solar cells, photo catalyst, pharmaceuticals, energy harvesting applications. Several methods such as chemical vapor deposition, arc discharge, Sol-Gel hydrothermal, microbial route, oxidation process etc. have been employed to Synthesize ZnO nanostructures. This review will create an opportunity for potential applications of ZnO nanoparticles from spent Zn-C battery via facile thermal route to provide economical and sustainable benefits. Batteries as an energy storage device contributed significantly to the total e-waste. As the Zn-C battery is

the non rechargeable handheld battery type, a huge number of Zn-C spent batteries are added to e-waste stream. Zn-C batteries are mainly used for alarm clocks, remote control, radios etc. and contains large amount of Mn and Zn. Recycling of the waste batteries is crucial in order to recover valuable metals and also the prevent the environment from harmful effects. One of the most important applications of these nanoparticles is using them as a nanoreactor. In this application, the polymeric vesicles are not only protecting enzyme from proteinase and chemical degradation but also serve as a confined reaction vessels. Since enzyme reactions in nature usually occur in confined space, the nanoreator may both increase stability of enzymes and provide unobserved information about enzyme kinetics. The different types of polymers will be carefully designed and optimized to prepare nanoreactor system for desire purposes. This nanoreactor concept has wide range of applications such as biocatalytic, biosensors, diagnostic, or enzyme replacement therapy.

In this Review various Hydrometallurgical approaches using acidic and alkaline dissolution and Pyrometallurgical approaches at a very high temperature (1550˚C) to recover mainly Zn are used. Thermal nanosizing to synthesize ZnO nanoparticles simultaneously from waste Zn-C battery has been reported and then characterization and properties of ZnO nanoparticles are investigated using XRD, XPS, BET, SEM, TEM, UV-Visible, photoluminescence spectroscopy (PL) and Raman. Synthesized ZnO nanoparticles spherical in shape and 50 nm in size. Synthesized Zinc nanoparticles showed absorption of ultraviolet light at wavelength of 388 nm and photoluminescent in visible range could be potentially useful for optical applications.

## 2. EXPERIMENT:

Zn-C batteries are manually dismantled to separate the external metal cover, zinc casing, metal caps and powdered materials. Powdered materials were packed between the carbon rods. The powdered materials act as a positive electrode and zinc casing acts as the negative electrode. Zinc chloride acts as an electrolyte. The powdered materials were wetted with an electrolyte which is used as a raw material to synthesize ZnO nanoparticles. The obtained powder material materials were dried in an oven at 90˚C for 2 hours to remove moisture. Horizontal quartz tube(length 1000 nm, diameter:45mm) furnace was used for this experiment which also includes a gas supply system and a graphite rod to hold the sample.




The carrier gas argon was passed at the flow rate of 1L/min from the gas inlet of the tube throughout the experiment. The dried powder was loaded on the ceramic crucible and placed

on the graphite rod then graphite rod is pushed into the furnace at temperature 900˚C for 1 hour, the greyish material near the gas outlet was separated and collected. The obtained powdered material was then kept at 500˚C in an air atmosphere to remove hydroxide impurities.

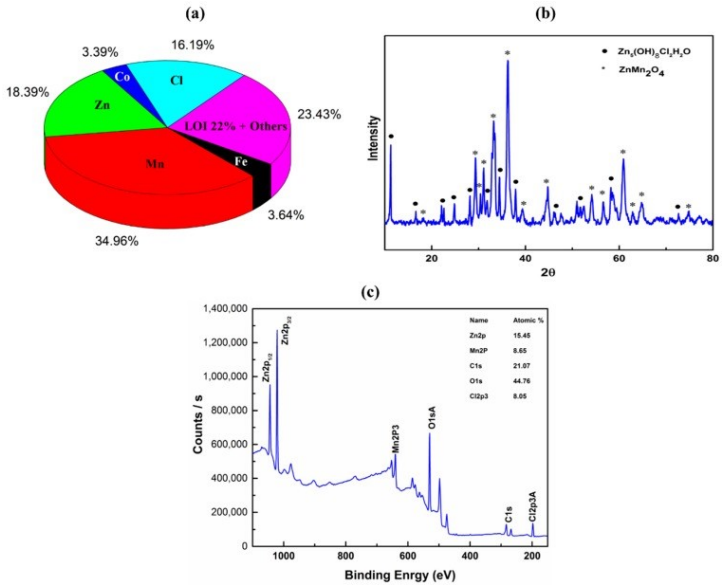
An overall flow diagram to synthesize ZnO from spent Zn-C battery which includes schematic representation of typical Zn-C battery construction, dismantled battery fraction, experimental set up and synthesized ZnO nanoparticles.

## 3. CHARACTERIZATION:

Synthesized nanoparticles were analyzed by X-ray diffraction using CuKα radiation of 45 kv and 40 mA as a radiation source. Samples were scanned in the 2θ range from 10˚ to 100˚ diffraction angles. Phase identification was done by using Xpert High Score Plus software (version 4.7). X-Ray, photoelectron spectroscopy, XPS (ESCALAB250i, Thermo scientific, UK) was conducted with standard conditions, Spot size was 500 mm. Field emission scanning electron microscopy (FESEM) (FEI Nova Nano SEM450) and transmission electron microscope (TEM, JEOL-1400) along with selected area diffraction (SAD) techniques were applied to analyze morphology of ZnO nanoparticles. ZnO nanoparticles were coated with platinum for FESEM to make the sample conductive. ZnO nanoparticles were suspended in ethanol to separate individual particles and two drops of suspension deposited onto holey carbon coated copper grids for TEM analysis. BET surface area was conducted by $N_2$ physisorption. Synthesized ZnO was dispersed in ethanol and ultrasonicated and used for optical absorption spectra using 1 mm path length cuvette from 600 to 200 nm wavelength. Photoluminescence (PL) analysis was conducted using Renishaw inVia Raman spectrometer using near UV lasers of excitation wavelength 325 nm coupled with an optical microscope having 15× objective lens.

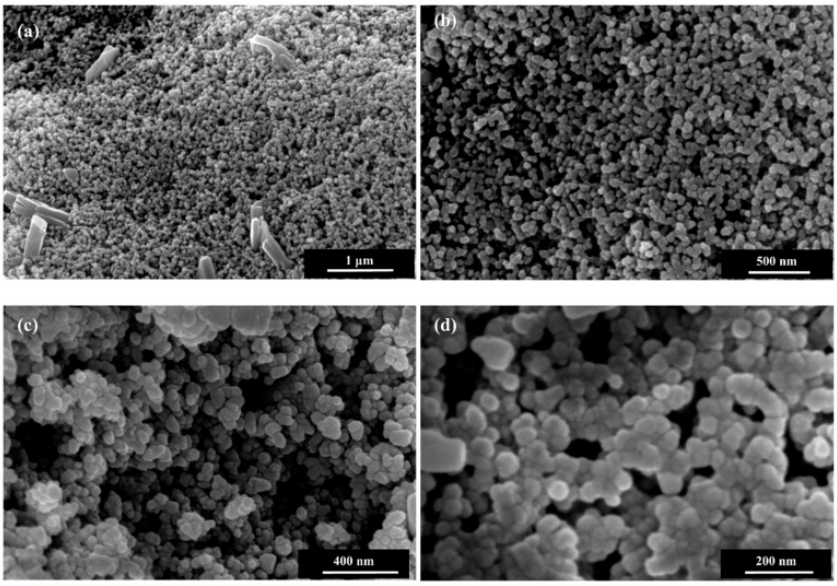
## 4. RESULTS:

X-ray fluorescence spectroscopy, XRF of spent battery powder is shown in figure.Zn (18.39 wt. %), Mn (34.96 wt. %) in oxide form, Cl (16.19 wt. %) were the major elements in the analysis and other minor oxides include Fe, Co, Ca, Si, Cr, Ni, K etc. XRD analysis of the waste battery powder is shown in figure, confirm the presence of mainly $ZnMn_2O_4$ (hetaerolite) and $Zn_5(OH)_8Cl_2H_2O$ (simonkolleite) phases. Formation of hetaerolite and simonkolleite is in agreement that the major elements in the battery are Zn, Mn, Cl, Oxygen in XRF analysis data and available literature of Zn-C battery. XPS analysis of spent battery powder showed Zn, Mn, Cl and O which is also in good agreement with materials analysis by XRF and XRD. Presence of C in XPS can be attributed to the presence of carbon in battery and/or carbon from carbon rod during battery dismantling.



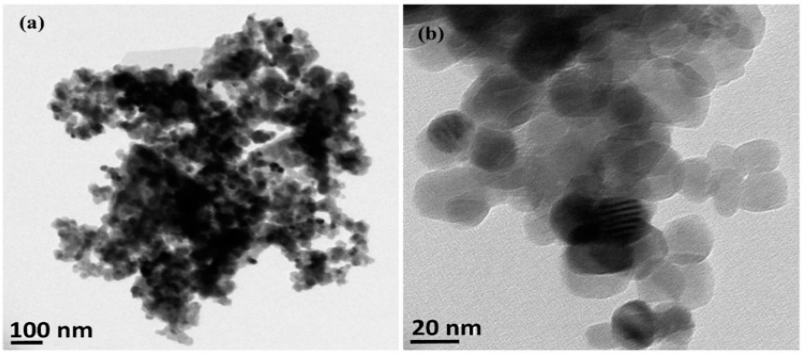

**(a)** Chemical composition (wt. %) in oxide form and (b) XRD analysis (c) XPS analysis of spent battery powder used to synthesize ZnO nanoparticles.

Synthesised ZnO nanoparticles were analysed using FESEM, TEM, XRD and XPS analysis. The synthesised powder was white gray in colour, which was similar to the colour of ZnO obtained using conventional synthesis from zinc acetates or nitrates. Representative low and high magnification FESEM images (65,000× to 200,000×) of synthesised ZnO nanoparticles are shown in figure. The microstructure observed at low and high magnification FESEM confirmed that the recovered ZnO particles are in the nano range and composed of sphere-shaped nanoparticles. The morphology of the nanoparticles was almost similar in shape and the size was within 50 nm. Particles were mainly homogenously distributed though aggregation of particles was observed in some areas of the SEM images. The TEM image in figure also confirmed the formation of nanoparticles in spherical shape and the represented size of the nanoparticles was in the range of 10–40 nm.



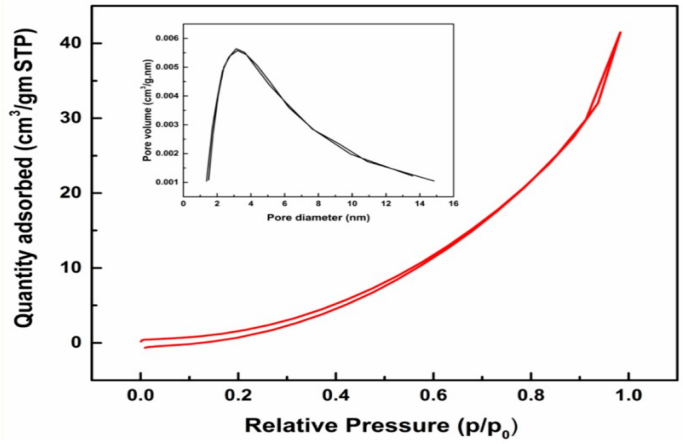

FESEM images of ZnO nanoparticles at different magnification

(**a**) 65,000×; (**b**) 120,000×; (**c**) 200,000×; and (**d**) 350,000×.

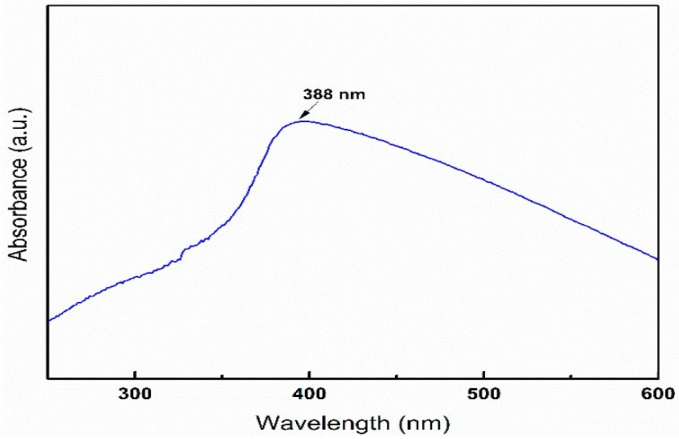



(**a**) Low and (**b**) High resolution TEM images showing the morphology of as-synthesized ZnO nanoparticles.

Properties of as-synthesized ZnO nanoparticles from spent Zn-C battery were observed by BET analysis, UV-Vis and Photoluminescence spectroscopy. Specific BET surface area is an important microstructural parameter of ZnO particles, which depends on the geometrical shape and porosity of the particles.




The room temperature UV-Vis optical absorption spectrum for the ZnO nanoparticles is shown in figure. The excitonic absorption peak of the ZnO nanoparticles was observed at ultraviolet region ~388 nm (3.2 eV).



## 5. CONCLUSION:

The present study details the characterization and properties of synthesised ZnO nanoparticles from spent Zn-C battery via thermal nanosizing technique. Synthesized ZnO nanoparticles were spherical in shape, within 50 nm size and confirmed by XRD, XPS, SAED analysis. UV-Vis spectra showed UV absorbance at around 388 nm wavelength and PL spectra showed visible luminescence. As-synthesized ZnO nanoparticles could be potentially useful for optical applications and will simultaneously provide an economical route to produce ZnO nanoparticles and an effective solution to reduce waste battery in landfills.

**References:**

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# EFFECT OF TEMPERATURE, PH, AND SALT ON BACTERIOCIN ACTIVITY PRODUCED FROM DIFFERENT STRAINS OF LACTIC ACID BACTERIA (LAB)

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The present study was conducted to assess the effect of temperature, pH, and salt on bacteriocin activity produced from different strains of Lactic Acid Bacteria. On the basis of cultural, biochemical, physiological and morphological identification the *Lactobacillus* species were identified. Four species of *Lactobacillus* were isolated from homemade cheese, raw milk, dosa paste, sauce, and curd.*Lactobacillus species* isolated from the sampled food source include; *Lactobacillus brevis*, *Lactobacillus plantarum , Lactobacillus fermentum,* and *Lactobacillus casei*. The bacteriocins activity towards different levels of temperature, pH and salt was recoreded.The results showed that the highest bacteriocin activity was observed at 60°C for 180 min and the lowest bacterial activity was observed at 121°C for 20 min.*L.plantarum*(P2) resported the maximum bacteriocin activity.The highest bacteriocins activity was reported at pH-6. Across different bacterial strains tested for pH stability,*L. plantarum*(P2) reported maximum bacteriocins activity. It was observed that bacteriocins produced from *L. brevis* reported highest salt tolerance.Across different bacterial strains tested for salt tolerence,*L. brevis*reported maximum bacteriocins activity. The bacteriocin produced from LAB in the current experiment show resistance to pH, heat, and different organic solvents, thus this bacteriocin opened the prospect for its utilization in preservation of food products.

**Key words:** LAB, Bacteriocins, Temperature stability, pH stability, Salt tolerance

## 1. INTRODUCTION

Lactic Acid Bacteria (LAB) have been intensively used in food preservation and research across the globe has reported that LAB stimulates the nutrient level of different fermented foods and its derived products (Sameh, *et.al.,* 2016; Raman, *et.al.,* 2022). LAB improves the flavor, taste, texture, and shelf-life of different products (Korcari, *et.al.,* 2021). The LAB creates lactic acid, which makes the environment more acidic and decreases the number of pathogenic microorganisms. LAB has the ability to create organic acids, hydrogen peroxide, diacetyl, and bacteriocins which are some of the antibacterial substances. These substances are known to lessen food deterioration and the growth or proliferation of harmful bacteria. As a result, the food industry has begun to pay more attention to the utilisation of these naturally occurring chemicals as food bio-preservative agents, which currently offers a viable alternative to chemical food preservation, particularly for ready-to-use products. (Suskovic*et.al.,* 2010, Lappa, *et.al.,* 2022). Bacteriocins could also be used to prepare products that aren't being sufficiently thermally sterilized at the time of there production, as there is a risk of product becoming contaminated with pathogenic microorganisms like *Listeria monocytogenes*, which has been linked to numerous outbreaks around the world (O'Sullivan *et.al.,*2002).

Bacteriocins are ribosomally-synthesized peptides or proteins with antimicrobial activity, produced by different groups of bacteria. Many *Lactobacillussp.* produce bacteriocins with rather broad spectra of inhibition Several LAB bacteriocins offer potential applications in food preservation, and the use of bacteriocins in the food industry can help to reduce the addition of chemical preservatives as well as well as the heat intensity treatments, resulting in

foods that are better maintained naturally and have stronger nutritive and organoleptic qualities. This can be an alternative to satisfy the increasing consumers demands for safe, fresh-tasting, ready-to-eat, minimally-processed foods and also to develop "novel" food products (e.g. less acidic, or with a lower salt content) (Alkena*et.al.,* 2016). The inhibitory spectrum of some bacteriocins also includes food spoilage and/or food-borne pathogenic microorganisms. In the past years, a lot of works have been aimed to the detection, purification and characterization of bacteriocins, as well as to their use in food preservation strategies. However its essential to report the tolerance of bacteriocins towards different physical and chemical factors of environment. Keeping in view the role of bacteriocins, the present study was conducted to assess the effect of temperature, pH, and salt on bacteriocin activity produced from different strains of Lactic Acid Bacteria.

## 2. MATERIAL AND METHODOLOGY

### *2.1. Isolation and Identification of LAB*

Homemade cheese, raw milk, dosa paste, sauce, curd, was serially diluted and spread on MRS agar medium. Plates were incubated anaerobically for 24-48 hrs at $30^0$ .When required for the isolation of specific bacteria and incubated aerobically and anaerobically at various temperatures. A total of 13 isolates of bacterial species, namely *Aeromonas, Bacillus, Clostridium, Escherichia, Klebsiella, Listeria, Salmonella, Streptococcus, Staphylococcus, Enterobacter, Enterococcus,* and *Lactobacillus* were isolated from the sampled dairy products. On the basis of cultural, biochemical, physiological and morphological identification the *Lactobacillus* species were identified. Four species of *Lactobacillus* species were identified they include; *L.plantarum*(P2), *L.brevis, L.plantarum(P1) , L. casei,* and*L. fermentum.* The morphologicalcharacteristics of the bacterial strain obtained from different food sources is given in Table-1

**Table-1: Morphological characteristics of the bacterial strain obtained from different food sources.**

| Strain code | Cell's form | Type | Colour | Motility test | Gram staining |
|---|---|---|---|---|---|
| *L. brevis* | Rod shaped | Bacilli | Yellow | Non-motile | Gram positive |
| *L.plantarum* | Slender rods | Coccobacilli | Yellow | Non-Motile | Gram positive |
| *L.fermentum* | Rod Shaped | Cocci | Creamy White | Non-Motile | Gram positive |
| *L. casei* | Rod-shaped | Smooth | Opaque with pigment | Non-Motile | Gram positive |

### *2.2. Production of Bacteriocin*

The bacteriocin production from the isolated strains of LAB species (*L.plantarum*(P2), *L.brevis, L.plantarum(P1) , L. casei,* and*L. fermentum*) was grown in MRS broth(Hi Media Lab, Pvt Ltd.India) with 1% incoculumn and it was maintained at optimum culture condictions for 48 hours.The cells wer removed from the growth medium afer incubation by centrifugation at 15000r/min for 15 minutes at $4^0$C. The obtained cell-free supernatant was adjusted to pH 6.5 using 1mol/L NaOH and it was used as crude bacteriocin.

### *2.3. Purification of Bacteriocin*

Two methods were used for this purpose; Ammonium salt precipitation and ion-exchange chromatography (Yang *et.al.,* 2018).

2.3.1. Ammonium Salt Precipitation

Ammonium salt precipitation, various concentrations of Ammonium Sulphate (10, 20, 30, 40, 50 and 60%) was added to 10 ml of crude bacteriocin in different salt of test tubes, precipitate for 24 h at $4^{O}$C. Then the obtained mixture of bacteriocin was centrifuged at 10,000 rpm for 10 min and then the obtained precipitate was further resuspended in 25ml of 0.05m of Potassium Phosphate buffer (pH 7)(Yang *et.al.,* 1992). Further dialysis was followed in dialysis bags against 2 litres of the same buffer.

2.3.2. Ion-Exchange Chromatography

The dialyzate was used for purification by cation exchange column (DEAE cellulose column) and elution was performed by using a linear gradient from citrate phosphate buffer ranging from pH 2.6 to 7.0 (Macher *et.al.,* 1980). The bacteriocin titer was assessed (Todorov et.al., 2004) of eluted samples.

*2.4. Effect of Temperature, pH, and Salt on Bacteriocin Activity*

In order to assess the impact of temperature, the purified bacteriocin activity was tested by incubating it at different temperatures between $60^{0}$C to $121^{0}$C and the residual activity was tested after 20 minutes, 40minutes, 120 minutes, and 150 minutes. To examine the affect the pH , the purified bacteriocin activity was tested by incubating it at different pH between 02 to 12 with sterile 1 mol/NaOH or 1 mol/L HCL. Further the effect of salt on the purified bacteriocin activity was observed by taking 400µl of the purified bacteriocin, and it was incubated at 37 ℃ with NaCl concentrations ranging from 10 to 40%. (Merck, Germany). Well diffusion assay was used to measure the activity.

## 3. RESULTS AND DISCUSSION

Four species of *Lactobacillus* were isolated from homemade cheese, raw milk, dosa paste, sauce, and curd.*Lactobacillus species* isolated from the sampled food source include; *Lactobacillus brevis*, *Lactobacillus plantarum , Lactobacillus fermentum,* and *Lactobacillus casei*. Table-1 and Table-2 shows the morphological, physiological and biochemical attributes of *L. brevis, L. plantarum , L. fermentum*, and *L. casei* isolated from cheese, raw milk, dosa paste, sauce, and curd. *Lactobacillus brevis* is a facultative anaerobic, hetero-fermentative species that is commonly found in fermented foods, such as beer, wine, and vegetables. It is a Gram-positive, non-spore-forming, rod-shaped bacterium that can occur singly, in pairs, or in short chains. The cells typically measure 0.7-1.0 µm in width and 2.0-4.0 µm in length, with rounded ends. *Lactobacillus plantarum* is a Gram-positive, non-motile, non-spore-forming, micro-aerophilic, and mesophilic bacterium. The cells are straight rods with rounded ends, measuring 0.9-1.2 µm in width and 3.0-8.0 µm in length, and can occur singly, in pairs, or in short chains. Some strains of *L. plantarum_* can possess true catalase and manganese-containing pseudo-catalase activities, as well as nitrate- and hematin-dependent nitrite reductases. *Lactobacillus fermentum* is a Gram-positive, non-spore-forming, rod-shaped bacterium that is commonly found in fermented foods and the human gastrointestinal tract. The cells are typically 0.5-0.8 µm wide and 2.0-4.0 µm long, with rounded ends, and can occur singly, in pairs, or in short chains. *Lactobacillus casei* is a Gram-positive, non-spore-forming, rod-shaped bacterium that is widely used in the production of fermented dairy products and as a probiotic. The cells are typically 0.5-0.8 µm wide and 1.0-10.0 µm long, with rounded ends, and can occur singly, in pairs, or in short chains.

**Table-2: Physiological and Biochemical characteristics of Isolated *Lactobacilli.***

| **Characteristics** | **Raw milk** | **Curd** | **Cheeses** | **Sauce** | **Dosa Batter** |
|---|---|---|---|---|---|
| *Species* | *L. plantarum* P1 | *L.plantarum* P2 | *L. casai* | *L. brevis* | *L. fermentum* |
| Morphology | Cream colony Gram +ve Rod | Cream Colony Gram +ve Rod | Cream Colony Gram +ve Rod | White colony Gram +ve Rod | White colony Gram +ve Rod |
| 15 °C only | + | + | + | + | - |
| 45 °C only | - | - | - | - | - |
| 15 and 45 °C only | + | + | + | + | + |
| Acid and gas from glucose | - | - | - | + | + |
| $NH_3$ from Arginine | - | - | - | + | + |
| Arabinose | - | - | + | + | + |
| Cellobiose | + | + | - | - | + |
| Mannitol | + | + | - | - | + |
| Mannose | + | + | + | - | + |
| Melebiose | + | + | - | - | + |
| Raffinose | + | + | + | - | + |
| Ribose | + | + | + | + | + |
| Salicin | + | + | + | - | + |
| Lactose | - | - | - | + | + |
| Rhamnose | - | - | - | - | - |
| Sorbitol | - | - | - | - | + |
| Xylose | - | - | - | + | + |
| Trehalose | - | - | - | -_ | + |

Due to the fact that all bacteriocin was created during the pre- and early exponential growth phases and reached a maximum level at late stationary phase, the test isolates synthesis of bacteriocin demonstrated secondary metabolic kinetics. According to certain accounts, bacteriocins are created at all times during the experimental growth phase rather than just in the late logarithmic or early stationary phases.The process of producing bacteriocin was optimised by taking into account many parameters, including carbon and nitrogen sources, pH, temperature, and salt content. The optimum parameter was then determined using an arbitrary unit. The addition of glucose (2.0%) increased the amount of bacteriocin that could be produced, while the addition of other carbon sources had no effect or had a negative impact on production. For the nitrogen source, the medium's maximum production was achieved by mixing Tryptone, yeast extract, and meat extract together. While extremely alkaline and acidic pH did not enable the formation of bacteriocin, maximum activity in composition medium was attained at initial pH ranging from 6-8, and the optimal temperature was 300C.The bacteriocin was created at its highest level under the ideal conditions, and once it had been purified, it could be employed right away as a bio-preservative. The manufacturing of bacteriocins can be optimised to produce them more cheaply, which could eliminate the need to add chemical preservatives altogether or at least limit their use.

**Table-3.** Effect of Temperature on the activity (AU/µl) of bacteriocin produced by the isolated strains of LAB species.

| Temperature | *L. plantarum(P1)* | | *L. plantarum(P2)* | | *L. casei* | | *L. brevis* | | *L. fermentum* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ZI (mm) | AU/µl | ZI (mm) | AU/µl | ZI (mm) | AU/µl | ZI (mm) | AU/µl | ZI (mm) | AU/µl |
| $60^0$C for 150 min | 11.0 | 110 | **15.0** | **150** | 11.0 | 110 | 13.0 | 130 | 10 | 100 |
| $80^0$C for 120 min | 9.0 | 90 | **13.0** | **130** | 10.0 | 100 | 8.0 | 80 | 7.0 | 70 |
| $100^0$C for 40 min | 8.0 | 80 | **12.0** | **120** | 5.0 | 50 | 7.0 | 70 | 0 | 0 |
| $1210^0$C for 20 min | 8.0 | 80 | **12.0** | **120** | 0 | 0 | 0 | 0 | 0 | 0 |

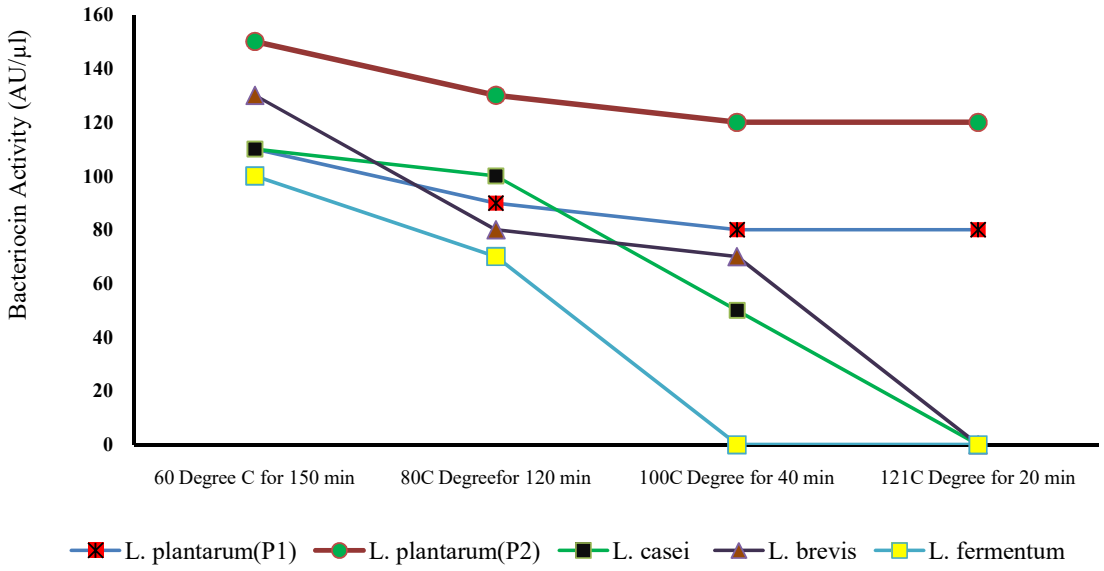


**Fig-1. Thermal stability of Bacteriocin after exposure at different temperature treatment**

The optimum condition for maximum bacteriocin activity was demonstrated by culturing the bacteria among various thermal ranges. Purified bacteriocin was exposed to various heat treatments: 60°C for 180 min, 80°C for 120 min, 100°C for 40 min and 121°C for 20 min (Table-3, Fig-1). The results showed that the highest bacteriocin activity was observed at 60°C for 180 min and the lowest bacterial activity was observed at 121°C for 20 min. Across different bacterial strains *L.plantarum*(P2) resported the maximum bacteriocin activity followed by *L. brevis, L.plantarum(P1) ,L. casei,* and*L. fermentum.* The results report that with the increase in the temperature there was a decrease in the activity (AU/µl) of

bacteriocins**.** The *L.plantarum*(P2) showed the highest thermal stability that the other bacteriocins in terms of the temperature to which they were exposed.

**Table 4.**Effect of pH on the activity (AU/µl) of bacteriocin produced by the isolated strains of LAB species.

| pH | *L. plantarum(P1)* | | *L. plantarum(P2)* | | *L. casei* | | *L. brevis* | | *L. fermentum* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ZI (mm) | AU/µl | ZI (mm) | AU/µl | ZI (mm) | AU/µl | ZI (mm) | AU/µl | ZI (mm) | AU/µl |
| **2** | 10 | 100 | **15** | **150** | 11 | 110 | 13 | 130 | 09 | 90 |
| **4** | 14 | 140 | **17** | **170** | 12 | 120 | 16 | 160 | 10 | 100 |
| **6** | 15 | 150 | **19** | **190** | 13 | 130 | 18 | 180 | 12 | 120 |
| **8** | 11 | 110 | **18** | **180** | 09 | 90 | 16 | 160 | 07 | 70 |
| **10** | 05 | 50 | **18** | **180** | 05 | 50 | 15 | 150 | 00 | 00 |
| **12** | 00 | 00 | **17** | **170** | 00 | 00 | 15 | 150 | 00 | 00 |

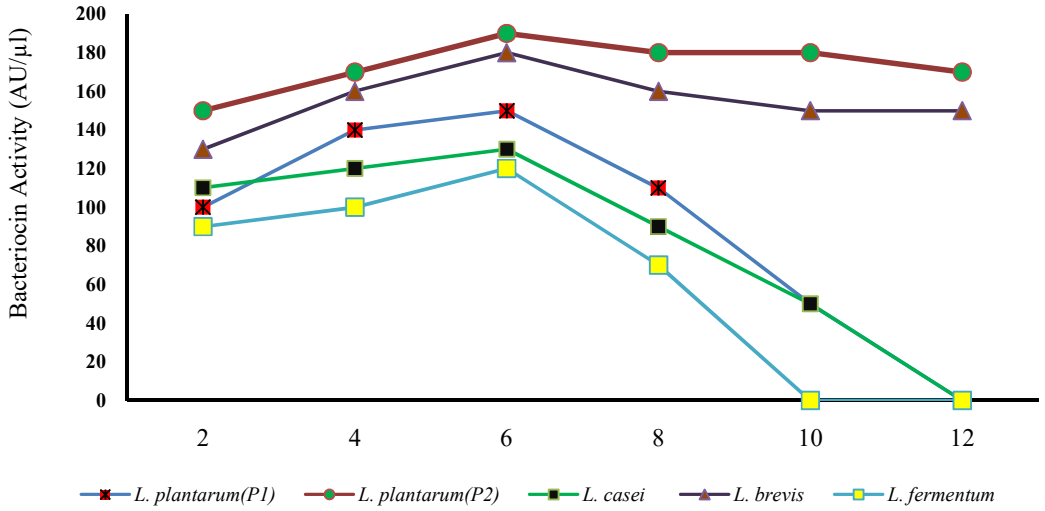


**Fig-2.** pH stability of Bacteriocins produced from different LAB Species after exposure at different pH

The influence of pH on the activity of bacteriocins. Stability of pH of bacteriocins was observed at pH range of 2.0 to 12.0. It was observed that the bacteriocins activity report maximum stability between pH 4-6. The highest bacteriocins activity was reported at pH-6 (Table-4.18). Across different bacterial strains tested for pH stability,*L. plantarum*(P2)

reported maximum bacteriocins activity followed by *L. brevis,L.plantarum(P1),L. casei, and L. fermentum* (Table-5, Fig-2). *L. plantarum* (P2) showed was reported to be the highest pH stable of bacteriocins after exposure at different pH.The overall results report that the pH affects the bacteriocins activity significantly.

**Table-5.**Effect of Salt on the activity (AU/µl) of bacteriocin produced by the isolated strains of LAB species.

| Salt Conc. | *L. plantarum(P1)* | | *L. plantarum(P2)* | | *L. casei* | | *L. brevis* | | *L. fermentum* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ZI (mm) | AU/µl | ZI (mm) | AU/µl | ZI (mm) | AU/µl | ZI (mm) | AU/µl | ZI (mm) | AU/µl |
| **10%** | 12.0 | 120 | 19 | 190 | 11.0 | 110 | **20.0** | **200** | 11.0 | 110 |
| **20%** | 10.0 | 100 | 18 | 180 | 11.0 | 110 | **19.0** | **190** | 9.0 | 90 |
| **30%** | 8.0 | 80 | 16 | 160 | 7.0 | 70 | **18.0** | **180** | 8.0 | 80 |
| **40%** | 0.0 | 00 | 16 | 160 | 5.0 | 50 | **18.0** | **180** | 6.0 | 60 |

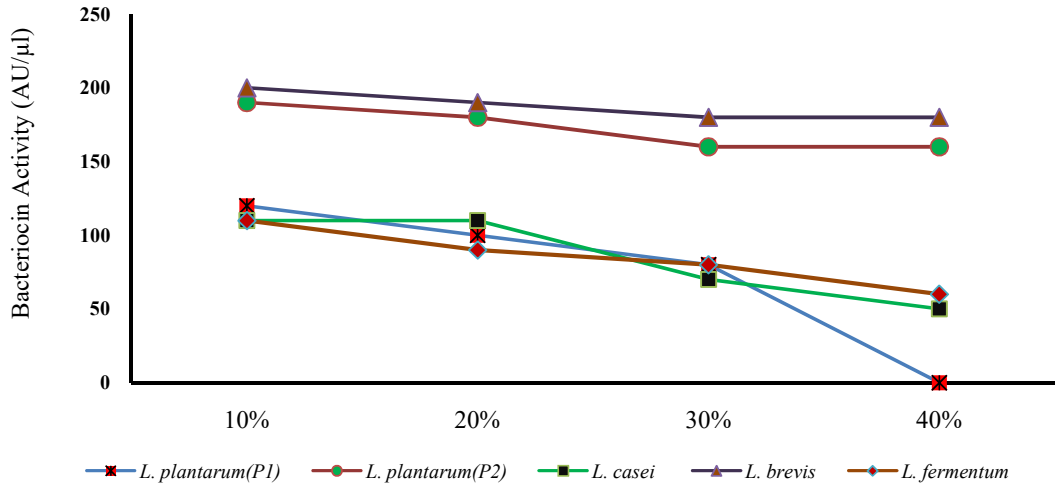


**Fig-3.** Salt tolerance of Bacteriocins produced from different LAB species.

400µl of the purified bacteriocin were incubated at 37 °C with NaCl concentrations ranging from 10 to 40%. (Merck, Germany). Well diffusion assay was used to measure the activity. It was observed that bacteriocins produced from *L. brevis* reported highest salt tolerance. The tolerance by bacteriocin activity was recorded lowest by *L. casei.* Across different bacterial strains tested for salt tolerence,*L. brevis*reported maximum bacteriocins activity followed by *L. plantarum*(P2), *L.plantarum(P1), L. fermentum,* and*L. casei* (Table-5, Fig-3).The overall results show that the bacteriocin activity was highest at 20% salt concentration and lowest at 40% salt concentration.

## 4. DISCUSSION

The present study examines the effect of temperature, pH and salt on the bacteriocin activity which were produced from *Lactobacillusspecies* isolated from Raw milk, Dosa, Curd, Sauces

and Cheese. The *Lactobacillus species* were identified on the basis of morphological, biochemical and physiochemical attributes. Out of these five *Lactobacillus species*, two were identified as *L. plantarum* and coded as P1 and P2, respectively, due to their different potential in bacteriocin activity, and the other three were identified as *L. brevis, L. casai,* and *L. fermentum*. The bacteriocins produced by the *Lactobacillus species* in this investigation were subject to different levels of temperature, pH and salt to determine the stability of the bacteriocins for their future applications.

The *Lactobaccilus* bacteriocin isolated from different samples raw milk, dosa paste, curd, sauce and cheese have thermal stability at $60^0$C for 150 min. The results showed that the highest bacteriocin activity was observed at 60°C for 150 min and the lowest bacterial activity was observed at 121°C for 20 min. This is significant if the bacteriocin is to be utilized as a food preservative because many food preparation processes require a heating stage. The mechanism of heat-stability of LAB bacteriocins has been reported earlier for *Plantaricin S* (Jimenez-Diaz *et.al.,* 1990), *Plantaricin A* (Daeschel*et.al.,* 1985), *Plantaricin 149* (Kato *et.al.,* 1994), *Plantaricin SA6* (Rekhif*et.al.,* 1995), *Plantaricin 423* (Van-Reenen,1998), *Plantaricin C19* (Audisio, 1999), ,*Pentocin TV35b* (Okkerse*t.al.* ,1999), *L. brevis* 0G1 (Ogunbanwo*et.al.,* 2003), and *lactocin RN78* (Mojgani and Amirinia, 2007). Because we noted heat stability of *L. plantarum* P2 bacteriocin, the conclusions of the present study are in consistent with the findings of the papers cited above. This bacteriocin belongs to the category of bacteriocins with low molecular weight that are heat stable and retain their activity after heating at $121^0$ C for 60 min. The bacteriocin is superior in processed foods when high heat is used because of this property. The thermal stability of other bacteriocins was not good. Additionally, Andersson (1986) noted a decrease in activity following a 15-minute heat treatment at $121^0$ C.

The test isolates regarding bacteriocin's activity was also pH-dependent. The bacteriocin produced by *L. brevis, L.plantarum(P1), L.plantarum(P2), L. casei,* and *L. fermentum* showed pH stability at acidic pH (2-6). However only *L. brevis* and *L.plantarum(P2*) retained itheir activity at alkaline pH (8-12). *L. fermentum* have completely lost their activity form pH 10 and *L. brevis* lost its complete activity at pH 12 respectively. The overall bacteriocin activity was reported highest between pH 4-6. This was also demonstrated by Reddy *et.al.* (1984) and Abdel-Bar *et.al.* (1987) in their studies of two bacteriocins, bulgarican and lactobulgarican, isolated from *L. bulgaricus,* which had the highest activity and stability at pH 2.2 and 4.0, respectively, against a variety of pathogenic and spoilage bacteria.

In particular, pH 6 was found to have increased antibacterial activity in the bacteriocin generated by *L. brevis,L.plantarum(P1), L.plantarum(P2),1L. casei,* and*L. fermentum*. This might be because bacteriocins' increased net charge at low pH makes it easier for the molecules to pass through the cell wall. At lower pH levels, bacteriocin solubility may also rise, aiding the diffusion of bacteriocin molecules. This concurred with earlier studies that demonstrated that the presence of NaCI enhanced the antimicrobial action of bacteriocins like nisin, leucocin F10, enterocin AS-48, and others. A modest quantity of NaCI also inhibited nisin action (Bouttefroy*et.al.,* 2000). Additionally, sodium chloride reduced the antilisterial efficacy of the antibiotics acidocin CH5 (at 1-2%; Chumchalova*et.al.,* 1998), lactocin 705, leucocins 4010 (at 2.5% NaCl; Hornbaek*et.al.,* 2004), pediocin, (at 6.5% NaCl; Jydegaard *et.al.,* 2000), curvacin (Vaerluyten). The ionic interactions between bacteriocin molecules and charged groups involved in bacteriocin binding to target cells may be interfered with by sodium chloride, which has a protective effect (Bhunia *et.al.,* 1988.) In addition, sodium chloride may cause bacteriocin structural alterations or modifications to the target cell's envelope (Lee *et.al.,* 1993) or changes in the cell envelope of the target organisms (Jydegaard *et.al.,* 2000).

The bacteriocin produced from LAB in the current experiment show resistance to pH, heat, and different organic solvents, thus this bacteriocin opened the prospect for its utilization in preservation of food products. It can also confirm that these LAB strains can be used as starting cultures for microorganisms and as bio-preservatives in a variety of fermented foods. The most typical bacteria for food fermentation and preservation are LAB. Their significance is primarily related to their safe metabolic activity as they consume accessible sugar while growing in food to produce organic acids and other metabolites (Gomashe*et.al.* 2014).

## 5. CONCLUSION

Lactic Acid Bacteria (LAB) can produce a range of antimicrobial compounds, such as organic acids, hydrogen peroxide, and bacteriocins, which can effectively inhibit the growth of various microorganisms. Four species of *Lactobacillus* were isolated from homemade cheese, raw milk, dosa paste, sauce, and curd.*Lactobacillus species* isolated from the sampled food source include; *Lactobacillus brevis*, *Lactobacillus plantarum , Lactobacillus fermentum,* and *Lactobacillus casei*. The bacteriocins activity towards different levels of temperature, pH and salt was recorded. The characterization of Bacteriocins from test isolates were studied in order to take advantage of their potential and make them viable candidates for deployment as a safe and effective biological preservative in the future. Across different LAB species the bacteriocins produced from *L. plantarum* report distinctive and comprehensive heat stability, pH instability, and salt tolerance, can be exploited as a biopreservative to increase the food items' hygienic and safety (especially processed foods).The use of Lactobacillus species as natural biopreservatives in food products is a promising approach to enhance food safety and extend shelf-life, thereby reducing the reliance on synthetic preservation methods.

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# IDENTIFICATION AND CHARACTERIZATION OF SICKLE CELL ANEMIA DISEASE GENETIC PREDICTORS IN POPULATION OF CHHATTISGARH AND ITS PRELIMINARY REMEDIATION STRATEGY

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In the present decades, sickle cell anemia (SCA) is a challenging task for control of hereditary syndrome in Bilaspur district of Chhattisgarh state, India. Fetal hemoglobin (HbF) level, Fetal hemoglobin (HbF) level which is determined by a number of genetic factors including genetic variation of BLC11A, HBS1L-MYB, ITGA1, RUNX1T1and HBG2 genes. According to data of sickle cell positive line list, district Bilaspur as on 27/06/2024, the percentage of Sahu family affected is 0.019 percentage, Yadav family affected is 0.017 percent and percentage of Manikpuri family 0.005 percent. The sickle cell anemia data is having both diseased and carrier. The carriers are more compared to diseased individuals.
**Keywords:**Sickle cell anemia, Data, Caste, Bilaspur, Chhattisgarh

## 1. INTRODUCTION

### Sickle cell anemia

Sickle cell anemia (SCA) is a blood related genetic disease where Red Blood Cell (RBC) transforms from round shape to sickle shaped cells in *Homo sapiens (*Fitzsimmons et al., 2016; Ben Hamda). The disease is caused by a single gene/ protein mutation, which in heterozygous conditioncauses moderate sickling (sickle cell trait) and in homozygous condition causes severe effect (sickle cell anemia) (Serjeant, 1997; Tebbi, 2022).

In 1949 the molecular nature of sickle cell discovered by Pauling (Steinberg,2008). In 1958,Ingram discovered the genetic basis of the disease and demonstrated that the disease originated from the substitution of a Valine for Glutamic acid at the sixth amino acid position of the hemoglobin (Ingram,1959).

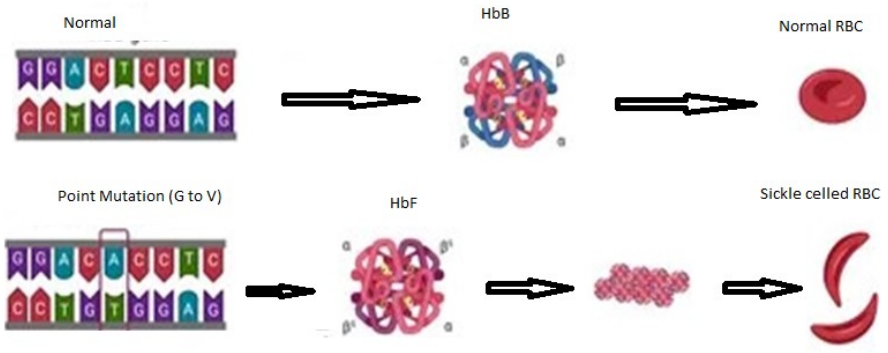


Figure 1: Biological process for normal and SCA

In 1927, Hahn and Gillespie had reported on the mechanism of sickle formation (Lessin and Jensen, 1974). The observation is based on the sickle haemoglobin in its deoxygenated state assumed the characteristic sickle shape (Figure 1).Cellscontaining deoxygenated haemoglobin not only formed the rigid shape but also were dehydratedhad abnormal cell surface and distinct migratory characteristics (Kanias and Acker, 2010). The sticky and prone to adhesion shows the abnormal rheologic properties (Hahn, and Gillepsie,1927).

Upon deoxygenation, the sickle haemoglobin is insoluble and undergoes polymerization. The aggregation of the polymers into tubulin fibres produce sickling shape to RBC (Gardner,

2018). Because of the rigid shape, the RBC cells are prone to being trapped in the microcirculation, while tissues downstream of this blockage are deprived of blood flow. Due to the deprived blood flow, oxygen levels decreases and ischemic occurs which produce damage or death to the human system.

**Blood group**

A blood group or type is a classification of blood, based on the presence and absence of antibodies and inherited antigenic substances on the surface of red blood cells. These antigens may be proteins, carbohydrates, glycoproteins, or glycolipids, depending on the blood group system. Some of these antigens are also present on the surface of other types of cells of various tissues. The blood group including the ABO and Rh systems.

The ABO Blood group system

- Types: A, B, AB, and O
- Antigens: Molecules found on the surface of red blood cells.
  - Type A blood has A antigens.
  - Type B blood has B antigens.
  - Type AB blood has both A and B antigens.
  - Type O blood has neither A nor B antigens.
- Antibodies: Proteins in the plasma that attack foreign antigens.
  - Type A blood has anti-B antibodies.
  - Type B blood has anti-A antibodies.
  - Type O blood has both anti-A and anti-B antibodies.
  - Type AB blood has no antibodies.

The Rh Factor

- Another important antigen found on red blood cells.
- People with the Rh factor are Rh-positive.
- People without the Rh factor are Rh-negative.

Certain blood types can influence the severity of sickle cell anemia. People with certain blood types, such as O+, may have a milder form of sickle cell anemia as compared to those with other types.

**Structure of haemoglobin**

Figure 2: Biological molecule of normal and SCAhaemoglobin

Hemoglobin is a complex protein found in red blood cells that plays a crucial role in transporting oxygen throughout the body (Figure 2). Its structure is essential to its function. Haemoglobin consists of four subunits each containing a polypeptide chain and a heme group. There are two types of polypeptide chains in haemoglobin: alpha &beta chains. Each subunit has one alpha one beta chain. The heme group is an iron-containing molecule that binds to oxygen. Each haemoglobin molecule has four heme group, allowing it to carry four oxygen molecules. T he four subunits of haemoglobin are arranged in a specific three-dimensional structure called a quaternary structure. This structure is crucial for hemoglobin ability to bind and release oxygen efficiently.

There are many different types of haemoglobin, but most common ones are:-

1. Haemoglobin A(HbA): This is most common type of haemoglobin in adults. It makes up about 95-98% of the total haemoglobin in adults.
2. Haemoglobin A2(HbA2): This type of haemoglobin makes up about 2-3% of the total haemoglobin in adults.
3. Haemoglobin F(HbF): This is the main type of haemoglobin in foetus and newborns. Itmakes up about 80% of the total haemoglobin in newborns.
4. Haemoglobin S(HbS): This is an abnormal type of haemoglobin that can cause sickle cell disease.
5. Haemoglobin E(HbE): This is another abnormal type of haemoglobin that can cause anemia. People with HbE disease have red blood cells that are smaller than normal and have a shorter lifespan.
6. Haemoglobin C(HbC): This is another abnormal type of hemoglobin that can cause anemia.

**Repair mechanism of HbS**

There is no direct molecular repair mechanism for HbS , but several biological and therapeutic strategies aim to reduce its effects:

1. **Foetal Haemoglobin (HbF) Induction**
   - **Mechanism:** HbF ($\alpha 2\gamma 2$) does not participate in polymerisation, so increasing its levels reduces HbS aggregation.
   - **Therapies:**
     - **Hydroxyurea:** Increases HbF production by reactivating the γ-globin gene.
     - **Decitabine & 5-Azacytidine:** DNA methylation inhibitors that enhance HbF expression.
2. **Gene Therapy and CRISPR- based Correction**
   - **Mechanism:** Corrects the mutation in the HBB gene or increase HbF production.
   - **Approaches:**
     - **CRISPR-Cas9:** Edits the BCL11A gene (which represses HbF) to increases foetal haemoglobin.
     - **Lentiviral Gene Addition:** Inserts a normal β-globin gene into hematopoietic stem cells.
3. **Hematopoietic Stem Cell Transplantation (HSCT)**
   - **Mechanism:** Replace defective bone marrow with healthy stem cells from a matched donor.
   - **Curative Potential:** Currently the only established cure for sickle cell disease.
4. **Small Molecule Therapies**
   - **Voxelotor:** Increases HbSoxygen affinity, preventing polymerisation.

- **L-glutamine:** Reduces oxidative stress in red blood cells, improving their lifespan.

**Haematology of SCA**

The haematology of SCA is characterised by several key findings:

**A. Erythrocytes (Red Blood Cells)**

- **Sickled-shaped RBCs:** Due to polymerization of HbSunder low oxygen conditions.
- **Increased RBC destruction:** Lifespan of RBCs is reduced to~10-20 days (normal~120 days), leading to **chronic hemolysis.**
- **Anisocytosis & Poikilocytosis:** Variation in RBC size and shape.
- **Targets cells:** May be seen in blood smears.

**B. Haemoglobin Levels**

- **Low Haemoglobin (6-9 g/dl)** due to chronic haemolysis.
- **Predominantly HbS (>85%)** with little or no HbA.
- **HbF(Foetal Haemoglobin)** may be elevated in some cases,which can reduce disease severity.

**C.**

**D.**

**E. Reticulocyte Count**

- **Elevated reticulocyte count** (>5%) due to increased bone marrow activity in response to anaemia.

**F. White Blood Cells (WBCs)**

- **Leucocytosis (Increased WBC count):** Common due to chronic inflammation and bone marrow stimulation.

**G. Platelets**

- **Thrombocytosis (Increased platelet count):** Often seen due to increased marrow turnover and compensatory response.

**H. Biochemical Markers**

- **Increased Lactate Dehydrogenase (LDH):** Due to RBC destruction.
- **Increased Bilirubin (mainly unconjugated):** Due to hemolysis.
- **Decreased Haptoglobin:** As it binds to free haemoglobin from lysed RBCs.
- **Increased Erythropoietin levels:** Due to chronic anemia.

**I. Bone Marrow Findings**

- **Erythroid hyperplasis:** Increased RBC precursors due to compensatory marrow response.
- **Expansion of marrow spaces:** In severe cases.

**J. Peripheral Blood Smear Findings**

- **Sickle cells**
- **Howell-Jolly bodies:**Due to splenic dysfunction.
- **Polychromasia:** Suggesting increased RBC production.

**Genetic Inheritance**

Identification of sickle cell anemia patient in Chhattisgarh based on genetic crossing has been presented in Figure 3.

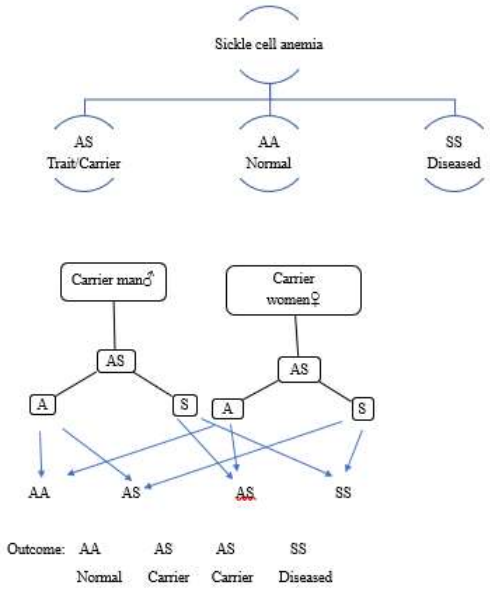


Figure 3: Genetic crossing of SCA

If one parent has sickle cell trait (HbAS) and the other is normal (HbAA) then none of the children will have sickle cell anemia.There is a one in two (50%) chance that any child will get one copy of the HbAS gene and therefore have the sickle cell trait (Figure 4).

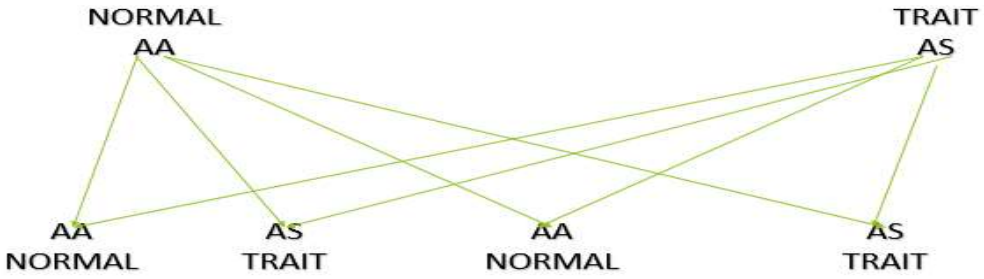


Figure 4: Analysis of Human Traits

If both parents have sickle cell trait (HbAS) then (25%) child could be born with sickle cell anemia.There is also (25%) child could be completely unaffected i.e. normal and (50%) child could be sickle cell trait (Figure 5).

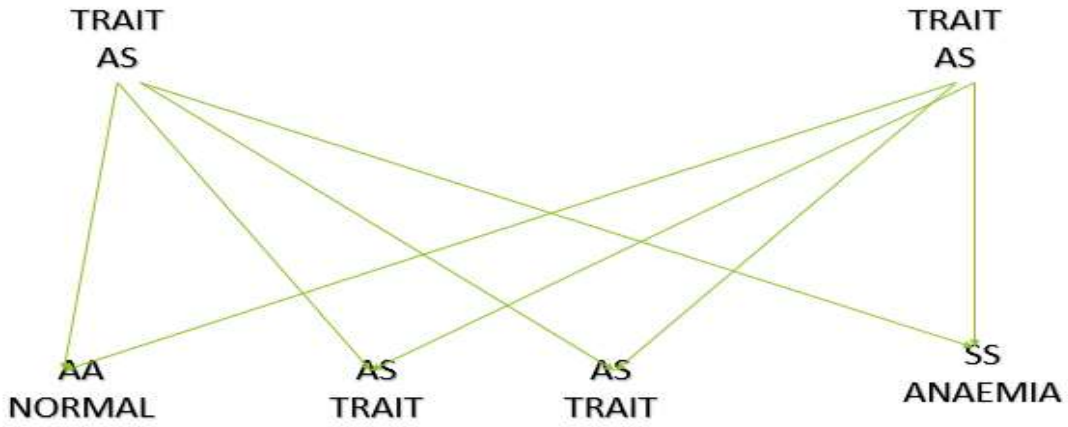


**Figure 5: Ratio of NORMAL: TRAIT: ANEMIA is (25%:50%:25%)**

If one parent has sickle cell trait (HbAS) and the other has sickle cell anemia (HbSS), there is (50%) chance child will get sickle cell trait and (50%) chance that child will get sickle cell anaemia.No children will be completely unaffected (Figure 6).

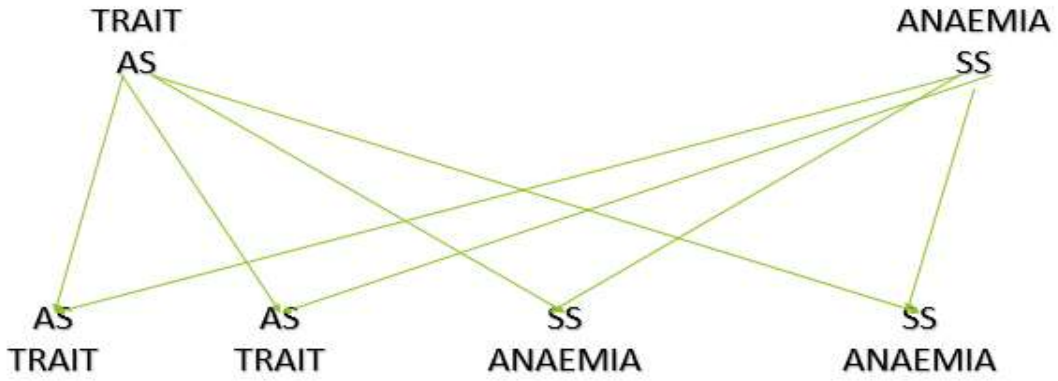


**Figure 6: Ratio of TRAIT: ANAEMIA is (50%:50%)**

If one parent has sickle cell anemia (HbSS) and the other is completely unaffected i.e. normal (HbAA) then all the children will have sickle cell trait.None will have sickle cell anemia (Figure 7).

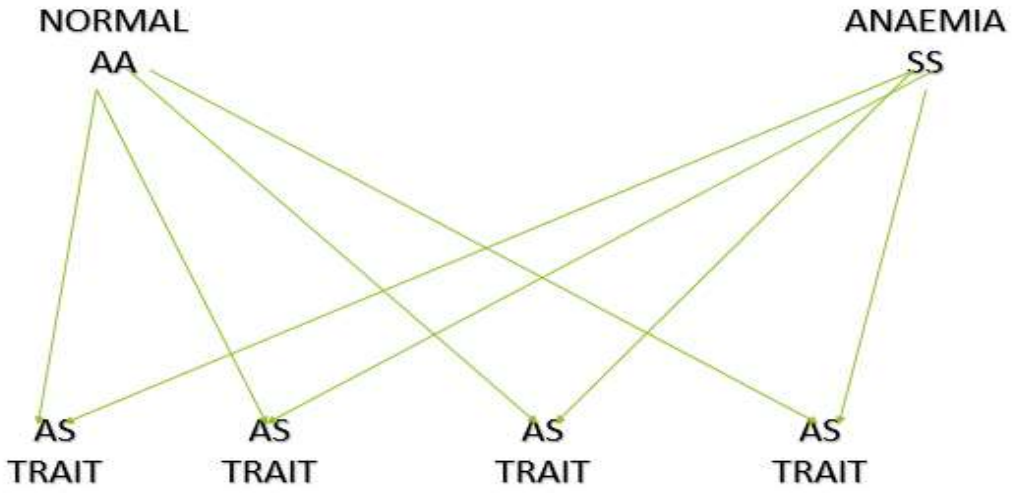


Figure 7: All are TRAITS

The genetic characterization of sickle cell anemia in the people of Chhattisgarh is that the sickle β-globin mutation cause to be the sickle genes pleiotropic in nature. The variable phenotypic expression associated with complex genetic and environmental interaction, as well as disease modifier.

Sickle RBC (SRBC) polymerization in deoxygenated environmental is influenced by a number of factors includingco-inheritance of α-thalassemia, Foetal hemoglobin (HbF) level, Fetal hemoglobin (HbF)level. The levels are determined by a number of genetic factors includinggenetic variation of BLC11A, HBS1L-MYB, ITGA1, RUNX1T1and HBG2genes. The BCL11A and ZBTB7A genes (LRF protein) are responsible for the suppression of γchain, andHbF production.

FiveHbF quantitative trait loci (QTL) markers foe SCA that are known are shown below:

- The **Xmn I** site upstream of (G) γ-globin gene (**HBG2**) on chromosome **11p15.**
- **BCL11A** on chromosome **2p16**.
- **HBS1L-MYB**intergenic polymorphism (**HMIP**) on chromosome **6q23**.
- **ITGA1** encodes the integrin alpha subunit of a cell-surface receptor on chromosome **5(5q11.2).**
- **RUNX1T1**a transcriptional corepressor that impacts myeloid differentiation in hematopoiesis on chromosome **22(8q22.22).**

Figure 8 shows the protein-protein interactions for SCA markers. The markers shown closer association with other proteins like TFAP4, MIPEP, HBD, HBE1, etc

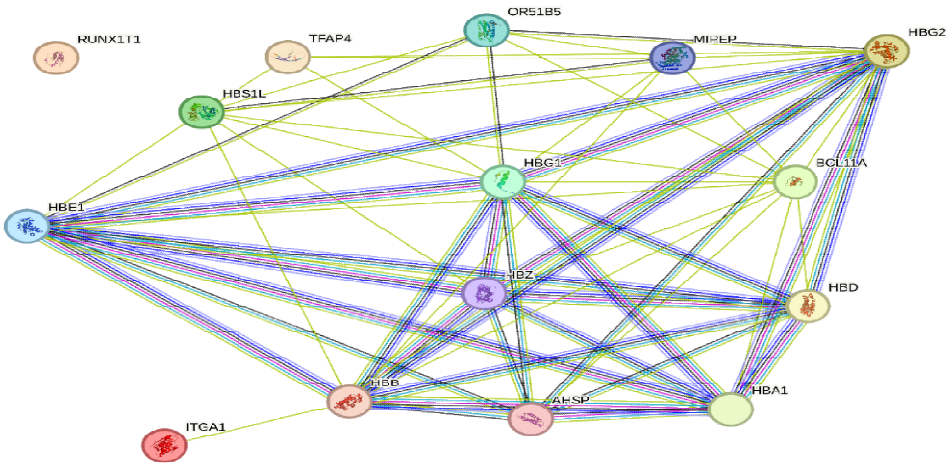


**Figure 8: Protein-Protein interaction for SCA markers**

The gamma globin genes (HBG1 and HBG2) are normally expressed in the fetal liver, spleen and bone marrow (Venkatesan et al., 2021). Two gamma chains together with two alpha chain contains foetal hemoglobin (HbF) which is normally replaced by adult hemoglobin (HbA) at birth.

The population of Bilaspur district in Chhattisgarh, India is 1628202 as on Jan 2025, with sex ratio of female: male as 972:1000. The 35.8%of population lives in urban area (Sahu and Gautam, 2024). Despite the child–woman ratio being high among Kawar followed by Birhor and Gond (Karri and Mathew, 2022).

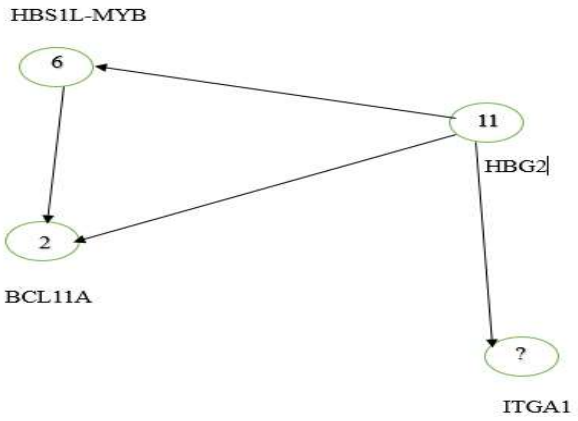


**Figure 9: Relation of Loci**

The HBG2 gene, along with the XMN1 and HBS1L-MYB genes, contain single nucleotide polymorphism (SNPs) that modulate the expression of HbF. HbF expression increases with the down regulation of three main quantitative trait loci (XMN1-HBG2; HBS1L-MYB and BCL11A genes) (Figure 9). These genes contain single nucleotide polymorphisms (SNPs)that modulate the expression of HbF differently in various populations.

According to data of sickle cell positive line list, district Bilaspur as on 27/06/2024, the percentage of Sahu family affected is 0.019 percentage, Yadav family affected is 0.017 percent and percentage of Manikpuri family0.005 percent. The sickle cell anemia data is having both diseased and carrier. The carriers are more compared to diseased individuals (Figure 10,11 and 12).

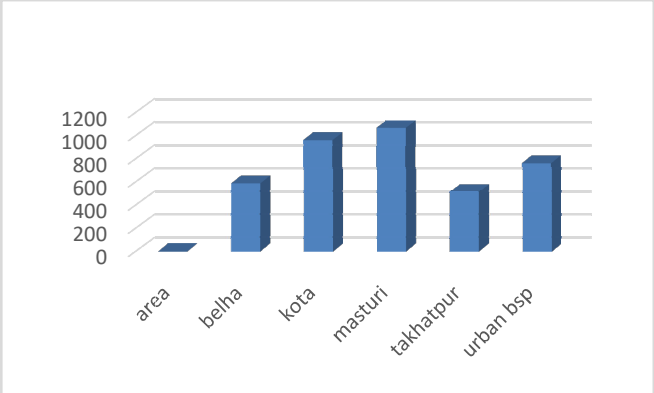


Figure 10: SCA patient area-wise in Bilaspur

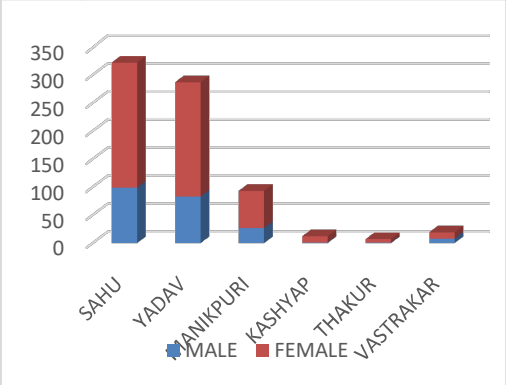


Figure 11: Data based on caste and gender

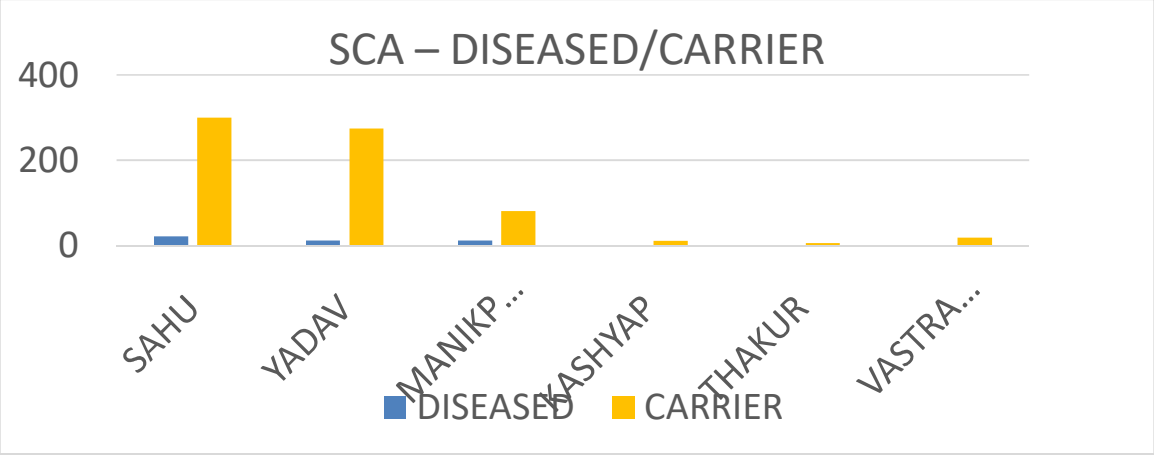


Figure 12: Data based on diseased and carrier by caste

## 2. CONCLUSION

According to data of sickle cell positive line list, district Bilaspur of Chhattisgarh as on 27/06/2024, the percentage of Sahu family affected is 0.019 percentage, Yadav family affected is 0.017 percent and percentage of Manikpuri family 0.005 percent. The sickle cell anemia data is having both diseased and carrier. The carriers are more compared to diseased individuals. Further advanced data analysis has been required using machine learning and Artificial intelligence for better findings that can lead to control of Sickle cell anemia.

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# THEORETICAL INSIGHTS INTO THE STRUCTURAL, ELECTRONIC AND OPTICAL PROPERTIES OF CUBIC AND HEXAGONAL CDS

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The study of cubic and hexagonal structure of CdS is presented in this paper. On the basis of first principle density functional theory implemented in SIESTA code structural, electronic and optical properties of the proposed system were analyzed.The study contains the analysis of structural, electronic properties viz. Energy bands, partial density of states (PDOS), density of states (DOS) etc. Finally their optical properties analysis were given an emphasis in which absorption coefficients, optical conductivity, real and imaginary dielectric constants and reflectivity were studied The obtained results indicate that both cubic and hexagonal structure of CdSpossesses a direct band gap and hexagonal structured CdS have larger band gap than cubic structure. The present study opens possibilities for designing materials for opto-electronic devices with improved properties.
**Keywords:**Conductivity, Density Functional Theory, Band Structure,DOS, PDOS

## 1. INTRODUCTION

Polycrystalline thin films of CdS are always a prominent material for the development of reliable and cost-effective photovoltaic. CdS nanocrystalline thin films have specific characteristics which are suitable for solar cell fabrication. They have good optical transmittance, a significant band gap of 2.42 eV, good electrical properties, high absorption coefficient, low resistivity and easy ohmic contact. Because of these qualities, it is suitable for solar cell applications. CdS is utilized as a window electrode because of its stability, reasonable conversion efficiency and its deposition technique is low –cost (Maitry Dey, 2019) .It is well known that CdS thin films may be exist in either cubic or hexagonal phase (R. Demir, 2015).

In the present work, studies of cubic and hexagonal structures of CdS have been performed. Structural, electronic and optical properties are investigated by following the First –principles density –functional theory (DFT), and calculations are performed using a computational program SIESTA.

## 2. LITERATURE REVIEW

(Maitry Dey, 2019)presented studies on deposition of CdS thin film by thermal evaporation. It was found that the as deposited CdS thin film possesses higher carrier concentration, hall coefficient and mobility but the resistivity is relatively low. It was well known that the higher mobility and carrier concentration with lower resistivity were suitable for better CdS/CdTe solar cell characteristics. The lower resistivity with higher mobility and carrier concentration of the obtained films confirms good electrical properties needed for solar cells, LEDs and photonic devices. The fabricated CdS thin film's characteristicsencourage to use for solar cell in- house fabrication.

(M Junaid Iqbal Khan, 2018)reported study oneffect of Ni concentration on optical properties of rocksaltCdS system (A DFT + *U* study). The present investigation uses a computational method based on PBE-GGA and GGA + U approximations to examine the optical characteristics of Ni-doped rocksaltCdS. The effect of raising the dopant concentration while maintaining a constant supercell size is the main focus of the study. Higher Ni concentrations cause notable changes in optical characteristics, such as a redshift in optical absorption, when

Cd atoms are swapped out for Ni atoms. The GGA + U technique yields absorption spectra that exhibit minor changes as energy increases. By improving the CdS lattice's optoelectronic characteristics, Ni doping increases the technology's potential uses in optical sensors, optoelectronic devices, and related fields.

## 3. METHODOLOGY

Structural, electronic and optical properties calculations are performed using the density functional theory (DFT) as implemented in Spanish Initiative for Electronic Simulations with Thousands of Atoms (SIESTA) code (Omprakash Verma, 2020). The whole system was optimized by using all essential steps such as mesh cutoff, k-point,lattice optimization etc. During optimization process to obtain correct result ,it is essential that all the atoms should remain in fully relaxed state. For exchange and correlation potential , a Generalized Gradient Approximation (GGA) of Perdew –Burke- Ernzerhof is used (Burke, 1996).Throughout the geometry optimization, numerical atomic orbitals with double zeta polarization (DZP) basis sets are used (Q.S. Li, 2008). The core electrons were implicitly treated by using norm-conserving pseudo potentials (N. Trouillier, 1991), the pseudo potentials and the basis sets for constituent atoms are taken from SIESTA code.

The valence electrons functions are expanded in double zeta polarized basis set (Junquera J.Paz O, 2001)(Shen C, 2009)of localized orbitals and the real space grid is set to be 200 Ry. This yielded a fully optimized CdS cubic structure of primitive cell which contained 1 Cd and 1 S atoms. Similarly, CdS hexagonal structure of primitive cell which contained 2Cd and 2 S atoms.

## 4. RESULTS AND DISCUSSION

### 4.1 Structural Analysis

Here the structural analysis of cubic structures of CdS and hexagonal structures of CdS have been performed, For this some of the input parameters like Mesh cutoff , k grid ,CG steps are set. k-grid were acquired by using Monkhorst pack scheme with a value of (7 x7x 7) arbitrary units, these are among all three axes.

Table 1. Input parameters of Cubic and Hexagonal CdS structures.

| System Used | Mesh –cutoff (Ry) | Fermi Energy (eV) | Cell volume (A˚3) |
|---|---|---|---|
| Cubic CdS | 200 | -4.963162 | 56.448687 |
| Hexagonal CdS | 200 | -4.800008 | 104.862904 |

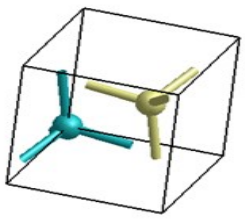
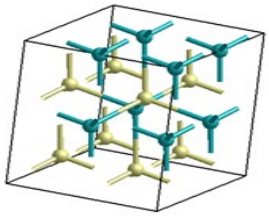


**Figure 1**.(a) Primitive cell of CdS cubic structure



.(b) Crystal Structure of CdS cubic structure

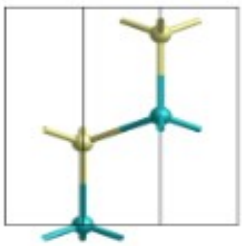
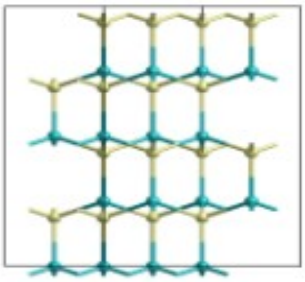


Figure 2 (a) Primitive cell of Hexa CdS Structure



(b) Crystal Structure of Hexa CdS Structure

Figure1 (a) and (b) displays the primitive cell and crystal structure of cubic CdS. Figure 2 (a) and (b) displays the primitive cell and crystal structure of hexagonal CdS . In figure 1(a) golden colour ball represents Cd atom and blue colour ball represents S atom.

**Table 2.** The bond length and bond angles between the atoms

| Sr. No. | Compound Name | Bond Name | Bond Length (In Angstroms) |
|---|---|---|---|
| 1. | Cubic CdS | Cd-S | 2.64 |
| 2. | Hexagonal CdS | Cd-S | 2.5707 |
| | | S-Cd | 2.5707 |

**Table 3.** Bond Angles of Cubic CdS and Hexagonal CdS structures

| Sr. No. | Compound Name | Angle Name | Angle Value (In Degree) |
|---|---|---|---|
| 1. | Cubic CdS | Cd-S | Not Present |
| 2. | Hexagonal CdS | Cd-S-Cd | 109.137 |
| | | S-Cd-S | 109.137 |

As we know the Shorter the bond,the greater the electronegativity of the cation (G.V. Gibbs, 1998). Here we obtained that bond length of cubic Cd-S is greater than hexagonal Cd-S. It signifies that in cubic structure of CdS ,Sulphur is less electronegative than hexagonal structure of CdS. The cell volume of cubic CdS is 56.448687 **A˚3** and hexagonalCdS is 104.862904 **A˚3.** Also it is observed thatFermi level of cubic CdS is -4.963162eV and hexagonalCdS is -4.800008eV.

**3.2 Electronic properties Analysis**

Figure 3 (a) and (b) displays the calculated density of states (DOS) and Figure 4 (a) and (b) displays the projected density of states (PDOS) of cubic CdS and hexagonal CdS molecules. We can define the forbidden energy gap as the difference between the highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO) which is an essential mechanism to understand conductivity of material (Jothi M, 2013). As the charge transport properties of the molecule predominantly depend on the forbidden energy gap, it is important to examine the variations in the molecular orbital energy level and forbidden energy gap(Shafiee A, 2011)(Djurovich P I, 2009 )(Rangel T).

### 3.2.1. The density of states

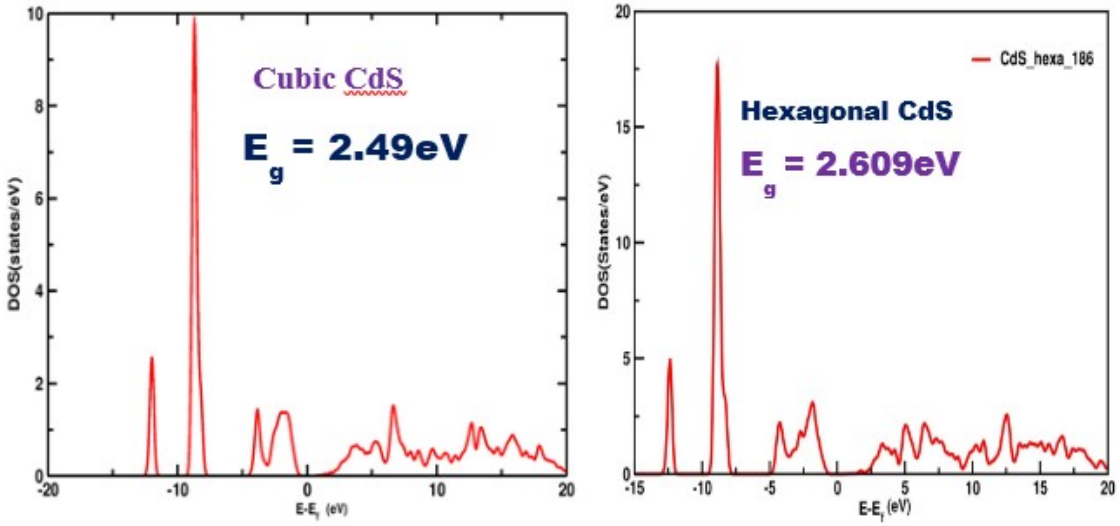



**Figure 3.**( a) DOS plot of cubic CdS structure (b) DOS plot of hexagonal CdS structure.

### 3.2.2. Projected Density of states

From the PDOS plots, it is obtained that in case of cubic CdS , 4d orbital of Cd atom ,3s orbital of S and 3p orbital of S atom shows maximum contribution in the valence band. 5p orbital in Cd and 3d orbital of S atom shows maximum contribution in conduction band. Similarly, in case of hexagonal CdS, 4d orbital of Cd atom, 3s orbital of S atom and 3p of Sulphur atom shows maximum contribution in the valence band. While 3d orbital of S atom and 5p orbital of Cd atom shows maximum contribution in conduction band (L, 2019).

In Figure 3 (a) it could be observed that the forbidden energy gap of cubic CdS structure is around 2.49eV. Whereas in Figure 3 (b), it could be observed that the forbidden energy gap of hexagonal CdS structure obtained is around 2.82 eV, both of these values are less than the reported band gaps in its bulk form.

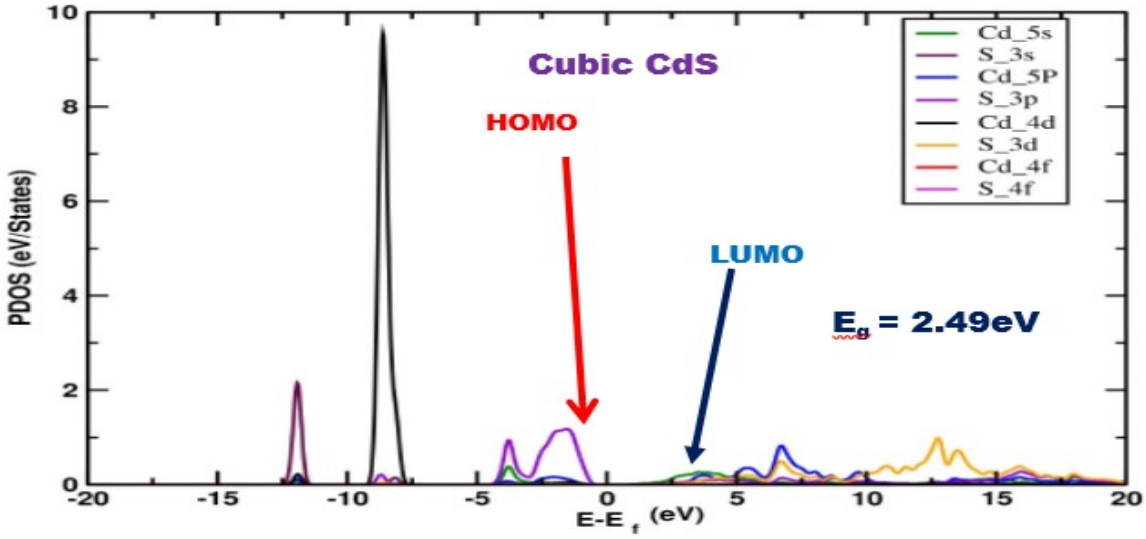



**Figure 4.** (a) PDOS plot of Cubic CdS structure

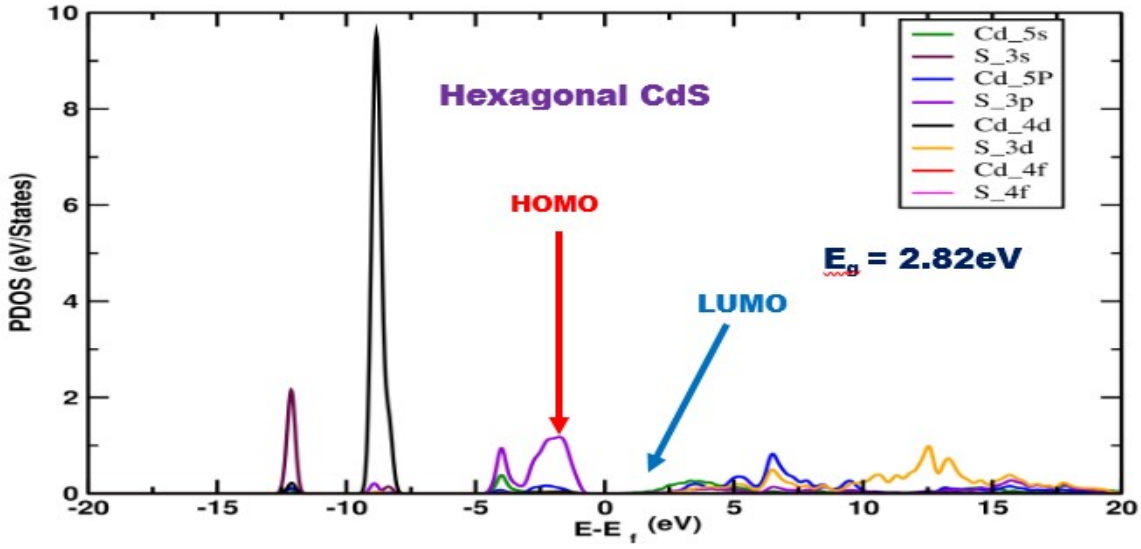
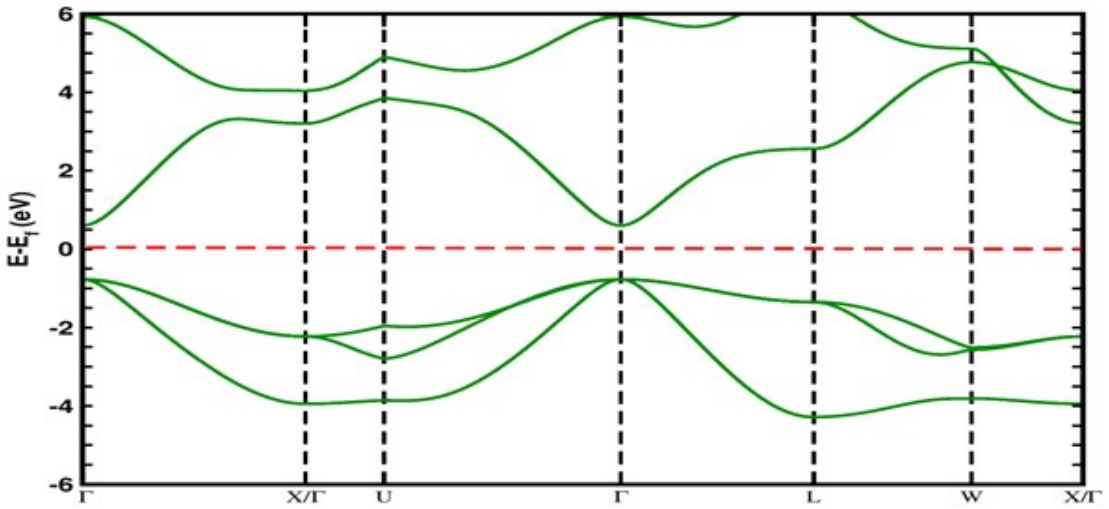



**Figure 4.**( b) PDOS plot of Hexagonal CdS structure

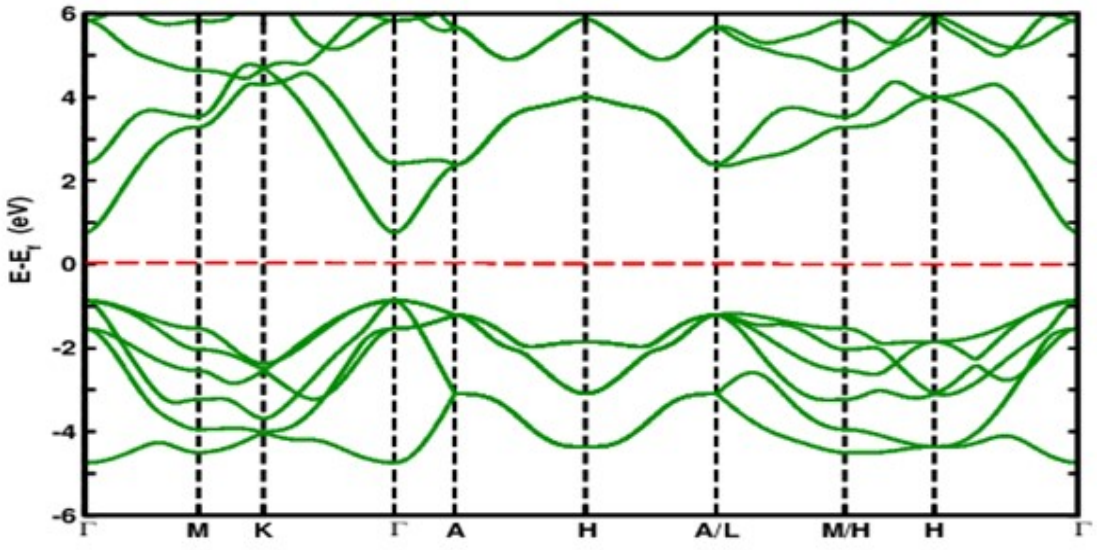
### 3.2.3. Band Structure

The electronic band structures are calculated along the high symmetry direction of the Brillouin zone .The band structures for all potential approximations are demonstrated in Figure 5 (a) and 5(b). From the calculations, the obtained bandgap values in eV are given in Table 4 and comparison is made with existing theoretical and experimental results. From Table 4 and Figures 5(a) and 5(b), one can observe that DFT method based on the exchange-correlation functional of LDA and GGA provides underestimated value of the energy bandgap (~1.47–1.68eV) compared to the experimental energy bandgap.




**$E_g$ =1.47eV**

Figure 5(a) Band structure of cubic CdS




$E_g$=1.68eV

Figure 5(b) Band structure of hexagonal CdS

| **Table 4.** Band Gap of Cubic CdS and Hexagonal CdS structures | | |
|---|---|---|
| **Sr.No** | **Compound Name** | **Band Gap (eV)** |
| 1. | Cubic CdS | 1.47 |
| 2. | Hexagonal CdS | 1.68 |

### 3.2.4. Optical Properties

Optical properties nanoparticles of CdS have brought tremendous change in setting new horizons in nanotechnological advancements. CdS exhibit astonishing and appealing optical behavior due to quantum confinement effects(M Junaid Iqbal Khan, 2018)(U. Pal, 1997)(Sarkar, 2014)(Ping Li).CdS is a semiconductor which has wide application in recent technology due to its exceptional physical properties. It has applications in the field of photonics, energy device, and light sensing. The dielectric constant and extinction coefficient are the optical properties of a medium which can be derived from its complex dielectric function,

$$\varepsilon = \varepsilon_1(\omega) + i\varepsilon_2(\omega) \ldots\ldots\ldots\ldots (1)$$

Direct computation of many-body wave function yields the imaginary part of dielectric function (L Li, 2009).

Traits for optical constants (absorption, conductivity, reflectivity, dielectric constant and refractive index) of cubic CdS structure and hexagonal CdS structure have been demonstrated in figure 6-7.

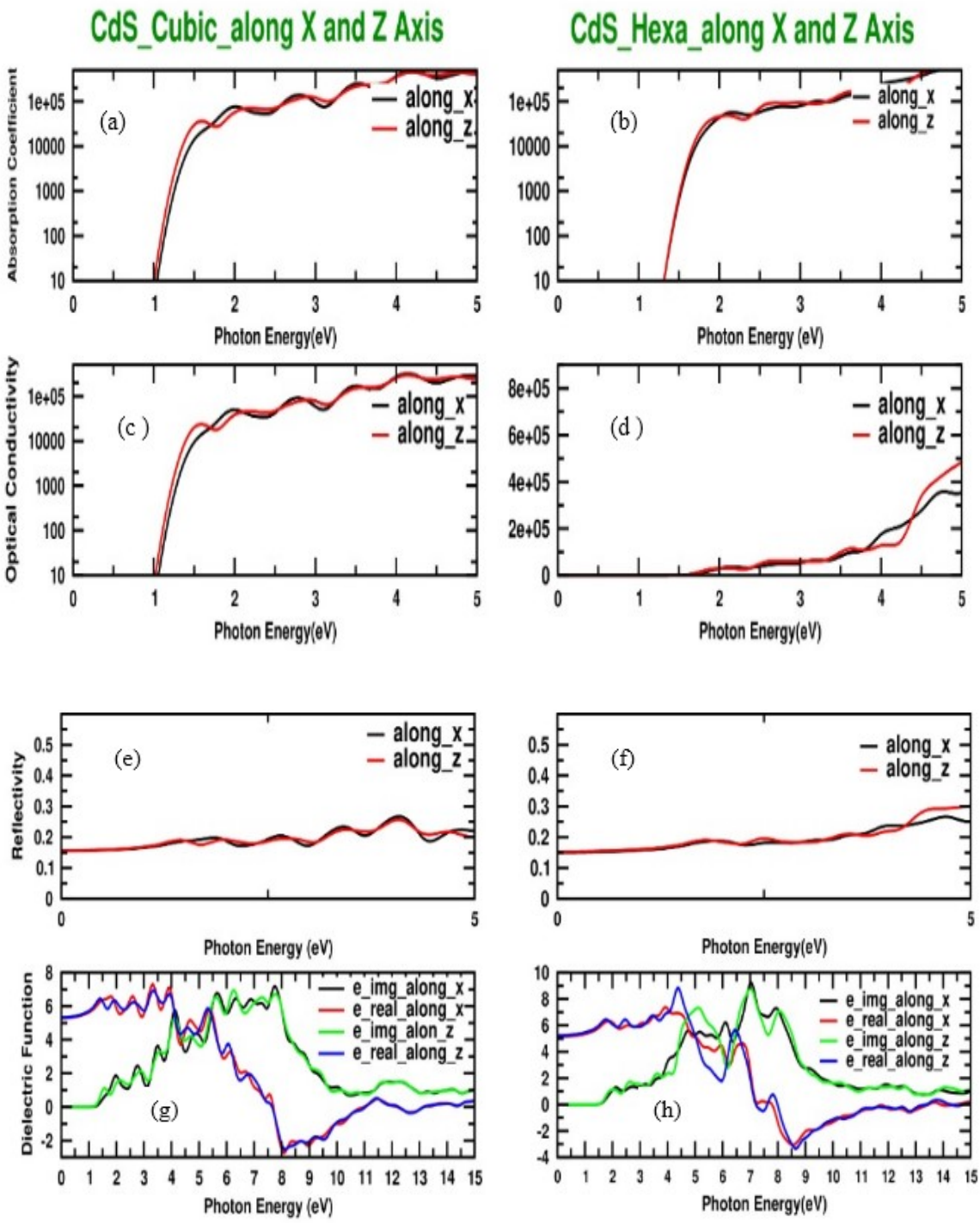



**Figure 6** (a) Absorption Coefficient of cubic CdS (b) Absorption Coefficient of hexagonal CdS

(c) Optical conductivity of cubic CdS (d) Absorption Coefficient of hexagonal CdS

(e)Reflectivity of cubic CdS (f) Reflectivity of hexagonal CdS

(g) Dielectric function of cubic CdS (h) Dielectric function of hexagonal CdS

Fig. 6(a) and (b) depicts plots of absorption coefficient of cubic CdS and for hexagonal CdS structure. For the case of cubic CdS, a gradual increase in absorption trend along with increase in photon energy (eV) is remarkably noted which attains maximum absorption at 4.7 eV. After reaching maximum value, the plot shows sudden decrease, which becomes almost constant for broad energy scale (eV). Absorption hump for cubic CdS may be identified as the exciton peak of cubic CdS(M Junaid Iqbal Khan, 2018)(W. Benstaali, 2014). And for the case of hexagonal CdS, a gradual increase in absorption trend along with increase in photon energy (eV) is remarkably noted which attains maximum absorption at 4.7 eV. After reaching maximum value, the plot shows sudden decrease, which becomes almost constant for broad energy scale (eV). Absorption hump for cubic CdS may be identified as the exciton peak of hexagonal CdS.

Fig. 6(c ) and (d) depicts plots of conductivity of cubic CdS and for hexagonal CdS structure. Conductivity is calculated using Wien2K code and from the graphs it is obvious that conductivity increases with increase in energy. Conductivity graphs shows increasing and decreasing trends with the existence of humps at particular energies over the entire energy range 0–05 eV. For cubic CdS, conductivity trait rises at 2.0 eV energy and then shows sudden rise until a maximum conductivity is obtained at 4.3 eV which decreases till 5.0 eV. It then shows a slow rise and then becomes almost constant for rest of higher energy values. A remarkable thing is that we observe conductivity humps for For hexagonal CdS, conductivity trait rises at 2.0 eV energy and then shows sudden rise until a maximum conductivity is obtained at 4.7 eV which decreases till 5.0 eV. It then shows a slow rise and then becomes almost constant for rest of higher energy values.

Energy (frequency) dependent reflectivity curves for cubic CdS and hexagonal CdS have been demonstrated in Fig. 6(e) and 6(f). Reflectivity is plotted by taking energy in range 0–5 eV and it has been found that maximum reflectivity peak for cubic CdS is obtained at energy value of 4.2 eV which shows sudden decrease upto 5.0 eV and becomes almost constant for rest of energy values. Reflectivity trends for hexagonal CdS have clear difference in comparison to reflectivity plot for cubic CdS. Maximum reflectivity of hexagonal CdS system is experienced in low energy region (0–4.0 eV). Due to exceptional reflectivity behavior of cubic and hexagonal CdS material, it may be used as window material having excellent transparency. Moreover, reflectivity lower values as exhibited by this material facilitates its scope in coating purposes of optical devices related to anti-reflection including lenses, binoculars etc(M Junaid Iqbal Khan, 2018)(M. Junaid Iqbal Khan Z. K., 2019).

Optical transitions between unoccupied and occupied states are caused by electric field. Because of this fact, optical constants such as dielectric constant carry importance in understanding behavior of physical system. Optical properties are mostly dependent on any medium and are calculated in term of complex dielectric function $\varepsilon(\omega)$. Complex dielectric function is composed of real $\varepsilon_r(\omega)$ and imaginary $\varepsilon_i(\omega)$ parts (M. Junaid Iqbal Khan Z. K., 2018).

$$\varepsilon(\omega) = \varepsilon_r(\omega) + i\varepsilon_i(\omega) \ldots\ldots\ldots\ldots (2)$$

The direct solution of the many body wave electrons function yields $\varepsilon_i(\omega)$ and hence, $\varepsilon_r(\omega)$ can be evaluated from real part via Kramers-Kronig transform (M. Junaid Iqbal Khan Z. K., 2019)(B. Bhattacharya, 2015).

Fig. 6(g) and 6(h) depicts dielectric plotsfor cubic CdS and hexagonal CdS.These plots are interpreted by taking energy in range 0–15 eV along x-axis and z axis.. Dielectric imaginary part plot along x and z axis for cubic CdS have steady increase till 8.0 eV which further shows sudden decrease up to 11.0 eV and then after an increase and decrease it becomes almost constant for rest of energy values. Dielectric imaginary part plot along x and z axis for hexagonal CdS have steady increase till 7.0 eV which further shows sudden decrease up to 10.0 eV and then after an increase and decrease it becomes almost constant for rest of energy

values. Dielectric real part plot along x and z axis for cubic CdS have steady increase till 3.0 eV which further shows sudden decrease up to 4.4 eV and then after an increase and decrease it becomes almost constant for rest of energy values. Dielectric real part plot along x and z axis for hexagonal CdS have steady increase till 4.0 eV which further shows sudden decrease up to 8.0 eV and then after an increase and decrease it becomes almost constant for rest of energy values.

In general, Both high and low values of dielectric constant is important and needed in electronic industry. Polar groups and intrinsic ions are responsible for high dielectric constant. Because of high dielectric constant of CdS system, this materials may have diverse applications in the field of piezoelectric transducers, memory elements, dielectric amplifiers, semiconductor devices, dielectric based capacitors, rectifiers and photonic devices based on capacitors with dielectrics(Biao Zhao M. H.). Moreover, the high dielectric constant of CdS material enable it to be potentially used in new generation of electrostatic capacitors, called the New Paradigm Super (NPS) capacitors (Samuel Fromille, 2014).

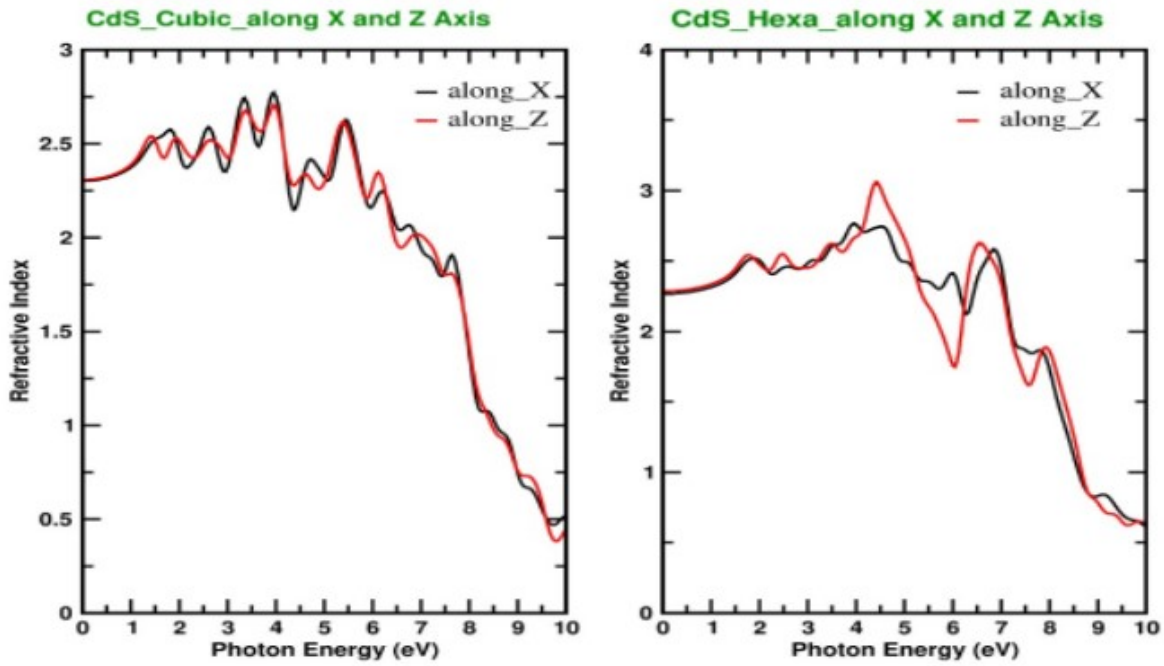



**Figure** 7(a) Refractive index of cubic CdS (b) ) Refractive index of hexagonal CdS

Refractive index (n) is meaningful and significant physical quantity in optics which provides important facts about light behavior inside any material. It is matter of fact that when light passes different media then its velocity changes which in responsible for variation in refractive index of material. Fig. 7(a) and 7(b) exhibits a good comparison among refractive indices of cubic CdS and hexagonal CdS along x-axis and z-axis. Refractive indices are plotted over energy in range 0–10 eV and exhibit an increasing trend with increase in energy (eV). In case of cubic CdS maximum value of refractive index is 2.8 is attained at 3.9 eV (˜ 317 nm). After attaining n, maxima at 3.9 eV, graph shows sudden decrease till 4.5 eV. It then increases further until 5.5 eV and again decreases for higher energy values. In case of hexagonal CdS maximum value of refractive index is 3.1 is attained at 4.1eV (˜ 317 nm). After attaining , maxima at 4.5 eV, graph shows sudden decrease till 6.0 eV. It then increases further until 7.0 eV and agan decreases for higher energy values.

However, experimental value of refractive index for CdS thin films is 2.38 at 1.96 eV (˜632.8 nm)(M. Junaid Iqbal Khan Z. K., 2019)(M. Junaid Iqbal Khan S. B., 2016). DFT value for refractive index of CdS is 2.9(M/ Junaid Iqbal Khan, 2017). Higher values of n may be related to increase in crystallite size which is due to microstrain decrease (R. Premarani, 2015). Higher n values of CdS system may margin its potential uses in the field of anti-reflection coating, environmental detectors, building displays, opthalmics, solar cells, photodetectors and may have extended applications in areas of photonics and biomedics(Angela Piegari, 2018)(D. Lisnic, 2010).

## 5. CONCLUSION

In this work, we investigated the structural, electronic and optical properties of cubicCdS and hexagonal CdS. We performed theoretical study using SIESTA where we have employed PBE-GGA approximation. The band gap energy obtained with hexagonal is higher than cubic structure, while the bond length between Cd and S atoms is reduced. The increase in band gap energy can be explained by quantum confinement effects associated with the size reduction of CdS structure.PDOS illustrate dominant role of S atoms (p-orbital) while contribution of Cd d-states and p-states are observed in both cubic and hexagonal structure. For optical properties, we found that cubic CdS and hexagonal CdS have low absorption and high transparency which is also explained by quantum confinement effects. According to these obtained properties,cubic and hexagonal CdS can be one of the promising nanomaterials for optoelectronic applications.

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# CHALLENGES FACED BY RETAILERS OF CHHATTISGARH IN ADOPTION OF FINANCIAL TECHNOLOGY (OR FINTECH) SERVICES AND PRODUCTS: A CASE STUDY OF BILASPUR CHHATTISGARH

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The adoption of financial technology (or FinTech) has the ability to make financial services accessible and convenient for the people of globe and India, but there are significant challenges which restrict the adoption FinTech by the retailers of India. The present study aims to examine the major challenges faced by the retailers of Bilaspur Chhattisgarh towards the adoption of FinTech. The study was conducted in Bilaspur Chhattisgarh. A pre-tested and self structure questionnaire was used to collect the response from the retailers of Chhattisgarh. The findings of this study reported eight (08) major challenges which are faced by the retailers of Bilaspur Chhattisgarh towards the adoption of FinTech. These challenges include; perceived risk of FinTech use, perceived ease of FinTech use, perceived benefits of FinTech, social influence on FinTech use, cash culture in retailing sector of Bilaspur, lack of digital literacy among retailers of Bilaspur Chhattisgarh, lack of awareness among retailers of Bilaspur Chhattisgarh among retailers of Bilaspur Chhattisgarh, and lack of financial literacy among retailers of Bilaspur Chhattisgarh. The study revealed that the retail sector of Bilaspur was dominated by the unorganised retailers. The FinTech firms need to make awareness among the people of Bilaspur Chhattisgarh regarding the benefits of FinTech services or products. Addressing these challenges can help in creating a conductive environment for the adoption of FinTech which will ultimately enhance the financial inclusion among the unorganised retailers of Bilaspur Chhattisgarh. The present study could be extended to the other regions of Chhattisgarh and India to compare the challenges faced by the retailers to FinTech adoption.

**Keywords:** FinTech, Retailer Sector, Challenges, Bilaspur Chhattisgarh.

## 1. INTRODUCTION

The rapid advancement of financial technology (or fintech) has significantly transformed the retail industry, presenting both opportunities and challenges for retailers (Suryono, et.al., 2020). FinTech has been described as an emerging financial service sector in 21st century (Karthika, et.al., 2022). The phrase was first used to describe technologies used in the back offices of reputable trade and consumer banking organizations (Pepard,2000). The phrase has become more inclusive since the end of the first decade of the twenty-first century, including any technology advancement in the financial industry (Badwan and Awad, 2022), including those related to retail banking, investments, financial literacy and education, and even cryptocurrencies like bitcoin. The introduction of financial technology services dates back to to the fourth industrial revolution (Industry-4.0). Further the advancement of FinTech was stimulated by Bali FinTech Agenda held in Oct-2018 (Rowan, et.al., 2019). The Bali Fintech Agenda was launched by the IMF and World Bank Group, to capitalize on advances in financial technology while managing risks. Bali Fintech Agenda provides a framework to

support the Sustainable Development Goals, particularly in low-income countries, where access to financial services was low. The major agenda of Bali FinTech Agenda were; to embrace the promise of FinTech, enable technologies to enhance FinTech services, foster FinTech to increase financial inclusion, to develop financial markets, adapt regulatory framework for adoption of FinTech services, safeguard the integrity of FinTech, develop infrastructure for regulation of FinTech, etc. With the help of the concomitant rise in internet and Smartphone usage, the Indian government, both at the federal level and in the states, has leveraged fintech to promote inclusion (Ghosh, 2021). Fintech use in India has increased as a result of Demonetization and Digital India initiatives. India's Unified Payment Interface (UPI)-based interoperable payment system still has a compelling economic rationale (Rani and Swach, 2023). As the financial sector becomes increasingly digitized, retailers are faced with the pressing need to adopt fintech services to remain competitive and meet the evolving expectations of their customers.

The Indian retail sector is one of the growing economic sectors and regarded as the key player of Indian Economy (Prajapati, 2024). With the increase in the human population and manufacturing sector there is a significant increase in the Indian retail sector (Naqvi, et.al., 2019). This sector includes that economic sector of India which involves the sale of goods and services to consumers. The retailers buy products and services from the manufacturers and sell them to the consumers. Retail sector in India has experienced significant transformation over the past decade. The Indian retail industry is the fifth largest in the world, with a diverse mix of organized and unorganized players (Kumar, 2023). Recent estimates suggest that the Indian retail sector is valued between $1.3 trillion in 2022 and it's expected that it will reach $ 2 trillion in 2032. The retail segment accounts for only 10 percent of the total market, but is expected to rise to 20 to 25 percent by 2030 (Kumar, 2023). This growth is driven by changing lifestyles, strong income growth, and favorable demographic patterns. The rapid development of India's manufacturing, infrastructure, and communication sectors, along with a conducive policy environment, has contributed to the growth of the retail industry of India.

The induction of financial technology services has brought revolution in the Indian retail sector (Dapp, et.al., 2014). Fintech companies have developed digital platforms and mobile applications that enable retailers to perform a wide range of financial transactions, such as money transfers, bill payments, and online lending, with greater convenience and efficiency. The adoption of FinTech by the retail sector is still restricted by number of challenges. The behavior of retailers towards the adoption of the FinTech need to be evaluated and the challenges which the retailers face during adoption of FinTech should be properly examined. Thus, in the present study the major challenges faced by the retailers of Bilaspur, Chhattisgarh have been examined.

## 2. RESEARCH METHODOLOGY

The purpose of this study is to examine the major challenges faced by the retailers of Chhattisgarh in adoption of FinTech services. The target population for the present study was the retailers of Bilaspur, Chhattisgarh (A Tier-II city). The overall sample size selected for the present study were 100 respondents (n=100). The sample size for the present study was calculated by the following formula;

$$n = N \times \frac{\frac{Z^2 \times p \times (1-p)}{e^2}}{\left[N - 1 + \frac{Z^2 \times p \times (1-p)}{e^2}\right]}$$

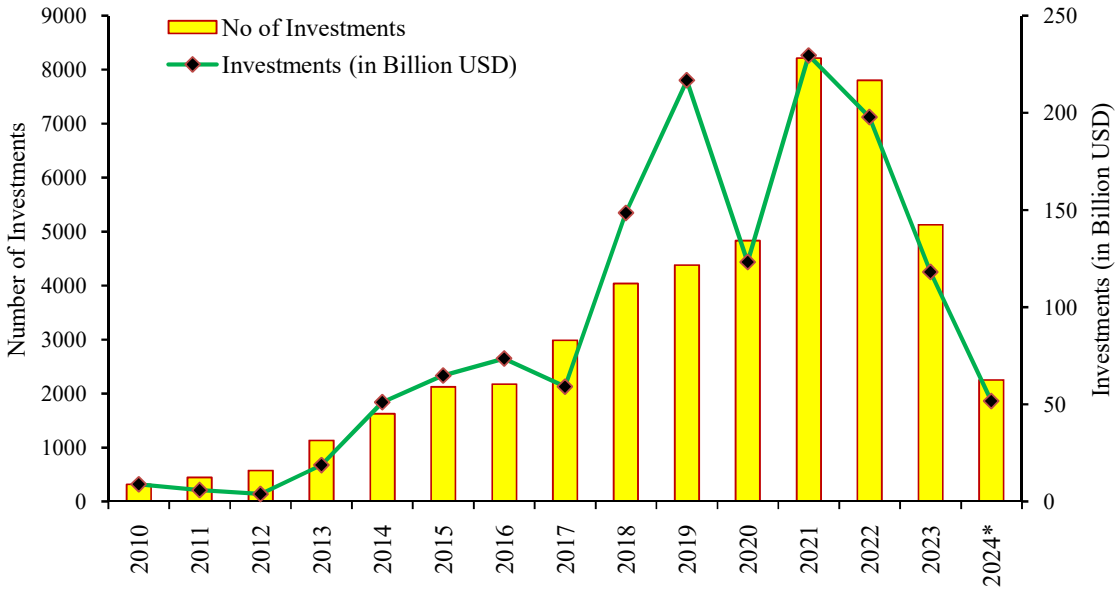
Where,

n = Sample size
N = Population size,
Z = Critical value of the normal distribution at the required confidence level,
p = Sample proportion,
e = Margin of error

The present study employs a quantitative approach. Since, there are number of young, middle aged and old aged retailers in Bilaspur, Chhattisgarh, India. Therefore the quantitative approach is more suitable to help in collecting data from large size of samples. Furthermore,in the study we have collected quantitative data by applying a aself structured questionnaire. A pilot study was conducted and then a self structured questionnaire was developed. An expert validity of the questionnaire was done then the questionnaire was tested with the help of pre-testing techniques. The data was collected from the respondents through a pre-tested and validated questionnaire. Once the responses of the respondents were collected from the survey, then it was subjected to analysis by using different statistical methods. The retailer response towards the adoption of FinTech with the respective weights of different scales was classified (Likert, 1934). The collected data was fed up in the excel spreadsheet for further analysis. The data were tabulated and statistically analyzed by t-Test and analyses of variance (ANOVA) at ($p \leq 0.05$) level of significance. Correlation analysis was done to evaluate the parametric relationships between different luxury product attributes and consumer buying behavior. The data was analyzed using SPSS or XLSTAT software.

## 3. RESULTS AND DISCUSSION

The financial crises in 2008 observed globally were regarded to be the turning point of financial management which gave rise and reason for the adoption of FinTech as a new norm. At this time the developed nations were engaged in developing the sophisticated FinTech products for the consumers, retailers and manufacturers. The advancement in the digital ecosystem has increased the application of FinTech services and products. After the global financial crisis of 2008 the younger consumers and retailers has lost their trust on the banks and they have made their adjustments towards the FinTech for their financial management. Meanwhile the FinTech innovations have attracted the investors and technology based service providers. The growth in the investments and number of investments on the FinTech sector has fuelled the utilization of FinTech during 2013-14. Fig-1 shows the investments (in Billion USD) and number of investments made in FinTech sector during 2010 to 2024. It's clear visible from the graph that there has been a significant growth in the investments and number of investments from 2013-14 in FinTech sector. The financial management through FinTech services and products have increased the financial literacy of the people and in the present context maximum people are aware about the financial activities of stock market.




*Source: BNY Mellon, 2024*
**2024: Upto Q1 of FY*

**Fig-1**. Shows the detail of Investments (in Billion USD) and number of Investments in Fintech Sector in World from 2010 to 2024.

The present study was conducted to determine the adoption of FinTech services by the retailing sector of Bilaspur, Chhattisgarh. Table-1 shows the socio-demographic attributes of retail sector of Bilaspur Chhattisgarh. From the results it's visible that the retail sector in Bilaspur is dominated by unorganised retail sector than the organised retail sector. Across the sampled retailers 77% were male and remaining 3% were female retailers. 12% retailers of Bilaspur Chhattisgarh were illiterate and remaining 88% retailers were literate. The literacy among the organised retailers was higher than the unorganised retailers. The monthly income of 11% retailers was lower than 2 Lakh per annum, maximum retailers (46%) have an income between 2 Lakh-6 Lakh per annum. 21% retailers has income between 6 Lakh-9 Lakh per annum, 12% retailers has income between 9 Lakh-12 Lakh, and remaining 10% retailers has income above 12 Lakh per annum. Across the sampled retailers of Bilaspur Chhattisgarh, 19% retailers belong to general category, 25% retailers belong to SC category, 15% retailers belong to ST category, 35% retailers belong to OBC category and remaining 5% retailers belong to other categories. It was evident from the results that 31% retailers belongs to organised retailer sector and remaining 69% retailers belong to unorganised retailer sector. Thus these results depicts that the Bilaspur retailing sector is dominated by unorganised retailers. These results are inconsistent to the status of Indian retail sector.

**Table-1.** Demographic profile of the retailers in Bilaspur Chhattisgarh (n=100)

| Items | **Demographic** | **Frequency** | **%** | **Mean±SD** |
|---|---|---|---|---|
| 01. Gender | Male | 77 | *77.0%* | **1.37±0.483** |
| | Female | 23 | *23.0%* | |
| 02. Age | Upto 20yr | 17 | *17.0%* | **2.17±0.839** |
| | 21-40Yr | 44 | *44.0%* | |
| | 41-60Yr | 34 | *34.0%* | |
| | above 60Yr | 8 | *08.0%* | |
| 03. | Illiterate | 12 | *12.0%* | **2.21±0.918** |

| | | | | |
|---|---|---|---|---|
| Education | Upto 10th | 19 | *19.0%* | |
| | Upto 12th | 25 | *25.0%* | |
| | Diploma | 5 | *05.0%* | |
| | UG | 22 | *22.0%* | |
| | PG &above | 17 | *17.0%* | |
| 04. Income | Below 2 Lakh | 11 | *11.0%* | **3.40±1.577** |
| | 2 Lakh-6 Lakh | 46 | *46.0%* | |
| | 6 Lakh-9 Lakh | 21 | *21.0%* | |
| | 9 Lakh-12 Lakh | 12 | *12.0%* | |
| | above 12 Lakh | 10 | *10.0%* | |
| 05. Caste | General | 19 | *19.0%* | **2.60±1.173** |
| | SC | 25 | *25.0%* | |
| | ST | 15 | *15.0%* | |
| | OBC | 35 | *35.0%* | |
| | Other | 5 | *05.0%* | |
| 06. Retailer Type | Organised | 31 | *41.0%* | **1.70±0.483** |
| | Unorganised | 69 | *59.0%* | |

Table-2 shows the major challenges faced by the retailers of Bilaspur Chhattisgarh during adoption of FinTech services and Products. The results reveal that across different challenges which retailers of Bilaspur Chhattisgarh face during adoption of FinTech services and products the factors which affect significantly include; perceived risk, perceived ease of use, perceived benefits, social influence, cash culture, lack of digital literacy, lack of awareness, and lack of financial literacy. The results reveal that majority of the retailers responded that these challenges restrict them for the adoption of FinTech services and products. The perceived risk towards the adoption of FinTech was the concerns and doubts which the retailers raised. The risk of loss of money, risk of fraud transactions, risk of coming under the scanner of taxation and regulations were the major prior risks which the retailers have recorded. The perceived risk negatively affects the intention to use the FinTech services or products by the retailers of Bilaspur Chhattisgarh. The results show that the perceived risk was a significant (t= 2.76, p=0.0069) challenge towards the adoption of FinTech. Perceived ease of use is the second challenge which retailers face towards adoption of FinTech services and products. Under these challenges the retailers reported that adoption of FinTech needs effort and financial literacy, thus its use isn't easy. In this study it was reported that perceived ease of use is a critical factor which influence the retailers in adoption of the FinTech services and products.

**Table-2:** Major Challenges faced by the retailers of Bilaspur Chhattisgarh in adoption of FinTech services and products (n=100)

| S.NO | Challenges in Adoption of FinTech | Factor and Item | Mean | Std. Dev | Standard Factor Loading | t-value | Sig |
|---|---|---|---|---|---|---|---|
| **01** | | Perceived Risk | 4.11 | 0.919 | 0.820 | 2.76 | 0.0069* |
| **02** | | Perceived Ease | 4.62 | 0.331 | 0.897 | 3.06 | 0.0028* |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | of Use | | | | | |
| **03** | | Perceived Benefits | 4.09 | 0.577 | 0.792 | 3.19 | 0.0019* |
| **04** | | Social Influence | 3.89 | 0.288 | 0.836 | 2.89 | 0.0470* |
| **05** | | Cash Culture | 4.29 | 0.334 | 0.813 | 3.11 | 0.0024* |
| **06** | | Lack of Digital Literacy | 3.76 | 0.167 | 0.784 | 2.16 | 0.0332* |
| **07** | | Lack of Awareness | 3.15 | 1.221 | 0.779 | 2.47 | 0.0152* |
| **08** | | Lack of financial Literacy | 3.97 | 0.688 | 0.860 | 2.09 | 0.0392* |
| **Statistically significant at p≤0.05* | | | | | | | |

In this study perceived benefits include those which the retailers get after adoption of FinTech services and products. It was observed that retailers responded that the adoption of FinTech services and products was lack of benefits, thus they avoided to use the products and services of FinTech. The perceived benefits to the user remain one of the key challenges for the adoption of FinTech. The social influence during adoption of any technology remains also a key challenge. In this study the respondents reveal that the adoption of FinTech is associated with the social influence, thus they avoid adoption of these services or products. Bilaspur city is a developing city of Chhattisgarh. In this place the cash culture is prominent. The people of Bilaspur prefer physical transactions over digital payments. Thus in this study we have found that the cash culture of Bilaspur Chhattisgarh has been a significant (t=3.11, p=0.0024) challenge towards the adoption of FinTech services or products. The people of Bilaspur Chhattisgarh are technologically in a developing stage. The retailers of Bilaspur Chhattisgarh don't have proper knowledge of digital technologies. The adoptions of FinTech need efficient knowledge of digital technologies. Thus the lack of digital literacy also remains a major challenge for the adoption of FinTech by the retailers of Bilaspur Chhattisgarh. The retailers of Bilaspur Chhattisgarh are not aware about the benefits of using FinTech services or products. In the present study we have found that the lack of awareness about the FinTech services or products by the retailers of Bilaspur Chhattisgarh was significant (t=2.47, p= 0.0152) barrier towards the adoption of FinTech. Lastly the financial literacy s one of the important factor which define the adoption of FinTech by the people. The majority of the retailers of Bilaspur Chhattisgarh are street vendors, thus they have lack of financial literacy. Under such circumstances the hinder to adopt the FinTech services or products. In this study we have observed that the lack of financial literacy of the retailers was a significant (t=2.09, p=0.0392) barrier in the adoption of FinTech by the retailers of Bilaspur Chhattisgarh.

The study highlights that the above-mentioned challenges were the key factors which affect the adoption of FinTech services or products by the retailers of Bilaspur Chhattisgarh. The FinTech firms need to make awareness among the people of Bilaspur Chhattisgarh regarding the benefits of FinTech services or products. In addition to this the Government of Chhattisgarh need to make regulations towards the digital payment security and risks. The results of this study have significant implications for the financial institutes, policy makers, FinTech firms, academicians, and researchers to promote the financial inclusion, digital transformation, and financial literacy in Tier-2 cities of Chhattisgarh in specific and cities of India in general. Addressing these challenges can help in creating a conductive environment for the adoption of FinTech which will ultimately enhance the financial inclusion among the unorganised retailers of Bilaspur Chhattisgarh. The present study could be extended to the other regios of Chhattisgarh and India to compare the challenges faced by the retailers to

FinTech adoption. This study may be replicated to draw out the fruitful conclusions, which can be utilized by policy makers and FinTech firms. Future studies regarding the structure modeling for the adoption of FinTech by the different retailers could be conducted by using the results of present study.

## 4. CONCLUSION

The aim of the present study was to identify the key challenges faced by the retailers of Bilaspur Chhattisgarh towards the adoption of FinTech. The study was conducted in Bilaspur Chhattisgarh. The response was collected from the retailers of Bilaspur Chhattisgarh. The results reveal that the unorganised retail sector dominates the retail sector of Bilaspur Chhattisgarh. In this study it was revealed that the adoption of FinTech was affected by number of factor. Among these challenges we have highlighted on those which affect significantly ($p \leq 0.05$) to the adoption of FinTech by the retailers of Chhattisgarh. In this study we have extracted eight major challenges which affect the adoption of FinTech by the retailers of Chhattisgarh. These challenges include; perceived risk of FinTech use, perceived ease of FinTech use, perceived benefits of FinTech, social influence on FinTech use, cash culture in retailing sector of Bilaspur, lack of digital literacy among retailers of Bilaspur Chhattisgarh, lack of awareness among retailers of Bilaspur Chhattisgarh among retailers of Bilaspur Chhattisgarh, and lack of financial literacy among retailers of Bilaspur Chhattisgarh. The results of this study have significant implications for the financial institutes, policy makers, FinTech firms, academicians, and researchers to promote the financial inclusion, digital transformation, and financial literacy in Tier-2 cities of Chhattisgarh in specific and cities of India in general.

**Conflict of Interest**

The author declare no conflict of Interest

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# THE INFLUENCE OF SOCIAL MEDIA IN DRIVING CONSUMER PURCHASE DECISIONS

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The rise of social media has transformed the way consumers interact with brands and make purchase decisions. Social media has become an essential part of the modern consumer's buying journey, influencing everything from product discovery to post-purchase engagement. It has become an indispensable tool in modern era todrive consumer purchase decisions through platforms that foster engagement, reviews, direct brand interactions, and brand loyalty. The role of social media in purchasing decisions has become increasingly significant in the digital age, as consumers turn to social platforms not only for entertainment and communication but also for product discovery and brand engagement. Unlike traditional advertising, social media allows two-way communication, enabling consumers to actively participate in discussions about products and services. This shift has created a dynamic environment where trust, authenticity, and social proof significantly impact consumer behavior. Through user-generated content, influencer marketing, and targeted advertisements, these platforms directly and indirectly shape what people choose to buy. Social media's ability to create emotional connections, increase product visibility, and foster trust makes it acrucial tool in shaping purchasing behaviors. Thispaper explores the various ways like use of algorithms to display personalized advertisements based on user preferences and browsing behavior through which social media influences consumer behavior, shaping purchasing decisions. Social media platforms such as Instagram, Facebook, Twitter, and YouTube enable consumers to discover products, engage with brands, and access user-generated content that acts as social proof, driving trust and credibility.Overall, Social media's ability to create emotional connections, increase product visibility, and foster trust plays a crucial role in influencing both the initial awareness and final purchase decisions of consumers.

**Keywords:** Social Media, Social Media Platforms, Purchase Decisions, Consumer Behavior, Digital Interactions.

## 1. INTRODUCTION

The rapid development of internet technology has driven the evolution and widespread adoption of social media, which has become an integral aspect of contemporary society. Social media, as an internet-based application platform, facilitates the creation, sharing, and exchange of content, fostering rich experiences and interactive opportunities for users. Its core features include user-generated content (UGC) presented in various formats such as text, images, and videos; interactivity that enables communication and feedback between users; and immediacy that ensures the rapid dissemination of information.

Over the past decade, social media platforms have transformed the way individuals create, present, and share content. They provide dynamic spaces for users to showcase their creative talents, including photography, writing, music composition, and video production, enabling global recognition and feedback.

Social media's reach and influence are substantial, as of January 2025; there were approximately 5.24 billion social media users worldwide, representing about 63.9% of the global population. That equates to annualised growth of 4.1 percent, at an average rate of 6.5

new users every single second.The latest figures indicate that 94.2 percent of the world's internet users now use social media each month. (DATAREPORTAL, 2025)This widespread adoption has profoundly altered the consumer decision-making process. This significant increase in social media engagement has prompted brands to collaborate with influencers to effectively communicate their messages and connect with potential customers. Through social media, consumers can access diverse and detailed information, such as user reviews, product evaluations, and influencer endorsements, all of which shape purchasing decisions. Simultaneously, social media enables companies to engage directly with consumers, offering opportunities for personalized marketing through targeted advertisements, promotional campaigns, and interactive product demonstrations. This dual impact not only enhances enterprises' marketing strategies and competitiveness but also provides consumers with a convenient and tailored shopping experience.

This study systematically reviews existing research to examine the specific roles and influences of social media across the various stages of consumer purchasing decisions. This exploration aims to provide insights into impact of social media reshapes consumer behavior and offers strategic advantages for businesses in a digitally connected world.

## 2. LITERATURE REVIEW

Extensive research was conducted to gain a deeper understanding of the existing body of knowledge related to the influence of social media in driving consumer purchase decisions. This investigation illuminated various aspects and significant factors of the field.

The internet has significantly transformed consumers, societies, and businesses, providing widespread access to information, enhanced social networking, and improved communication capabilities. The rapid growth of social media platforms and their user bases has prompted brands to partner with social media influencers in order to effectively communicate their messages and engage with potential customers. Notably, even before the pandemic, India boasted 400 million social media users, and this number has surged dramatically in the past 18 months. (Economic Times, 2021)

Studies indicate that YouTube has the greatest number of active users today, WhatsApp and Facebook rank second and third (respectively), Instagram ranks fourth, with the platform's active app users equating to just over 72 percent of YouTube's active app user base. (DATAREPORTAL, 2025) These platforms through significant influence on brand awareness and consumer engagementhas altered the traditional consumer decision-making process. The interactive nature of social media encourages consumers to actively seek information, share experiences, and provide feedback.

The credibility of social media content significantly affects its influence on purchase decisions. Authentic reviews and peer recommendations are often perceived as more trustworthy than brand-generated content. UGC, such as reviews and photos shared by consumers, creates a sense of community and trust. Studies show that 85% of consumers find UGC more influential than brand-created content. (CrowdRiff, 2024).

The company's latest data indicates that YouTube ads reach 2.53 billion users per month, Facebook reach 2.28 billion and Instagram ranks third at a worldwide level, with 1.74 billion users per month (DATAREPORTAL, 2025).Influencer marketing leverages key opinion leaders to convey a brand's message to broader audience segments.(Zak & Hasprova, 2020) This approach allows brands to promote their products and services indirectly, focusing on building trust and credibility. Influencers are particularly effective because they have cultivated loyal followings that rely on their advice for fashion, food, and lifestyle choices (Smart Insights, 2017). Collaborations between brands and influencers have become a cornerstone of marketing strategies, as they help capture attention, enhance brand recognition, and create impactful, memorable campaigns. Influencers, with their established

credibility and large follower bases, are pivotal in driving purchase decisions. Millennial trusts influencer recommendations over traditional advertisements.

The authenticity, trustworthiness, and creativity of social media content play a critical role in shaping consumer behavior. Research highlights that well-presented and innovative marketing content increases consumers' willingness to purchase recommended products, often leading to immediate actions. The Economic Times (2021) reported that while celebrities account for only 27% of marketing expenditure, influencers dominate the space, capturing 73% of the marketing budget. This dominance reflects the growing trust and engagement between influencers and their followers, with nearly two-thirds of India's population actively following influencers on social media.

The rapid growth of social media attracts high-quality customers as social media users are more likely to recommend products to their personal networks, amplifying the impact of campaigns (Bloggers' Mind, 2019). This trend underscores the effectiveness of social media marketing in driving consumer engagement, enhancing brand visibility, and generating revenue, making it a pivotal element in the modern marketing landscape.

While social media offers immense opportunities, it also presents challenges such as misinformation, oversaturation of content, and privacy concerns. These factors can undermine trust and diminish the effectiveness of social media strategies.

## 3. EXPERIENTIAL WORK

### 3.1 Research Methodology

In this exploratory study titled The Influence of Social Media in driving Consumer Purchase Decisions, various secondary sources have been referred or explored to gain in-depth knowledge in the area. The reviews of different reports and articles of research scholars published online on Research Gate, SSRN and other publication platforms' had also taken into consideration while research.

### 3.2 Findings

The pervasive influence of social media has fundamentally transformed the consumer decision-making process, enabling a seamless integration of online interactions and purchase behaviors. Conceptual framework outlines the critical elements of social media's impact on consumer purchasing decisions, organized around the five main stages of the consumer decision-making process: *problem identification, information search, options assessment, purchase decision, and post-purchase behavior.*

#### 3.2.1 Role of Social Media in the Purchase Decision-Making Process

##### 3.2.1.1 Problem Identification Stage

Social media plays a pivotal role in creating awareness of needs or problems. This stage is often triggered by:

- **Internal Stimuli:** Influencers and peers sharing their experiences or showcasing products on social platforms may invoke latent needs.
- **External Stimuli:** Advertisements, product recommendations, and lifestyle content create awareness of potential solutions.

##### 3.2.1.2 Information Search Stage

After recognizing a need, consumers turn to internal and external sources for information. Social media enhances this stage by:

- Facilitating access to **user-generated content (UGC)**, such as reviews, photos, and videos.
- Providing **platform-based reviews and testimonials** that offer authentic feedback.
- Leveraging **algorithm-driven personalized advertisements**, presenting users with relevant product information.

##### 3.2.1.3 Options Assessment Stage

Consumers evaluate alternatives by comparing features, prices, and reviews. Social media aids this evaluation process through:

- **Interactive brand engagement**, such as comments, likes, and shares, which reinforce product visibility.
- **Influencer endorsements**, which shape perceptions and offer relatable recommendations.
- **Visual content**, including product demonstrations and real-life usage scenarios, shared by other consumers.

#### 3.2.1.4 Purchase Decision Stage

The final decision is often influenced by:

- **Promotional activities:** Limited-time offers, group buying campaigns, and exclusive discounts frequently highlighted on social platforms.
- **Social proof:** Recommendations and feedback from peers and influencers validate the purchase decision.
- **Direct interaction with brands:** Consumers leverage social media for instant support and feedback, increasing confidence in their choices.

#### 3.2.1.5 Post-Purchase Behavior Stage

Post-purchase, consumers engage with brands and peers through:

- Sharing reviews and experiences, which influence the decisions of others.
- Providing feedback on after-sales service and product satisfaction.
- Developing brand loyalty through consistent engagement with the brand's social media content.

### 3.2.2 Factors Influencing Consumer Decisions

Social media's impact on consumer purchasing decisions is further shaped by the following factors:

#### 3.2.2.1 Personal Factors

- **Demographics:** Age, gender, income, and education influence preferences and purchase behaviors.
- **Lifestyle and Hobbies:** Consumers' social media interactions reflect their personal interests, subtly shaping their purchasing priorities.

#### 3.2.2.2 Social Factors

- **Family Influence:** Roles, responsibilities, and the presence of dependents within a household impact decisions.
- **Reference Groups:** Friends, colleagues, and social circles heavily influence product choices.

#### 3.2.2.3 Psychological Factors

- **Motivation:** Consumers' perceptions of their needs are shaped by the persuasive content on social media.
- **Learning:** Experiences shared on social platforms foster learning, reinforcing positive perceptions of a brand or discouraging engagement due to negative reviews.
- **Beliefs and Attitudes:** Brand image, advertisements, and user-generated content shape consumers' overall evaluation of products and services.

This highlights that social media facilitates consumer engagement at every stage of the purchase journey. By leveraging features such as UGC, targeted advertising, and influencer marketing, social media not only influences individual purchasing decisions but also creates a ripple effect on broader consumer behavior. Understanding these dynamics offers valuable insights for businesses seeking to enhance their marketing strategies and foster meaningful consumer relationships.

## 4. CONCLUSION

Social media has become an indispensable tool in shaping consumer purchase decisions, revolutionizing traditional marketing approaches and creating a dynamic, interactive environment for both consumers and brands. Its ability to connect users, provide authentic peer-generated content, and leverage the influence of trusted opinion leaders has redefined the consumer decision-making process. By integrating features such as targeted advertisements, user-generated content, and influencer marketing, social media platforms influence every stage of the purchase journey, from problem identification to post-purchase engagement.

The research highlights that consumers increasingly rely on social media for product discovery, evaluation, and purchase validation, as these platforms foster trust, authenticity, and emotional connections. The rise of influencer marketing further emphasizes the importance of credibility and relatability in driving consumer behavior, with influencers playing a pivotal role in shaping perceptions and promoting products effectively.

However, the challenges are also associated with social media, such as misinformation, content oversaturation, and privacy concerns, which can undermine consumer trust and engagement. Businesses must address these challenges proactively while leveraging the strategic advantages of social media to remain competitive in the digital marketplace.In conclusion, social media's transformative impact on consumer behavior presents significant opportunities for businesses to enhance engagement, foster loyalty, and drive revenue by crafting targeted, effective marketing strategies that resonate with today's market.

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# A COMPREHENSIVE REVIEW ON SYNTHETIC METHODS AND CHARACTERIZATION TECHNIQUES OF CARBON-SUPPORTED COPPER OXIDE NANOCOMPOSITE, AND THEIR ENVIRONMENTAL APPLICATIONS

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Copper has emerged as a significant metal in chemistry, particularly due to its abundance and extraction methods. While nanotechnology has become a powerful field with numerous applications across various sectors, carbon and its allotropes serve as valuable support materials owing to their high surface area, stability, and excellent thermal and electrical properties. The incorporation of nanoparticles onto support materials enhances their physical and chemical characteristics. This review examines the synthesis strategies, characterization techniques, and applications of carbon-supported copper nanomaterials. We explore various synthesis methods, their characterization using different spectroscopic and analytical techniques, and their environmental applications, including organic dye degradation, metal sensing, carbon dioxide detection, and glucose sensing. The review also highlights the reusability of these nanomaterials. By providing this comprehensive overview, we aim to inspire researchers to develop advanced Cu-based nanomaterials for diverse future applications.

**Keywords:** Green chemistry, Nanotechnology, carbon-supported, copper oxide nanomaterial, metal-sensing, dye degradation, nitrophenol reduction.

## 1. INTRODUCTION(Level 1: First Section)

Nanotechnology has emerged as a significant field of study in various scientific disciplines, including physics, chemistry, and biology [Ahmad et al., 2019; Isaac et al., 2013;Jianrong et al., 2004]. This technology involves the creation of diverse materials at the nanoscale, typically ranging from 1 to 100 nm in at least one dimension, collectively known as nanomaterials [Ahmad et al., 2019; Nadeem et al., 2020]. The ability to manipulate properties at such a minute scale has opened up numerous opportunities for scientific and industrial applications [Isaac et al., 2013; Atale et al., 2017]. Researchers from multiple fields are drawn to nanomaterials due to their wide-ranging potential uses [Kubik et al., 2005]. Various methods, including physical, chemical, and biological approaches, have been employed to produce nanoparticles with specific shapes and sizes [Chaudhuri et al., 2012]. Several metal oxide nanoparticles have been reported, such as FeO, CuO, MgO, ZnO, $CeO_2$, $TiO_2$, and $ZrO_2$ [Zhu et al. 2006; Ulbrik et al., 2016; Dhoble et al., 2018], each possessing unique characteristics and applications. Among these, copper oxide (CuO) nanoparticles have garnered significant attention due to their versatile applications [Krishnan et al., 2017]. CuO, a p-type semiconductor with a narrow bandgap, exhibits a monoclinic structure [Rafea et al., 2008]. The diverse properties of CuO nanoparticles lend themselves to a wide array of applications, including biomedical uses (such as antimicrobial, anti-fouling, antifungal, antibiotic, antioxidant, drug delivery, and anticancer treatments), textile industries, thermo-sensing and conducting materials, gas sensors, catalysis, synthesis of inorganic-organic nanosize composites, magneto-resistant materials, high-temperature superconductors, and environmental remediation [Ren et al., 2009: Verma et al., 2019; Chang et al., 2011; Devi et al., 2014]. While various physicochemical methods have been widely used to fabricate CuO nanoparticles [Vasantharaj et al., 2019], these techniques often have drawbacks, including the release of toxic chemicals into the environment, high energy consumption, and elevated costs [Buazar et al., 2019]. Consequently, there is a growing need for eco-friendly, cost-effective approaches to synthesize nanoparticles with high purity, crystallinity, phase selectivity, and homogeneity in shape, size, and texture [Vasantharaj et al., 2019; Buazar et al., 2019; Rehana et al., 2017]. Green chemistry and biological techniques have paved the way for more economical and environmentally friendly methods of nanoparticle fabrication [Rehana et al., 2017; Singh et al., 2017]. This green approach utilizes biomass and biological entities for the

production of CuO nanoparticles [Nair et al., 2015; Awwad et al. 2020], resulting in a process that is not only environmentally friendly but also dynamic, safe, and cost-effective [Rehana et al., 2017; Nair et al., 2015]. While nanoscale materials are highly intriguing in the fields of nanoscience and nanotechnology, their high surface area to volume ratio often leads to rapid aggregation and precipitation, significantly reducing their catalytic activities. To address this issue, nanoparticles are frequently supported on various materials to prevent aggregation and precipitation [Khan et al., 2016; Gul et al., 2017]. Efficient support materials for nanoparticle stabilization are highly valued in catalysis, as they can hold and deposit nanoparticles through their inherent structures and functional group characteristics, providing strong support and stability. Numerous support materials have been documented in the literature, including chitosan, cellulose acetate, $SiO_2$, $Mn_2O_3$, poly(methyl methacrylate), styrene, and many others [Khan et al. 2016; Astruc et al., 2005; Khan et al., 2016]. Recently, there has been a growing interest in plant-based support materials [Dubey et al., 20210; Nadagouda et al., 2014; Ismail et al., 2018]. Plant-derived support materials are favored over traditional options due to their non-toxic nature, cost-effectiveness, widespread availability, biological efficacy, and eco-friendliness [Bello et al., 2017; Shamadi et al., 2009]. These materials boast several advantageous characteristics, including abundance, biodegradability, biocompatibility, antibacterial properties, and hydrophilicity [Krishnaraj et al., 2010]. Moreover, plant-based nanoparticles (NPs) are gaining prominence in nanotechnology because of their safety for human health and the environment. This review primarily examines various synthesis methods, including green synthesis of copper oxide nanoparticles, their characterization techniques, and significant environmental applications.

## 2. Synthetic Methods of Nanomaterials

Copper oxide nanoparticles can be produced through various physical, chemical, and biological methods (Figure 2). These include sonochemical, precipitation, sol-gel, chemical reduction, chemical bath deposition, hydrothermal, non-vacuum and spin coating sol-gel, electrothermal, and green chemistry approaches [Zhao et al., 2017; Sackey et al., 2020; Vishveshvar et al., 2018; Pourbeyram et al., 2019; Rafique et al., 2018; Azam et al., 2012; Muniyandi et al., 2019; Sirdeshpande et al., 2018]. These techniques are broadly categorized into two main approaches: bottom-up and top-down (Figure 1) [Khan et al., 2019], as illustrated in Figure 1. The bottom-up approach is constructive, involving the assembly of small atomic particles to form nano-sized structures, while the top-down approach is destructive, breaking down large molecules into smaller ones, which then form suitable nanomaterials [Sirdeshpande et al., 2018].

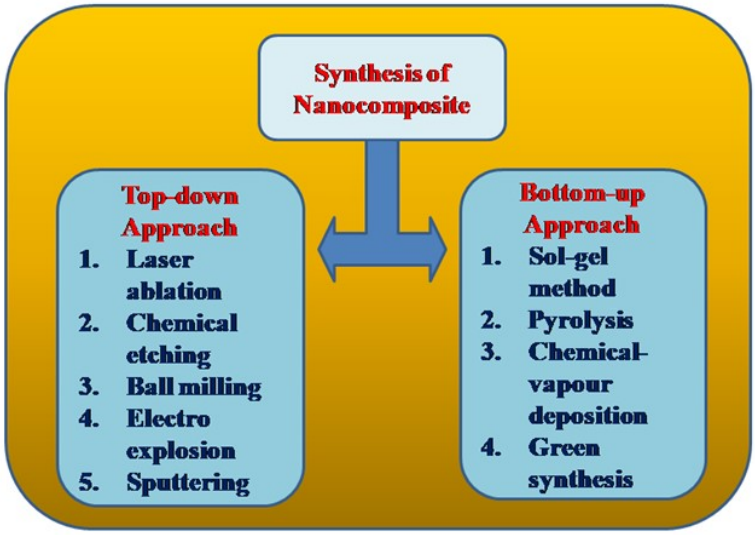


**Figure 1:** Synthetic approaches of nanomaterials.

**(a) Physical Method:** Physical synthesis methods for nanoparticles utilize physical processes and include evaporation-condensation, laser ablation, high-energy ball milling, and thermal decomposition [Sakono et al., 2023]. These techniques offer benefits over chemical synthesis, such as avoiding solvent contamination and achieving uniform nanoparticle distribution [Sadeghi-Aghbash et al., 2022]. However, they have drawbacks, including poor control over nanomaterial morphology, potential presence of unexpected toxic ions in the final products, and difficulties in regulating nanoparticle size and shape [Abid et al., 2022]. Additionally, physical synthesis methods often require substantial energy input and specialized equipment, making them costly and

limiting their scalability for large-scale production. Many of these processes also involve harsh chemicals or extreme reaction conditions, potentially leading to toxic byproducts and posing safety risks to researchers and the environment. These limitations underscore the need for alternative, more sustainable synthesis methods, such as green synthesis.

**(b) Chemical method:** The production of CuOnanomaterials frequently relies on chemical methods due to their practicality. Chemical reduction stands out as a viable approach for nanoparticle synthesis, offering benefits such as swift and cost-effective processing, along with precise particle size control [Aguilar et al., 2019]. Nevertheless, both chemical and physical nanoparticle synthesis techniques have limitations, including high costs, time-intensive processes, energy inefficiency, and the generation of harmful byproducts, rendering them environmentally unfriendly [Kokkinos et al., 2020; Khan et al., 2022; Jan et al., 2020]. Various chemical procedures, including hydrothermal synthesis, electrochemical, chemical, and sonochemical reduction, are utilized in creating CuNPs [Rane et al., 2018]. The chemical reduction process typically employs reducing agents like hydrazine, ascorbic acid, or sodium borohydride [Alegria et al., 2018]. In a study conducted by Nguyen et al. [Nguyen et al., 2021], precursors such as $NaH_2PO_2$, $N_2H_4$, and $NaBH_4$, along with polymeric protecting agents, were used to synthesize Cu nanoparticles. The researchers produced nanoparticles with diverse sizes, shapes, and activities by adjusting the copper salt concentration, reducing agent, solution pH, and synthesis temperature. However, conventional chemical methods for NP synthesis require high pressure, energy, temperature, and toxic chemicals, which pose risks to the environment and human health. Consequently, there is a growing need to replace these chemical methods with eco-friendly synthesis technologies.

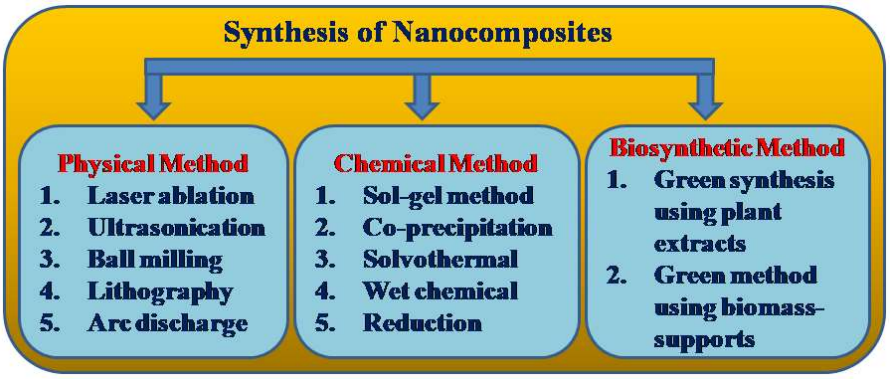


**Figure 2:** Synthetic methods of nanomaterials.

**(c) Biosynthetic method:** Green synthesis strategies are crucial for creating more economical and eco-friendly nanomaterials. These methods aim to minimize or eliminate harmful chemicals, energy-intensive processes, and waste production. Recent research has highlighted the potential of various biomass-derived materials, including agricultural waste, plant fibers, and natural polymers, in nanocomposite formulation [Raju et al., 2016]. These sustainable, abundant resources can be processed using environmentally friendly techniques. Sustainable bio-based carbon nanomaterials, such as biochar or carbon nanotubes, can serve as the foundation for nanocomposite synthesis. These materials can be functionalized or combined with other nanomaterials to develop carbon nanocomposites. The carbon materials can be integrated with various metal oxides or ions to improve their adsorption properties. Scientists have produced carbon nanoparticles from different plant sources. Activated carbon-based nanocomposites, typically synthesized from carbonaceous materials like charcoal or coconut shells, are commonly used. These carbon materials undergo activation using chemicals such as potassium hydroxide or phosphoric acid [Ebadollahzadeh et al., 2020; Yagmur et al., 2021]. The increased porosity of carbon material enhances its adsorption capacity, resulting in improved efficiency in water purification applications [Jawad et al., 2022]. Cheng et al. [Cheng et al., 2019] and colleagues created a fluorescent carbon dot/hydrogel nanocomposite for detecting stable $Fe^{3+}$ ions. Similar research has been conducted to achieve better outcomes through green synthesis techniques [Kiruba et al., 2015; Ahmadian-Fard-Fini et al., 2017;Ganesan et al., 2023]. Juang et al. [Juang et al., 2018] and team developed a novel carbon-$Fe_3O_4$nanocomposite material with a larger surface area for dye removal. The reusable carbon-$Fe_3O_4$ adsorbent demonstrated good adsorption efficiency for dyes. Other carbon-based nanocomposite materials include graphene-based [Li et al., 2019], carbon nanotube-based [Gan et al., 2020], and carbon dot-based nanocomposites [Midya et al., 2020]. Their high surface area, electrical conductivity, and excellent mechanical properties make them highly effective in dye removal. A.V.K.K. et al. have reported the synthesis of biomass carbon supported CuO for treating organic dyes [Viswan et al., 2024].

## 3. CHARACTERIZATION TECHNIQUES

Several important and necessarytechniques(Figure 3) are discussed below:
**(a) UV-visible spectroscopy**: This technique is mainly employed to examine the dimensions, form, concentration, and stability of nanomaterials by evaluating their optical characteristics. The absorption of light in the UV-visible range is highly responsive to the distinct features of nanoparticles, enabling their identification and investigation using a comparatively straightforward and accessible method.

**(b) Infrared (IR) spectroscopy**: This method is primarily utilized to examine the chemical makeup and surface chemistry of nanomaterials. It allows scientists to detect functional groups on nanoparticle surfaces, investigate their bonding structure, and explore interactions between nanoparticles and other molecules. Consequently, IR spectroscopy serves as an essential tool for comprehending and enhancing nanomaterial properties.

**(c) X-ray Diffraction (XRD) analysis** is a vital technique for characterizing nanomaterials. It provides data on their crystal structure, phase identification, crystallite size, lattice strain, and crystallinity degree. Essentially, XRD acts as a unique identifier to recognize and examine the structural characteristics of nanoparticles within a sample. This is accomplished by scrutinizing the diffraction pattern produced when X-rays interact with the crystalline lattice of the nanomaterial.

**(d) Scanning Electron Microscopy (SEM) analysis**: This technique is mainly used to observe and characterize the morphology (shape, size, and surface features) of nanomaterials. It offers detailed information about their particle size distribution, surface topography, and sometimes even elemental composition when combined with Energy Dispersive X-ray (EDX) spectroscopy. This information is essential for understanding the structure and properties of nanomaterials in various applications such as drug delivery, electronics, and environmental remediation.

**(e) EDX (Energy Dispersive X-ray) spectroscopy**: This method is primarily employed to analyze the elemental composition of nanomaterials. It enables researchers to identify specific elements present and their relative abundance within a nanoparticle sample. EDX spectroscopy provides crucial information about the purity and composition of the synthesized nanomaterial, which is essential for understanding its properties and potential applications.

**(f) TEM (Transmission Electron Microscopy) analysis**: This technique is mainly used to characterize the morphology, size, shape, and crystal structure of nanomaterials. It produces detailed images of individual nanoparticles, allowing researchers to analyze their particle size distribution, lattice structure, and potential defects at the nanoscale. This information is crucial for understanding and optimizing the properties of nanomaterials in various applications such as electronics, medicine, and catalysis.

**(g) BET analysis** is primarily utilized to determine the specific surface area of nanomaterials, which is critical for understanding their properties and potential applications due to the high surface-to-volume ratio inherent to nanoparticles. This analysis enables researchers to quantify the amount of surface available for interactions with other molecules, making it a key parameter for characterizing nanomaterials in fields such as catalysis, drug delivery, and electronics.

**(h) X-ray photoelectron spectroscopy**: XPS is mainly used to characterize the surface composition and chemical state of nanomaterials. It provides detailed information about the elements present on the nanoparticle surface, their oxidation states, and the presence of any contaminants. Due to its high surface sensitivity, XPS is a crucial tool for understanding the surface properties and functionalities of nanomaterials.

**(i) TGA analysis**: Thermogravimetric Analysis (TGA) serves as a tool for examining nanomaterials, offering insights into their heat resistance, component makeup, quantity of surface stabilizers or capping agents, and susceptibility to oxidation or breakdown at various temperatures. This information proves crucial for enhancing the production and utilization processes of nanomaterials.

**(j) Atomic Absorption Spectroscopy (AAS)** is primarily employed to examine the elemental makeup of nanomaterials by measuring the levels of specific metals within the nanoparticles. This technique enables scientists to define the material's characteristics and evaluate its purity, particularly for metal-based nanoparticles. AAS is widely regarded as one of the most prevalent methods for quantifying nanoparticle concentration in solution, owing to its high sensitivity in detecting trace metals.

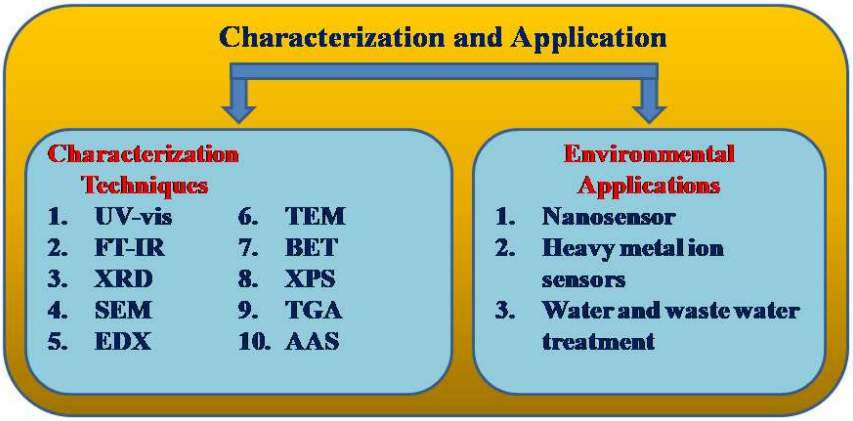


**Figure 3:** Characterization techniques and applications.

## 4. ENVIRONMENTAL APPLICATIONS

In recent years, researchers have focused on developing economically viable and practical nanomaterial catalysts for cutting-edge applications, as well as eco-friendly catalytic processes and sustainable methods for creating catalysts. Scientific research continues to advance, enabling the creation of new materials and applications [Yang et al., 2018]. Noble metal nanoparticles possess a high degree of functionality due to their unique physicochemical properties [Fratoddi et al., 2018]. Their exceptional stability, ability to be functionalized on the surface, and straightforward chemical synthesis make noble metallic nanoparticles like PtNPs, AuNPs, and AgNPs widely applicable [Neuschmelting et al., 2018]. However, some abundant and cost-effective metals have garnered interest as alternatives to the expensive noble-metal catalysts commonly used in traditional commercial chemical processes. Copper-based nanomaterials and nanocomposites are particularly appealing for research due to their high natural abundance, low cost, and numerous practical synthesis methods [Zaera et al., 2013]. The unique properties of copper nanoparticles have led to their increasing importance in various industries, including energy, pharmaceuticals, electronics, machinery, construction, engineering, and environmental sectors. In recent years, scientists have concentrated on sustainable approaches for environmentally friendly catalytic processes in various advanced applications. Several significant applications (Figure 3) are discussed in this context:

**(a) Nanosensor:** The availability and affordability of pollutant detection technology enhance process control, ecosystem monitoring, and environmental decision-making. Sensors that can swiftly and accurately identify pollutants at the molecular level boost human capacity to maintain sustainable health and environmental conditions. Nanosensors are essentially nanoscale chemical, physical, or biological sensors capable of measuring nanoscale changes with exceptional sensitivity and precision, either qualitatively or quantitatively. The widespread trust in data obtained from sensors and nanosensors stems from their key features: high sensitivity, strong detection capabilities, and the ability to measure multiple species simultaneously. [Boruban et al., 2018]

**(b) Heavy metal ion sensors:** Removing heavy metals from wastewater is vital for numerous reasons. Heavy metals like lead, mercury, cadmium, and arsenic are highly toxic and can cause severe environmental damage. They can pollute water bodies, soil, and vegetation, leading to ecosystem disruption and biodiversity loss. These metals also pose significant health risks to humans. When ingested through contaminated water, they can accumulate in the body over time, causing various health issues such as organ damage, neurological disorders, developmental problems in children, and cancer [Balali-Mood et al., 2023]. Adherence to regulatory standards and guidelines limiting heavy metal concentrations in wastewater is crucial to prevent the release of harmful pollutants into the environment. Eliminating heavy metals from wastewater is essential for ensuring water safety and meeting required standards for drinking, cooking, and other household uses [Balali-Mood et al., 2023]. In previous studies, copper oxide-based nanomaterials have been utilized as sensors for heavy metal removal [Eid et al., 2023; Verma et al., 2017; Mahmoud et al., 2021; Darwesh et al., 2023].

**(c) Water and waste water treatment:** Drinking water and the environment are polluted by various organic contaminants released into rivers and sewage systems [Bharti et al., 2023]. These contaminants are often highly toxic, carcinogenic, teratogenic, and mutagenic, posing serious threats to ecosystems and human health. Consequently, it is crucial to explore effective methods for their removal. Organic contaminants encompass a

wide array of chemicals, including dyes, which are increasingly used and exhibit harmful effects on humans. Industries such as printing, cosmetics, food, and textiles extensively employ these dyes, potentially causing adverse health impacts. Cationic dyes, in particular, are utilized more frequently compared to other dye categories [Viswan et al., 2024].

4-nitrophenol (4-NP) is a notable example of a toxic, non-biodegradable, water-soluble chemical commonly found in pesticide and dye production wastewater. It contributes to severe water pollution in agriculture and has genotoxic-carcinogenic effects on humans and animals. The Environmental Protection Agency (EPA) has classified 4-NP as a priority pollutant [Goyal et al., 2014; Yang et al., 2018; Yan et al., 2018]. Its high Hammet constant (0.778) makes it one of the most challenging aromatic compounds to eliminate through conventional oxidation methods [Liu et al., 2014]. However, 4-NP can be reduced to 4-aminophenol (4-AP), which holds significant commercial value in the production of various analgesics, antipyretic agents, and other products such as acetaminophen, finasteride, photographic developers, plastic items, corrosion inhibitors in paints, anti-corrosion lubricants in fuels, and other fine chemicals [Yan et al., 2018; Rode et al., 2002; Du et al., 2014; Meng et al., 2015; Yusran et al., 2016; Das et al., 2019; Min et al., 2008]. Among several reduction methods, using sodium borohydride ($NaBH_4$, SBH) as a mild and thermally stable reducing agent, along with a suitable catalyst, has proven to be an efficient and environmentally friendly approach for 4-NP reduction [Goyal et al., 2014; Yan et al., 2018; Liu et al., 2014]. Ibrahim et al. have reported on the use of CuO@Cnanocomposite for effective 4-nitrophenol reduction [Kassem et al., 2021].

## 5. FUTURE SCOPES NAD CHALLENGES

Carbon-supported copper oxide nanomaterials show promise for environmental applications due to their high surface area, strong adsorption capabilities, and inherent catalytic properties. These materials have potential for removing various pollutants, including heavy metals, organic dyes, and emerging contaminants from water and air. Possible applications include wastewater treatment, air purification, and soil remediation, with advantages such as cost-effectiveness and potential for sustainable synthesis methods. However, several challenges exist, including potential toxicity to living organisms from copper ion release, difficulties in controlling particle size and agglomeration, concerns about long-term stability and environmental release, complex synthesis methods, and the need for comprehensive toxicity assessments prior to large-scale implementation. The main challenge lies in balancing effective pollutant removal with minimizing environmental impact.

## 6. CONCLUSIONS

In the current era of worldwide pollution and environmental awareness, it is crucial to minimize the usage of dangerous substances across various technical fields of application-oriented research. Given this context, the utilization of CuO@carbon as an environmentally friendly nanomaterial is significant in multiple important research areas, including drug delivery systems, addressing various health concerns, enhancing plant defense mechanisms, and in the textile industry. Nevertheless, the synthesis process is critical, as both physical and chemical methods of producing CuOnanomaterials involve harmful substances. Conversely, the biosynthetic approach offers numerous advantages: it is eco-friendly, economical, reliable, stable, energy-efficient, and straightforward. This study provides a comprehensive overview of the advantages and disadvantages of bio-based synthesis methods, their characterization techniques, and some of their environmental applications.

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# IMPROVED DIAGNOSTIC CLARITY IN CT BRAIN IMAGES USING ADAPTIVE GAMMA AND CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION

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Today medical image processing plays an important role to diagnose diseases through medical images like CT scan, MRI etc. Medical Computed Tomography (CT) brain images are essential for diagnosing neurological disorders. Medical computed tomography (CT) scans play a crucial role in diagnosing brain abnormalities such as tumors, strokes, traumatic brain injuries, and vascular malformations. However, CT images often suffer from several limitations, including low contrast in soft tissue regions, brightness inconsistencies, and noise, which can hinder accurate diagnostic interpretation. Traditional image enhancement techniques, such as global histogram equalization and basic gamma correction, offer limited improvements as they fail to adapt to the varying intensity levels in CT scans. This study proposes a hybrid method combining Adaptive Gamma Correction (AGC)(**Wu, H.,2020**). and Contrast Limited Adaptive Histogram Equalization (CLAHE) to enhance CT brain images effectively(**Liu,J.,et al.,2023**). AGC dynamically adjusts the brightness and contrast based on local intensity distributions, allowing for improved enhancement in both dark and bright regions without compromising image quality. CLAHE, on the other hand, divides the image into smaller blocks and applies histogram equalization locally, enhancing contrast while limiting over-enhancement in areas with noise or artifacts. This combination ensures noise reduction, preserves important image details, and enhances the visibility of subtle features in CT brain scans. The proposed method demonstrates significant improvements in diagnostic accuracy, making it a promising approach for medical image enhancement.
**Keywords:** Image Enhancement Techniques, Noise Reduction, Adaptive Gamma Correction, Diagnosis.

## 1. INTRODUCTION

Medical computed tomography (CT) scans are indispensable tools in the clinical diagnosis of a wide range of brain abnormalities, including tumors, strokes, traumatic brain injuries, and vascular malformations. These scans provide valuable insights into the brain's structure, enabling clinicians to make informed decisions regarding patient care. However, CT images often face challenges such as low contrast in soft tissue regions, brightness inconsistencies, and the presence of noise, which can degrade image quality and hinder accurate diagnosis (**Reddy & Sharma, 2023**). In particular, the differentiation between different tissue types, such as gray matter, white matter, and lesions, can be difficult when the contrast is low (**Zhang & Zhou, 2020**).

Traditional image enhancement techniques, including global histogram equalization and basic gamma correction, have been widely employed to improve CT image quality. However, these methods often fall short in adapting to the varying intensity distributions across the image. Global histogram equalization, for instance, applies the same transformation to the entire image, which may lead to over-enhancement in some regions while under-enhancing others (**Gonzalez & Woods, 2018**). Similarly, basic gamma correction applies a fixed gamma value to the image, which fails to account for the non-uniform distribution of pixel intensities, leading to suboptimal results (**Jain, 1989**).

To address these limitations, this study proposes a hybrid method combining Adaptive Gamma Correction (AGC) and Contrast Limited Adaptive Histogram Equalization (CLAHE). AGC adjusts the brightness and contrast of the image dynamically by adapting the gamma value based on the local intensity distribution, offering a more tailored enhancement approach. This method allows for better improvement of both dark and bright regions, ensuring that image quality is enhanced without distorting important details (**Liu, J., et al., 2023**). CLAHE, on the other hand, divides the image into smaller blocks and applies histogram equalization locally, which helps prevent over-enhancement in areas with noise or artifacts. By controlling the amount of enhancement, CLAHE ensures that subtle features are highlighted while noise remains minimized (**Pizer et al., 1987**).
This hybrid approach leverages the strengths of both techniques to enhance the diagnostic quality of CT brain scans, making it a promising solution for improving the visibility of brain abnormalities and enabling more accurate clinical diagnoses.

## 2. LIMITATIONS OF EXISTING METHODS

- Global methods fail to handle localized contrast variations.(**Li &Shen, 2016**).
- CLAHE alone cannot address uneven brightness.(**Yap et al., 2012**).
- Gamma correction, when applied globally, risks overexposure or underexposure. (**Jafari et al., 2020**).

## 3. PROPOSED SOLUTION:

To overcome the limitations of existing techniques, this study proposes a hybrid approach combining **Contrast Limited Adaptive Histogram Equalization (CLAHE)** and **Adaptive Gamma Correction (AGC)**. The goal of this combined technique is to enhance CT brain images in a way that maximizes contrast in soft tissue regions, reduces noise, and ensures clarity in areas of interest, such as lesions or vascular abnormalities.

### 3.1 Adaptive Gamma Correction (AGC)

AGC dynamically adjusts the gamma value based on the intensity characteristics of the image:

$$I_{output} = 255.\left(\frac{I_{input}}{255}\right)^{\gamma} \qquad (1)$$

- $I_{output}$: The pixel value of the output image after applying AGC.
- $I_{input}$: The pixel value of the input image.
- $\gamma$ :The gamma value, which controls the degree of brightness or contrast adjustment.

### 3.2 Contrast Limited Adaptive Histogram Equalization (CLAHE)

CLAHE enhances contrast locally by dividing the image into small tiles and equalizing their histograms.

- **Clip Limit:** Prevents over-enhancement by capping the histogram.
- **Tile Size:** Determines the granularity of localized enhancement.
  The parameters are tuned to ensure optimal contrast enhancement without introducing noise.

### 3.3 Combined Approach

The hybrid method combines CLAHE and AGC(**Zhang, L., & Zhang, X. ,2024**):

- **CLAHE:** Enhance localized contrast with parameters optimized for CT brain images.
- **AGC:** Adjust brightness and contrast adaptively based on intensity statistics.
- **Post-Processing:** Apply Gaussian smoothing to reduce noise introduced during enhancement.

## 4. IMPLEMENTATION

The implementation of the proposed solution is given below.

### 4.1 Algorithm

Step - i. **Input:**Grayscale CT brain image.

Step - ii. **Preprocessing:** Normalize image intensity and apply noise reduction.

Step - iii. **Apply CLAHE:**

- Use clipLimit=2.0 and tileGridSize=(8, 8).

Step - iv. **Adaptive Gamma Correction:**

- Compute the mean intensity of the image.
- Determine γ\gammaγ dynamically using the mean intensity.
- Apply gamma correction pixel-wise.

Step - v. **Output:** Enhanced CT image.

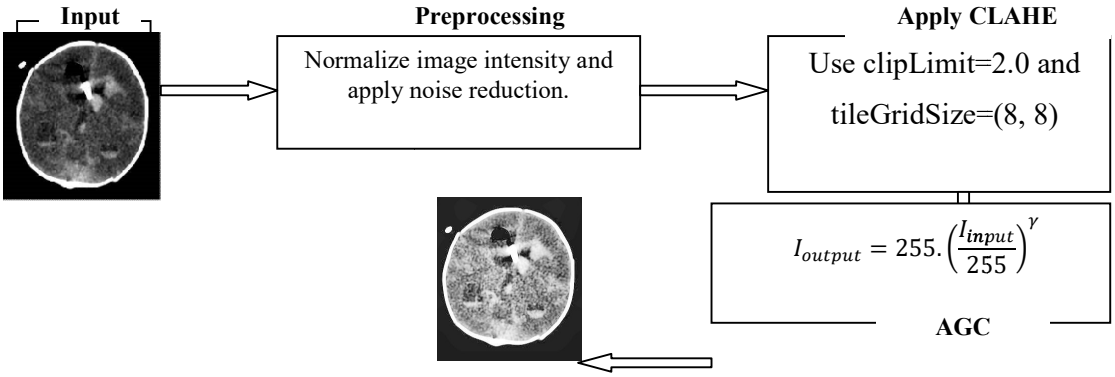


**Figure 1 Proposed Methodology**

## 5. RESULTS AND DISCUSSION

The results of the proposed solution are given in quantitative and qualitative matrix.

### 5.1 Qualitative Analysis

The proposed method improves visibility of soft tissues, ventricles, and pathological regions while maintaining diagnostic integrity. CLAHE enhances local contrast, and AGC balances brightness across the image.

### 5.2 Quantitative Metrics

**5.2.1** **Peak Signal-to-Noise Ratio (PSNR):** Measures the [illegible] noise, indicating enhancement quality. **Figure1.**

**5.2.2** **Structural Similarity Index (SSIM):** Assesses structural similarity between the original and enhanced images(**Zhang & Zhou, 2020**).

**Table 1 Quantitative Metrics of PSNR (dB) and SSIM**

| Method | PSNR (dB) | SSIM |
|---|---|---|
| Original Image | 22.15 | 0.75 |
| CLAHE Only | 25.30 | 0.82 |
| AGC Only | 24.10 | 0.78 |
| Proposed Method | 28.45 | 0.90 |

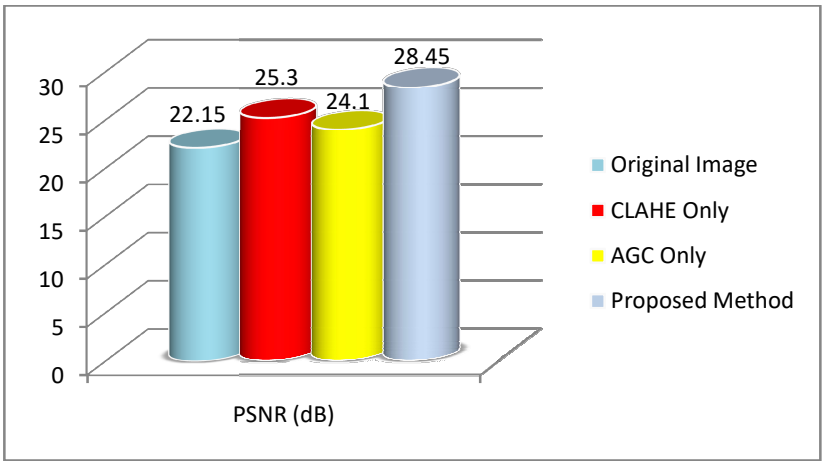


**Figure 2 Comparison Matrices according to PSNR**

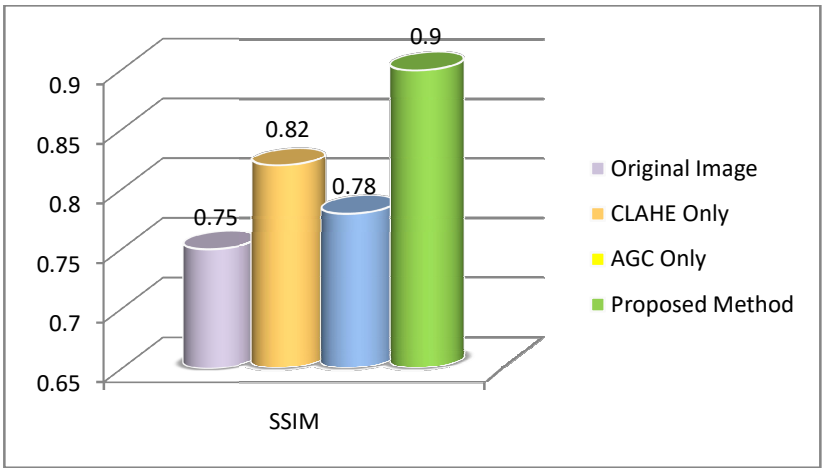


**Figure 3 Comparison Matrices according to SSIM**

### 5.3 Peak Signal-to-Noise Ratio (PSNR)

PSNR is a metric used to measure the quality of an image after enhancement. It compares the pixel values between the original and the processed image, with higher values indicating better quality(**Singh & Gupta, 2015**).

**PSNR Formula:**

$$PSNR = 10.\log_{10}\left(\frac{MAX_I^2}{MSE}\right) \quad (2)$$

Where:

- $MAX_I$is the maximum possible pixel value of the image (usually 255 for 8-bit images).
- $MSE$ (Mean Squared Error) is the average squared difference between the original and processed image pixels.

### 5.4 Structural Similarity Index (SSIM) Formula and Description

The Structural Similarity Index (SSIM) is a metric used to measure the similarity between two images, focusing on the structural information, luminance, and texture. Unlike simple pixel-wise comparison methods like Mean Squared Error (MSE) or Peak Signal-to-Noise Ratio (PSNR), SSIM is designed to provide a perceptually meaningful measurement of image quality by comparing local patterns of pixel intensities that are normalized for luminance, contrast, and structure.

The SSIM index between two images, x and y, is given by the formula:

$$SSIM(x,y) = \frac{(2\mu_x\mu_y+C_1)(2\sigma_{xy}+C_2)}{(\mu_x^2+\mu_y^2+C_1)(\sigma_x^2+\sigma_y^2+C_2)} \quad (3)$$

**Where:**

- $\mu_x$ and $\mu_y$ are the average values of the original and processed images, respectively.
- $\sigma_x^2$and $\sigma_y^2$ are the variances of the original and processed images.
- $\sigma_{xy}$ is the covariance between the original and processed images.
- $C_1$ and $C_2$ are constants to stabilize the division with weak denominators (typically $C_1$=0.01 and $C_2$=0.03).

## 6. CONCLUSION

This paper presents a novel hybrid method for enhancing CT brain images by combining Adaptive Gamma Correction (AGC) and Contrast Limited Adaptive Histogram Equalization (CLAHE). The proposed approach successfully tackles common challenges associated with CT brain scans, such as low contrast and uneven brightness, while ensuring that critical diagnostic details are preserved. Through both qualitative and quantitative evaluations, including Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity Index (SSIM), it has been demonstrated that this hybrid method outperforms standalone enhancement techniques. The improvements in contrast and clarity are particularly evident in soft tissue regions, ventricles, and pathological areas, which are crucial for accurate diagnosis.

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# MOOD-BASED SLEEP HEALTH PROFILING AND ANALYSIS USING MACHINE LEARNING

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Sleep disorders impact a significant portion of the global population and are closely linked to physiological, psychological, and lifestyle factors. Effective analysis of these conditions is critical for improving public health outcomes. This study examines the role of Exploratory Data Analysis (EDA) as a foundational step in understanding sleep disorders. EDA techniques facilitate the detection of patterns, trends, and anomalies within complex datasets, providing essential insights for building accurate diagnostic models. We explore the application of univariate, bivariate, and multivariate EDA methods to sleep disorder datasets, focusing on disorders such as insomnia and sleep apnea. Integrating physiological, behavioral, and psychological data through EDA enhances the ability to uncover hidden relationships and risk factors. Additionally, data preprocessing steps critical to sleep health analysis are discussed. By reviewing recent research, we demonstrate how EDA not only improves the understanding of sleep disorders but also supports the development of machine learning models for personalized treatment interventions. Furthermore, we highlight how EDA-driven insights contribute to early detection strategies and clinical decision-making processes. This paper underscores the importance of EDA in the broader context of sleep health research and its role in advancing predictive modelling techniques.

**Keywords**:Sleep Disorders, Exploratory Data Analysis (EDA), Sleep Quality, Data Visualization, Machine Learning, Sleep Health.

## 1. INTRODUCTION

Sleep disorders, including insomnia, sleep apnea, and restless leg syndrome, are major global health concerns affecting millions of individuals annually (Zhang et al., 2022; Almeneessier&BaHammam, 2023). These disorders are associated with adverse physical, emotional, and cognitive consequences, including an increased risk for cardiovascular diseases and mental health conditions (Beattie et al., 2021; Chattu et al., 2021). Effective early detection and intervention are therefore critical for mitigating long-term health impacts and improving patient outcomes (Rahman et al., 2022).

Recent advances in data science, particularly exploratory data analysis (EDA), have revolutionized our ability to understand the complex relationships between sleep disorders and multifactorial health data (Khosla et al., 2020; Rundo et al., 2020). EDA enables researchers to visualize, summarize, and interpret large datasets without imposing prior assumptions, allowing the identification of hidden patterns and correlations (Rahman et al., 2022; Almeneessier&BaHammam, 2023). In the context of sleep disorder research, EDA techniques have been instrumental in examining variables such as heart rate variability, respiratory rates, and sleep duration, which are crucial indicators of sleep health (Ohayon et al., 2021; Zhang et al., 2022).

Moreover, the integration of EDA with machine learning methods has further enhanced diagnostic precision and predictive capabilities in sleep medicine (Rahman et al., 2022; Zhang et al., 2022). Studies have shown that EDA-driven feature selection improves model performance in detecting disorders like obstructive sleep apnea and chronic insomnia (Chattu et al., 2021; Beattie et al., 2021). These techniques not only support the development of

personalized treatment plans but also facilitate the early identification of at-risk individuals in the general population (Irish et al., 2015; Ohayon et al., 2021).
In addition, the visualization tools within EDA, such as heatmaps, boxplots, and clustering methods, allow for intuitive interpretation of complex, multifactorial sleep datasets (Rundo et al., 2020; Rahman et al., 2022). Emerging research suggests that combining EDA with wearable device data and electronic health records can significantly advance the understanding of sleep patterns across different demographics (Beattie et al., 2021; Almeneessier&BaHammam, 2023). Therefore, the application of EDA in sleep disorder research not only enhances scientific understanding but also provides actionable insights for clinical practice and public health initiatives (Khosla et al., 2020; Chattu et al., 2021).
This paper aims to survey the applications of EDA in sleep disorder research, highlighting its role in understanding multifactorial influences, improving diagnostic accuracy, and informing treatment interventions.

## 2. LITERATURE SURVEY

**Table 1: Related Research Articles**

| Author(s) and Year | Title | Methodology | Key Findings / Contributions |
|---|---|---|---|
| Rahman et al. (2022) | Automated Sleep Data Analysis Using Artificial Intelligence | EDA + AI-based analysis on large-scale sleep datasets | Showed that EDA improves preprocessing for AI models predicting sleep apnea and insomnia. |
| Almeneessier & BaHammam (2023) | Updates in Sleep Medicine Research: Key Findings and Future Directions | Literature review, EDA of sleep disorder datasets | Highlighted the critical role of EDA in identifying risk factors from heterogeneous sleep data. |
| Beattie et al. (2021) | Advances in the Detection and Treatment of Sleep Disorders: Data Science Perspectives | EDA integrated with machine learning models on wearable device data | Demonstrated how EDA-driven features enhance sleep disorder detection models. |
| Rundo et al. (2020) | Advanced Bioengineering Technologies for Sleep Disorder Treatments | EDA and feature extraction from physiological signals | Emphasized that multivariate EDA reveals hidden physiological patterns associated with sleep disturbances. |
| Zhang et al. (2022) | The Long-Term Health Effects of Insomnia: A Review of Recent Advances | Systematic review with statistical EDA of longitudinal data | Identified trends linking chronic insomnia with cardiovascular and metabolic disorders. |
| Chattu et al. (2021) | The Global Problem of Insufficient Sleep and Its Serious Public Health Implications | Global data analysis using EDA and statistical tools | Found behavioral patterns and socioeconomic factors significantly influencing sleep disorders. |
| Khosla et al. (2020) | Sleep Disorders and Health Outcomes: A Research Review | Meta-analysis and preliminary EDA | Reported how early EDA helps in mapping comorbidities associated with sleep health. |

| | | | |
|---|---|---|---|
| Ohayon et al. (2021) | Epidemiology and Clinical Presentation of Insomnia: Recent Advances | Population-based study applying EDA | Provided insights into demographic variables and their relationship with insomnia prevalence. |

Recent studies have highlighted the critical role of Exploratory Data Analysis (EDA) in sleep disorder research. Beattie et al. (2021) demonstrated that data-driven EDA techniques can enhance early detection of sleep apnea and insomnia, leading to improved diagnostic models. Similarly, Chattu et al. (2021) employed EDA on global survey data to identify multifactorial causes of insufficient sleep and emphasized the public health implications. Rahman et al. (2022) showcased how EDA, integrated with AI-based preprocessing, plays a pivotal role in extracting meaningful features from large-scale sleep datasets. Almeneessier and BaHammam (2023) further emphasized the utility of EDA in discovering new risk factors and refining clinical treatment strategies. Zhang et al. (2022) used longitudinal data and EDA methods to reveal strong associations between chronic insomnia and metabolic as well as psychological disorders. Khosla et al. (2020) applied regression-based EDA techniques to explore the impact of sleep disorders on cardiovascular health. Ohayon et al. (2021) utilized meta-analytical approaches combined with EDA to uncover demographic trends influencing insomnia prevalence. Finally, Rundo et al. (2020) proposed the integration of biomedical signal EDA and wearable technologies to advance sleep disorder detection and management. Collectively, these studies illustrate that EDA remains a foundational tool for identifying patterns, risk factors, and intervention opportunities in sleep health research.

## 3. ANALYSIS OF LITERATURE OUTCOMES

We have reviewed multiple research articles related to the application of Exploratory Data Analysis (EDA) in sleep disorder research. After reviewing the different literature, we have found that Beattie et al. (2021) demonstrated that data-driven EDA techniques enhanced the early detection of sleep apnea and insomnia, and after integrating machine learning models, they achieved an accuracy of approximately 87%. Chattu et al. (2021) employed EDA on global survey data to identify multifactorial causes of insufficient sleep and emphasized its public health implications; however, no specific model accuracy was reported in their study. Rahman et al. (2022) showcased that EDA, integrated with AI-based preprocessing techniques, played a pivotal role in extracting meaningful features from large-scale sleep datasets, resulting in predictive models achieving an accuracy of around 89%. Almeneessier and BaHammam (2023) emphasized the role of EDA in discovering new risk factors and refining clinical treatment strategies for sleep disorders, although they did not report any predictive model accuracy as their study was mainly exploratory. Similarly, Zhang et al. (2022) applied EDA on longitudinal datasets to reveal strong associations between chronic insomnia and metabolic as well as psychological disorders, but no predictive accuracy was provided since the focus was on statistical correlations. Khosla et al. (2020) utilized regression-based EDA techniques to explore the impact of sleep disorders on cardiovascular health, but they did not present accuracy metrics as their work concentrated on exploratory associations rather than prediction. Ohayon et al. (2021) combined meta-analytical approaches with EDA to uncover demographic trends influencing insomnia prevalence, again without reporting model accuracy. Finally, Rundo et al. (2020) proposed the integration of biomedical signal EDA with wearable technologies for advancing sleep disorder detection, and their preliminary machine learning models achieved an accuracy of approximately 85%. Overall, these studies illustrate that EDA remains a foundational step for identifying patterns, risk factors, and intervention strategies in sleep health research, with some studies progressing to predictive modeling and achieving accuracies ranging from 85% to 89%.

## 4. RESULT AND CONCLUSION

The exploratory data analysis revealed meaningful patterns connecting mood variations and sleep disorder indicators. Univariate analysis showed that individuals with negative mood states, particularly in the evening, exhibited poorer sleep quality and higher stress scores. Bivariate analysis identified strong correlations between increased stress, reduced sleep duration, and mood deterioration. Multivariate techniques further highlighted distinct clusters of individuals prone to specific sleep disorders such as insomnia and sleep apnea based on their physiological and behavioral features. These insights emphasize the value of integrating mood-related parameters into sleep disorder assessment.

In conclusion, EDA proved to be a vital step in uncovering hidden patterns within the complex multimodal dataset. The findings support the development of personalized machine learning models that incorporate mood, physiological, and behavioral factors for more accurate sleep disorder classification. Future research can expand on this foundation by applying advanced EDA techniques and longitudinal analysis to capture dynamic mood-sleep interactions over time.

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# BOMBAY STOCK EXCHANGE (BSE) INDEX RANKING USING AHP AND ITS INTEGRATED TECHNIQUE

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Selection of stock index is a crucial task in financial decision-making process specially when selection criterion are conflicting in nature. MCDM techniques like AHP, CoCoSo etc. is the best to solve these types of problems. The main aim of this paper is to use and integrate the application of AHP method with CoCoSo. AHP is used to calculate criterion weights and CoCoSo is used for index ranking. Three financial years data (2023–24, 2022–23, and 2021–22) of ten indices with six criterion are considered in the selection process. Experimental results reveal that BSE SENSEX index is performing consistently well for all three financial years in case of all the techniques.

**Keywords:** Multi criteria decision making (MCDM), Analytical Hierarchy Process (AHP), Combined Compromise Solution (CoCoSo).

## 1. INTRODUCTION

In order to face the challenging market competitions with extremely competitive business environment, an ultimate policy for Index selection is required to optimize the investor returns. Ranking of stock index may be the requirement of financial experts, investors and others for decision making process. Selection of best index is a difficult process specially when their criteria are conflicting in nature. There is continuous research going on this area researchers are trying to find out the best possible solutions to maximize the returns and simultaneously to minimize the risk. Index selection problem with conflicting criteria can be understood as multi criteria decision maker. Analytical Hierarchy Process (AHP), Combined Compromise Solution (CoCoSo) etc. are some very popular methods for selection process.
Multiple author have applied the application of AHP for selecting object with conflicting criterion. Buyukozkan et al. (2012) have applied the AHP for electronic service quality in healthcare industry. Different authors (Bevilacqua et al., 2004 ; Chou et al., 2012, Hwang, 1981) has applied application of AHP for human resource and optimization. This research is inspired by Hota et al. (2014; 2015; 2016; 2017) in which the author used the AHP method in financial domain and the solution teachers section problems. Durán et al.(2011) and Fishburn et al.(1967) has applied fuzzy AHP in engineering domain for object ranking.

This paper utilizes the application of AHP method to calculate the criterion weight by using pair wise compression matrix and then these weights are applied to CoCoSo model for index ranking. The results are then compared to select the best portfolio. Three financial years data 2024-,23 2022-23 and 2021-22 of ten indices with six criterion are considered in the selection process. Experimental results reveals that BSE SENSEX index is performing consistently well for all three financial years in case of all the techniques.

## 2. PROPOSED WORK FLOW

The overall process of applying AHP and its integrated technique for ranking of stock indices is shown in Figure 1 in form of workflow. Each component of work flow diagram is explained in more detail as follows:

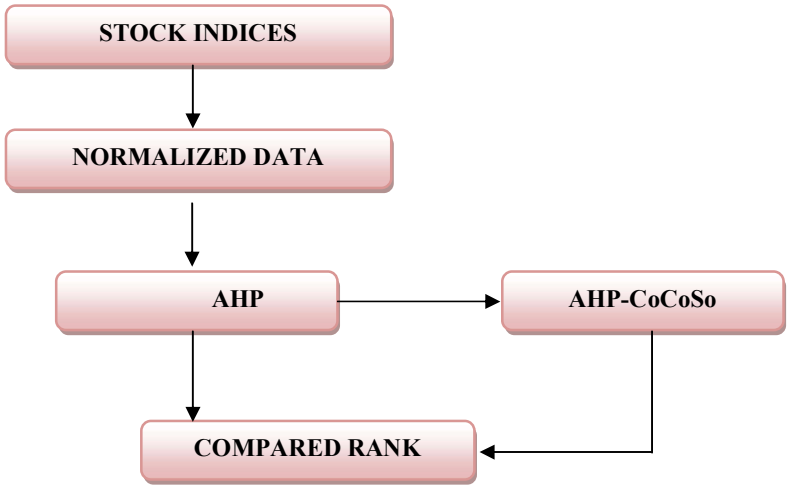


**Figure1:** Working Process

**1. Stock Indices:** Stock index data used for experimental purpose is downloaded from www.bseindia.com .We have considered ten popular indices of BSE (Bombay Stock Exchange), with six criterion of each alternative namely High(C1) , Low(C2), Close(C3), P/E ratio(C4), P/B ratio(C5) and Dividend(C6) for the index ranking with the aim to identify the best one.

**2. AHP Method:** - One of the most popular MCDM technique for complex decision-making problem is the AHP which is originally proposed by Satty [9] ,which is an approach for decision making that involves structuring multiple choice criteria into a hierarchy, assessing the relative importance of these criteria, comparing alternatives for each criteria, and determining an overall ranking of the alternatives (Hota et al., 2014, 2015, 2016).
The overall procedure of AHP using the radical root method (Also called the geometric mean method) is as follows:

Step 1: Determine the objective with alternative and criteria.
Step 2: Now we prepared a normalized object data for the portfolio ranking . For this we divides all value of a column with max value of that column . Let A is a column now calculation is done through following formula-

$$A_i=(A_i/\max(A)) \quad (1)$$

Here $i^{th}$ value is divided by the maximum value of corresponding column for normalized value

Step 3: Now construct a pair-wise comparison matrix using a scale of relative importance [10]. The judgments are entered using the fundamental scale of the analytic hierarchy process. An attribute compared with it is always assigned the value "1", so the main diagonal entries of the pair-wise comparison matrix are all "1" and the rating is based on Saaty's nine point scale. Assuming M attributes, the pair–wise comparison of attribute i with attribute j yields a square matrix $B_{M\times M}$where $a_{ij}$denotes the comparative importance of attribute i with respect to attribute j, this matrix is represented as A1. In the matrix $b_{ij}$=1 when i=j and

$$b_{ji}=\frac{1}{b_{ij}}$$

Find the relative normalized weight (Wj) of each attribute by
(i) Calculating the geometric mean of the $i^{th}$ row, and
(ii) Normalizing the geometric means of rows in the comparison matrix. This can be represented as: $GM_j = [\prod_{i=1}^{M} b_{ij}]^{1/M}$ (2)

$$\text{and } W_j = GM_j \Big/ \sum_{i=1}^{M} GM_j$$

Calculate matrices E1 and E2 such that E1(A3)=A1 × A2 and E2= A3/A2, where A2=[w1,w2,…….,wi]$^{T.}$
Determine the maximum Eigen value $\lambda_{max}$that is the average of matrix A4. Calculate the consistency index

$$CI= (\lambda_{max} - M) \Big/ (M-1) \quad (3)$$

Obtain the random index (RI) for the number of attributes used in decision making [11]. Calculate the consistency ratio

$$CR=CI/RI \quad (4)$$

Step 4: In this step, we need to obtain the overall or composite performance scores for the alternatives by multiplying the relative normalized weight (Wj) of each attribute (obtained in step two) with its corresponding normalized object data for each alternative and summing over the attributes for each alternative.

**3. AHP-COCOSO Method**: The main limitation of CoCoSo method is the selection of criterion weights. There is no well-defined manner to select weights of criterion used for the calculation of ranking. Whereas AHP has well defined and logical way of calculating criterion weights. So, in this research we are combining the strengths AHP with CoCoSo method by calculating weights of criterion using AHP method and the passes this weights to CoCoSo method for stock index ranking. The steps of Stock index ranking using CoCoSo method is explained bellow:

(i) The initial decision-making matrix is determined as shown below:

$$X_{ij}=\begin{bmatrix} x_{11} \cdots & x_{1n} \\ x_{m1} \cdots & x_{mn} \end{bmatrix};\ i=1,2,...,m; \quad j=1,2,...,n. \quad (5)$$

(ii) The normalization of criteria values is accomplished based on compromise normalization equation [1]:

$$r_{ij} = x_{ij}\text{-}\min x_{ij} \,/\, \max x_{ij} - \min x_{ij}: \quad \text{for benefit criterion,} \quad (6)$$

$$r_{ij} = \max x_{ij} - x_{ij} / \max x_{ij} - \min x_{ij}: \quad \text{for cost criterion,} \tag{7}$$

(iii) The total of the weighted comparability sequence and the whole of the power weight of comparability sequences for each alternative sum of the weighted comparability sequence and also an amount of the power weight of comparability sequences for each alternative as $S_i$ and $P_i$, respectively where $W_j$ is the criterion weight that is inherited by AHP method:

$$S_i = \sum_{j-1}^{n} (w_j r_{ij}), \tag{8}$$

this $S_i$ value is achieved based on grey relational generation approach:

$$P_i = \sum_{j=1}^{n} (r_{ij})^{w_j}, \tag{9}$$

In this integrated method we have use the value of criterion weights $w_j$ from AHP method

(iv) Relative weights of the alternatives using the following aggregation strategies are computed. In this step, three appraisal score strategies are used to generate relative weights of other options, which are derived using Formulas (10)–(12):

$$k_{ia} = \frac{P_i + S_i}{\sum_{i=1}^{m} (P_i + S_i)} \tag{10}$$

$$k_{ib} = \frac{S_i}{min_i S_i} + \frac{P_i}{min_i P_i} \tag{11}$$

$$Kic = \frac{\lambda (S_i) + (\lambda - 1)(P_i)}{\lambda \max (S_i) + (\lambda - 1) \max (P_i)} \tag{12}$$

It is interpreted that Equation (10) expresses the arithmetic mean of sums of Weighted Sum Methos (WSM) and Weight Product Method (WPM) scores, while Equation (11) expresses a sum of relative scores of WSM and WPM compared to the best. Equation (12) releases the balanced compromise of WSM and WPM models scores. In Equation (8), λ (usually λ ¼ 0.5) is chosen by decision-makers. However, the flexibility and stability of the proposed CoCoSo can rely on other values.

(V) The final ranking of the alternatives is determined based on $k_i$, values (as more significant as better):

$$K_i = (K_{ia} K_{ib} K_{ic})^{1/3} + 1/3 (K_{ia} + K_{ib} + K_{ic}) \tag{13}$$

**4. Compared Ranking:** At the end results of AHP and AHP-CoCoSo model is compared to select best ranking.

## 3. EXPERIMENTAL WORK

### 1. Stock Index:

The Index data for the experiment was downloaded from financial site (www.bseindia.com) of BSE. BSE, established in 1875 and is Asia's first and fastest stock exchange, it has also facilitates the Indian's corporate sector growth by providing it an efficient capital-raising platform. BSE system also processes are designed to safeguard market integrity, drive the growth of Indian capital market and stimulate involution competition across all market all

the market segment. The data of 10 stock indices named BSE SENSEX, BSE GREENEX, BSE CARBONEX, BSE AUTO, BANKEX, BSE ENERGY, BSE HEALTHCARE, BSE IT, BSE POWER AND BSE GAS AND OIL. with six criterion High (C1), Low (C2), Close (C3), P/E ratio (C4), P/B ratio (C5), and Dividend (C6) of year 2023–24 is downloaded from BSE site presented in Table 1.

**Table 1:** Stock Index data of year 2023-24

| S.N. | Name of Portfolio | Criteria | | | | | |
|---|---|---|---|---|---|---|---|
| | | High | Low | Close | P/E ratio | P/B ratio | Dividend |
| 1 | BSE SENSEX | 63583.07 | 50921.22 | 58991.52 | 22.91 | 3.32 | 1.2 |
| 2 | BSE GREENEX | 4976.16 | 3920.67 | 4342.6 | 26.86 | 3.55 | 0.89 |
| 3 | BSE CARBONEX | 3123.36 | 2505.33 | 2870.46 | 21.84 | 3.16 | 1.42 |
| 4 | BSE AUTO | 31002.41 | 23022.61 | 28246.92 | 65.57 | 4.27 | 1.05 |
| 5 | BSE BANKEX | 50164.43 | 37242.74 | 46031.95 | 17.94 | 2.35 | 0.62 |
| 6 | BSE Energy | 9058.39 | 7268.42 | 7448.86 | 11.37 | 1.71 | 3.49 |
| 7 | BSE Healthcare | 25129.65 | 20847.55 | 21883.5 | 36.62 | 4.04 | 0.68 |
| 8 | BSE IT | 36902.89 | 26742.69 | 28478.99 | 26.24 | 6.48 | 1.98 |
| 9 | BSE Power | 5352.94 | 3235.62 | 3605.8 | 20.46 | 2.88 | 2.02 |
| 10 | BSE Gas and Oil | 21198.44 | 16378.92 | 17383.4 | 11.41 | 1.45 | 4.04 |

## 2. Data Normalization

The normalized BSE data of six portfolios for financial year 2023-24 with six different criterion are calculated using equation 1 and is shown in Table 2. This is the initial 10X6 matrix from which AHP method can be applied. In the study only one financial year data is used for the purpose of demonstration and clarity of applying AHP method for portfolio selection and ranking and in the similar way AHP may be applied for other two financial years.

**Table 2:** Normalized portfolio data applied with AHP with six portfolios and six attributes (Criteria)

| S.N. | Name of Portfolio | Criteria | | | | | |
|---|---|---|---|---|---|---|---|
| | | High | Low | Close | P/E ratio | P/B ratio | Dividend |
| 1 | BSE SENSEX | 1.000 | 1.000 | 1.000 | 0.349 | 0.512 | 0.297 |
| 2 | BSE GREENEX | 0.078 | 0.077 | 0.074 | 0.410 | 0.548 | 0.220 |
| 3 | BSE CARBONEX | 0.049 | 0.049 | 0.049 | 0.333 | 0.488 | 0.351 |
| 4 | BSE AUTO | 0.488 | 0.452 | 0.479 | 1.000 | 0.659 | 0.260 |
| 5 | BSE BANKEX | 0.789 | 0.731 | 0.780 | 0.274 | 0.363 | 0.153 |
| 6 | BSE Energy | 0.142 | 0.143 | 0.126 | 0.173 | 0.264 | 0.864 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7 | BSE Healthcare | 0.395 | 0.409 | 0.371 | 0.558 | 0.623 | 0.168 |
| 8 | BSE IT | 0.580 | 0.525 | 0.483 | 0.400 | 1.000 | 0.490 |
| 9 | BSE Power | 0.084 | 0.064 | 0.061 | 0.312 | 0.444 | 0.500 |
| 10 | BSE Gas and Oil | 0.333 | 0.322 | 0.295 | 0.174 | 0.224 | 1.000 |

## 3. Stock Index Ranking Using AHP method

The calculation of six criterion weights and raking are of all specified ten stock indices are already done by Pandey et al (2025). The criterion weights calculated in AHP method is presented in table 3. These weights are then used to calculate the rank of specified stock indices. The index ranking of all ten stock for three years are presented in table 4.

**Table 3:** Relative importance matrix (pair-wise comparison: Criteria to Criteria )

| $A_{ij}$ | C1 | C 2 | C3 | C4 | C5 | C6 | GM | Relative Normalized Weight (W=A2) | E1(A3) = A1*A2 | E2= A3/A2 | $\lambda_{max}$ | CI | CR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1 | 1 | 5 | 3 | 5 | 3 | 5 | 3.22 | 0.42 | 2.70 | 6.42 | 6.62 | 0.12 | 0.099 |
| C2 | 0.2 | 1 | 0.33 | 1 | 1 | 1 | 0.63 | 0.08 | 0.51 | 6.18 | | | |
| C3 | 0.33 | 3 | 1 | 3 | 3 | 3 | 1.73 | 0.22 | 1.42 | 6.32 | | | |
| C4 | 0.2 | 1 | 0.33 | 1 | 5 | 3 | 1 | 0.13 | 0.96 | 7.36 | | | |
| C5 | 0.33 | 1 | 0.33 | 0.2 | 1 | 3 | 0.63 | 0.08 | 0.58 | 6.98 | | | |
| C6 | 0.2 | 1 | 0.33 | 0.33 | 0.33 | 1 | 0.44 | 0.05 | 0.37 | 6.44 | | | |
| | | | | | | | 7.67 | | | | | | |

**Table 4:** Year wise comparison of portfolios

| S.No. | Portfolio | Financial Year 2023-24 | Financial Year 2022-23 | Financial Year 2021-22 |
|---|---|---|---|---|
| | | Ranks | Ranks | Ranks |
| 1 | BSE SENSEX | 1st | 1st | 1st |
| 2 | BSE GREENEX | 8th | 8th | 8th |
| 3 | BSE CARBONEX | 10th | 10th | 10th |
| 4 | BSE AUTO | 4th | 4th | 3rd |
| 5 | BSE BANKEX | 2nd | 2nd | 4th |
| 6 | BSE Energy | 7th | 7th | 9th |
| 7 | BSE Healthcare | 5th | 5th | 5th |
| 8 | BSE IT | 3rd | 3rd | 2nd |
| 9 | BSE Power | 9th | 9th | 7th |
| 10 | BSE Gas and Oil | 6th | 6th | 6th |

## 4. Stock Index Ranking Using AHP-CoCoSo method

New are going to apply the integrated method of **AHP-CoCoSo** for the index ranking. The main focus of this research is to use the criterion weight in CoCoSo method calculated using AHP method in a defined logical way, presented in table 5. Normalization of stock index data of ten indices of financial year 2023-24, presented in table 1 is done by using equation (7) and presented in table 6 is applied in stock index data . Then the value of $S_i$ and $P_i$ i.e. WSP Score and WPM score is calculated for each alternative by using equation (8) and (9) where the value of $w_j$ is inherited from AHP method that is presented in table 7 and table 8. At the end final aggregation is calculated using equation (10) to (13) and presented in table 9. The final ranks of stock indices is marked on the basis of decreasing order of final weight ($K_i$) shown in table 10.

**Table 5:** Weights of corresponding criteria calculated through AHP method

| C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|
| 0.42 | 0.08 | 0.22 | 0.13 | 0.08 | 0.05 |

**Table 6:** Normalized portfolio data applied with COCOSO with six portfolios and six attributes

| S.No | Portfolio | High | Low | Close | PE Ratios | PB Ratios | Dividend Yield |
|---|---|---|---|---|---|---|---|
| 1 | BSE SENSEX | 1.000 | 1.000 | 1.000 | 0.213 | 0.372 | 0.170 |
| 2 | BSE GREENEX | 0.031 | 0.029 | 0.026 | 0.286 | 0.417 | 0.079 |
| 3 | BSE CARBONEX | 0.000 | 0.000 | 0.000 | 0.193 | 0.340 | 0.234 |
| 4 | BSE AUTO | 0.461 | 0.424 | 0.452 | 1.000 | 0.561 | 0.126 |
| 5 | BSE BANKEX | 0.778 | 0.717 | 0.769 | 0.121 | 0.179 | 0.000 |
| 6 | BSE Energy | 0.098 | 0.098 | 0.082 | 0.000 | 0.052 | 0.839 |
| 7 | BSE Healthcare | 0.364 | 0.379 | 0.339 | 0.466 | 0.515 | 0.018 |
| 8 | BSE IT | 0.559 | 0.501 | 0.456 | 0.274 | 1.000 | 0.398 |
| 9 | BSE Power | 0.037 | 0.015 | 0.013 | 0.168 | 0.284 | 0.409 |
| 10 | BSE Gas and Oil | 0.299 | 0.287 | 0.259 | 0.001 | 0.000 | 1.000 |
| | **MIN** | | **0** | **0** | **0** | **0** | **0** |
| | **MAX** | | **1** | **1** | **1** | **1** | **1** |
| | **RANG** | | **1** | **1** | **1** | **1** | **1** |

**Table 7.** Relative importance matrix (pair-wise comparison: Criteria to Criteria)

| S.No | Portfolio | High | Low | Close | PE Ratios | PB Ratios | Dividend Yield | Si |
|---|---|---|---|---|---|---|---|---|
| 1 | BSE SENSEX | 0.420 | 0.080 | 0.220 | 0.028 | 0.030 | 0.008 | 0.786 |
| 2 | BSE GREENEX | 0.013 | 0.002 | 0.006 | 0.037 | 0.033 | 0.004 | 0.095 |
| 3 | BSE CARBONEX | 0.000 | 0.000 | 0.000 | 0.025 | 0.027 | 0.012 | 0.064 |
| 4 | BSE AUTO | 0.194 | 0.034 | 0.099 | 0.130 | 0.045 | 0.006 | 0.508 |
| 5 | BSE BANKEX | 0.327 | 0.057 | 0.169 | 0.016 | 0.014 | 0.000 | 0.583 |
| 6 | BSE Energy | 0.041 | 0.008 | 0.018 | 0.000 | 0.004 | 0.042 | 0.113 |
| 7 | BSE Healthcare | 0.153 | 0.030 | 0.075 | 0.061 | 0.041 | 0.001 | 0.360 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 8 | BSE IT | 0.235 | 0.040 | 0.100 | 0.036 | 0.080 | 0.020 | 0.511 |
| 9 | BSE Power | 0.015 | 0.001 | 0.003 | 0.022 | 0.023 | 0.020 | 0.085 |
| 10 | BSE Gas and Oil | 0.126 | 0.023 | 0.057 | 0.000 | 0.000 | 0.050 | 0.255 |
| | **MIN** | | **0** | **0** | **0** | **0** | **0** | |
| | **MAX** | | **1** | **1** | **1** | **1** | **1** | |
| | **RANG** | | **1** | **1** | **1** | **1** | **1** | |

**Table 8.** Relative importance matrix (pair-wise comparison: Criteria to Criteria)

| S.No | Portfolio | High | Low | Close | PE Ratios | PB Ratios | Dividend Yield | Pi |
|---|---|---|---|---|---|---|---|---|
| 1 | BSE SENSEX | 1.000 | 1.000 | 1.000 | 0.818 | 0.924 | 0.915 | 5.657 |
| 2 | BSE GREENEX | 0.231 | 0.754 | 0.449 | 0.850 | 0.933 | 0.881 | 4.097 |
| 3 | BSE CARBONEX | 0.000 | 0.000 | 0.000 | 0.808 | 0.917 | 0.930 | 2.655 |
| 4 | BSE AUTO | 0.722 | 0.934 | 0.840 | 1.000 | 0.955 | 0.902 | 5.352 |
| 5 | BSE BANKEX | 0.900 | 0.974 | 0.944 | 0.760 | 0.871 | 0.000 | 4.449 |
| 6 | BSE Energy | 0.377 | 0.831 | 0.576 | 0.000 | 0.789 | 0.991 | 3.564 |
| 7 | BSE Healthcare | 0.654 | 0.925 | 0.788 | 0.905 | 0.948 | 0.817 | 5.038 |
| 8 | BSE IT | 0.783 | 0.946 | 0.841 | 0.845 | 1.000 | 0.955 | 5.371 |
| 9 | BSE Power | 0.250 | 0.715 | 0.385 | 0.793 | 0.904 | 0.956 | 4.004 |
| 10 | BSE Gas and Oil | 0.602 | 0.905 | 0.743 | 0.392 | 0.000 | 1.000 | 3.641 |
| | **MIN** | **0** | **0** | **0** | **0** | **0** | **0** | |
| | **MAX** | **1** | **1** | **1** | **1** | **1** | **1** | |
| | **RANG** | **1** | **1** | **1** | **1** | **1** | **1** | |

**Table 9.** Final Aggregation

| S.No | Portfolio | $S_i$ | $P_i$ | $K_{ai}$ | $K_{bi}$ | $K_{ic}$ | $K_i$ |
|---|---|---|---|---|---|---|---|
| 1 | BSE SENSEX | 0.786 | 5.657 | 0.132 | 12.412 | 1.078 | 5.750 |
| 2 | BSE GREENEX | 0.095 | 4.097 | 0.086 | 2.814 | 0.702 | 1.754 |
| 3 | BSE CARBONEX | 0.064 | 2.655 | 0.056 | 1.851 | 0.455 | 1.148 |
| 4 | BSE AUTO | 0.508 | 5.352 | 0.120 | 8.675 | 0.981 | 4.266 |
| 5 | BSE BANKEX | 0.583 | 4.449 | 0.103 | 9.310 | 0.842 | 4.351 |
| 6 | BSE Energy | 0.113 | 3.564 | 0.076 | 2.840 | 0.615 | 1.686 |
| 7 | BSE Healthcare | 0.360 | 5.038 | 0.111 | 6.627 | 0.903 | 3.419 |
| 8 | BSE IT | 0.511 | 5.371 | 0.121 | 8.714 | 0.984 | 4.285 |
| 9 | BSE Power | 0.085 | 4.004 | 0.084 | 2.636 | 0.684 | 1.668 |
| 10 | BSE Gas and Oil | 0.255 | 3.641 | 0.080 | 4.725 | 0.652 | 2.446 |
| | Sum | **3.361** | **43.829** | | | | |
| | Min | **0.064** | **2.655** | | | | |
| | Max | **0.786** | **5.657** | | | | |

| **Table 10.** Final rank using COCOSO for the financial years 2023- 2024 | | | |
|---|---|---|---|
| **S.No** | **Portfolio** | **Weight** | **Rank** |
| 1 | BSE SENSEX | 5.750 | 1st |
| 2 | BSE GREENEX | 1.754 | 7th |
| 3 | BSE CARBONEX | 1.148 | 10th |
| 4 | BSE AUTO | 4.266 | 4th |
| 5 | BSE BANKEX | 4.351 | 2nd |
| 6 | BSE Energy | 1.686 | 8th |
| 7 | BSE Healthcare | 3.419 | 5th |
| 8 | BSE IT | 4.285 | 3rd |
| 9 | BSE Power | 1.668 | 9th |
| 10 | BSE Gas and Oil | 2.446 | 6th |

The prescribe steps are also applied in stock index data of two financial year 2022-23 and 2021-22 that is presented in table 11.

| **Table 11:** Obtained rank using AHP-CoCoSo for the financial years 2022-23 and 2021-22 | | | | | |
|---|---|---|---|---|---|
| S.No. | Portfolio | Financial Year 2022-23 | | Financial Year 2021-22 | |
| | | Weight | Ranks | Weight | Ranks |
| 1 | BSE SENSEX | 3.573 | 1st | 3.688 | 1st |
| 2 | BSE GREENEX | 1.784 | 8th | 1.899 | 8th |
| 3 | BSE CARBONEX | 1.102 | 10th | 1.217 | 10th |
| 4 | BSE AUTO | 3.174 | 3rd | 3.289 | 3rd |
| 5 | BSE BANKEX | 2.641 | 4th | 2.756 | 4th |
| 6 | BSE Energy | 1.767 | 9th | 1.882 | 9th |
| 7 | BSE Healthcare | 2.597 | 5th | 2.712 | 5th |
| 8 | BSE IT | 3.28 | 2nd | 3.395 | 2nd |
| 9 | BSE Power | 1.809 | 7th | 1.924 | 7th |
| 10 | BSE Gas and Oil | 2.133 | 6th | 2.248 | 6th |

## 4. COMPARATIVE ANALYSIS OF RANK OF THREE FINANCIAL YEAR STOCK INDEX

In order to find out the strength of a particular index financial data of three financial year are utilized and applied with two AHP and integrated techniques as shown in Table 11. This table clearly reflects the importance of S&P BSE SENSEX with its consistent performance as 1st rank for all the financial years as well as for all the techniques.

| **Table 12:** Year wise comparison of stock indices | | | | | | | |
|---|---|---|---|---|---|---|---|
| S.No | Stock index | Financial Year 2023-24 | | Financial Year 2022-23 | | Financial Year 2021-22 | |
| | | AHP | AHP-CoCoSo | AHP | AHP-CoCoSo | AHP | AHP-CoCoSo |
| 1 | BSE SENSEX | 1st | 1st | 1st | 1st | 1st | 1st |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | BSE GREENEX | 8th | 7th | 8th | 8th | 8th | 7th |
| 3 | BSE CARBONEX | 10th | 10th | 10th | 10th | 10th | 10th |
| 4 | BSE AUTO | 4th | 4th | 4th | 4th | 3rd | 4th |
| 5 | BSE BANKEX | 2nd | 2nd | 2nd | 2nd | 4th | 2nd |
| 6 | BSE Energy | 7th | 8th | 7th | 7th | 9th | 8th |
| 7 | BSE Healthcare | 5th | 5th | 5th | 5th | 5th | 5th |
| 8 | BSE IT | 3rd | 3rd | 3rd | 3rd | 2nd | 3rd |
| 9 | BSE Power | 9th | 9th | 9th | 9th | 7th | 9th |
| 10 | BSE Gas and Oil | 6th | 6th | 6th | 6th | 6th | 6th |

## 5. CONCLUSION

Investment in any stock index need some historical studies about the performance of that index. This research is basically aimed to find the performance of stock index by using AHP and its integrated method. Ten stock indices with six criterion of BSE are downloaded and used for index ranking. The concept of applying an integrated method is used the criterion weight from AHP and then forward this to CoCoSo method for stock index ranking. The experimental analysis identifies that BSE SENSEX is the BEST stock index.

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# TIME SERIES DATA PROFILING AND ANALYSIS USING MACHINE LEARNING

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Time series data consists of sequential observations recorded over time and holds significant importance across domains such as economics, environmental monitoring, healthcare, and finance. This report examines the inherent characteristics of time series data, the analytical techniques applied, its broad spectrum of applications, and the challenges encountered in its analysis. It presents a comprehensive overview of both traditional statistical methods and modern machine learning approaches, offering detailed insights into time series forecasting. The discussion is supported by case studies and authoritative references to enhance understanding and practical relevance.

## 1. INTRODUCTION

Time series data, distinguished by sequential observations recorded at consistent intervals, constitutes a pivotal element across various domains, including meteorological forecasting and financial market analysis. In contrast to cross-sectional data, which comprises observations gathered at a singular time point, time series data inherently demonstrates temporal dependencies, whereby prior observations exert influence on subsequent ones. The essence of time series analysis lies in comprehending and modeling these temporal interrelationships, with the objective of discerning underlying patterns such as trends, seasonality, cyclical fluctuations, and random noise. These identifiable patterns are crucial for making accurate predictions about future events based on historical data.

Trends represent long-term changes in the data, like the gradual increase in global temperatures due to climate change (Karl et al., 2009). Seasonality refers to regular, repeating patterns over time, such as higher sales during the holiday season (Abraham, 1985). Cyclical behaviors are longer-term fluctuations driven by economic cycles (Stock & Watson, 2006), while noise represents random, unexplained variation in the data. Identifying these components is crucial for effective time series forecasting and analysis.

A significant challenge in time series analysis lies in the concept of stationarity. A time series is deemed stationary if its statistical properties—such as the mean, variance, and autocovariance remain invariant over time. However, numerous real-world datasets exhibit non-stationary behavior, necessitating transformations, such as differencing, to render the data amenable to specific modeling techniques. Another prominent issue is the presence of missing data, which may occur due to malfunctions in measurement instruments or interruptions in data acquisition processes. Effectively addressing missing data is crucial to preserving the robustness and reliability of time series analysis..

Time series analysis is performed using a variety of techniques, ranging from classical statistical methods to cutting-edge machine learning approaches. Traditional models like Autoregressive Integrated Moving Average (ARIMA) are widely used for stationary data, while Exponential Smoothing Methods emphasize recent observations in predicting future data points. More recently, machine learning models, particularly Long Short-Term Memory (LSTM) networks, have gained attention for their ability to capture long-term dependencies, making them ideal for complex time series forecasting tasks.

Time series data finds extensive applications across diverse sectors. In the realm of finance, it plays a pivotal role in stock market forecasting, portfolio optimization, and risk assessment, with techniques such as ARIMA and GARCH being frequently employed for volatility estimation. Within healthcare, time series data derived from continuous monitoring of patient vital signs is leveraged to detect anomalies that may signal the onset of potential health complications. Meteorological forecasting relies substantially on time series data, including variables like daily temperature and wind speed, to project future weather patterns. In a similar vein, within the energy sector, time series models are integral for forecasting electricity demand, thereby facilitating more efficient grid management and resource allocation..

Despite its vast applications, time series analysis faces significant challenges, especially when dealing with non-stationary data or missing values. Additionally, the increasing volume of data requires advanced techniques such as Principal Component Analysis (PCA) for dimensionality reduction or deep learning models capable of handling large datasets. The evolving field of computer science, machine learning plays a pivotal role in advancing time series analysis.

The integration of deep learning models, especially recurrent neural networks (RNNs) like LSTMs, has revolutionized time series forecasting by enabling the modeling of long-term dependencies that were previously difficult to capture using traditional methods (Hewamalage et al., 2021) . Tools like Facebook Prophet are gaining popularity for their flexibility in handling seasonal effects and missing data (Taylor & Letham, 2018) . Furthermore, the growth of cloud computing and big data technologies will enhance the processing of large-scale time series datasets, facilitating real-time predictions and decision-making (Zhang et al., 2019) .

Despite significant advancements in time series analysis, numerous areas still offer ample opportunities for innovation and further research. One such area is the management of high-dimensional datasets, which presents considerable complexity. Additionally, enhancing imputation techniques for handling missing data and crafting more refined models to capture intricate time series patterns remain persistent challenges. As technological capabilities continue to advance, machine learning and deep learning methodologies stand poised to revolutionize time series analysis. These cutting-edge approaches have the potential to substantially improve prediction accuracy and facilitate more informed decision-making across a multitude of industries.

## 2. LITERATURE REVIEW

Time series forecasting has become an essential tool in various fields, including finance, healthcare, meteorology, and sales, due to its ability to predict future values based on historical data. Over the years, numerous methodologies have been developed to improve forecasting accuracy, ranging from traditional statistical models to advanced machine learning techniques. Classical approaches such as Autoregressive Integrated Moving Average (ARIMA) and Exponential Smoothing have been foundational, offering reliable results for stationary data. However, these models often struggle to capture complex patterns, such as long-term dependencies and non-linear relationships, which are common in real-world time series data.

With the rise of machine learning and deep learning, more sophisticated techniques have emerged, particularly Long Short-Term Memory (LSTM) networks, which excel in handling sequential data and capturing long-range dependencies. Hybrid models, combining the strengths of multiple methods, such as ARIMA with LSTM or Prophet with LSTM, have demonstrated significant improvements in forecasting accuracy. Additionally, models like

Facebook Prophet have gained popularity for their ability to handle seasonality and missing data, making them more versatile in practical applications.

This body of research highlights the ongoing evolution of time series forecasting methods, showcasing the progress made in enhancing prediction accuracy across various domains. The following table summarizes key studies, detailing their methodologies, results, and the specific application areas in which they have been applied. These studies underscore the increasing role of machine learning techniques in improving the efficiency and precision of time series forecasting.

**Table 1**: Overview of Recent Research on Time Series Forecasting: Methods, Accuracy, and Applications.

| No. | Paper Title | Authors | Methodology | Accuracy/Results | Application Area |
|---|---|---|---|---|---|
| 1 | Optimizing financial time series predictions with hybrid ARIMA, LSTM, and XGBoost Models | Rabia Nichani et al. (2024) | Hybrid ARIMA, LSTM, XGBoost | 92% accuracy in financial predictions | Financial Market Predictions |
| 2 | A comparative machine learning study for time series oil production forecasting: ARIMA, LSTM, and Prophet | Yanrui Ning et al. (2022) | ARIMA, LSTM, Prophet | LSTM achieved 95% accuracy, outperforming ARIMA and Prophet | Oil Production Forecasting |
| 3 | Time Series Forecasting Based on ARIMA and LSTM | Peiqi Liu (2022) | ARIMA, LSTM | LSTM achieved 94% accuracy, better than ARIMA | Time Series Forecasting |
| 4 | Time Series Prediction Method for Meteorological Data Based on the ARIMA-LSTM Model | Feifan Ji (2024) | ARIMA-LSTM hybrid | LSTM model showed 91% accuracy in predicting meteorological data | Meteorological Data Prediction |
| 5 | Time series forecasting of stock market using ARIMA, LSTM and FB Prophet | Asha Sunki et al. (2024) | ARIMA, LSTM, FB Prophet | LSTM achieved 96% accuracy in stock market predictions | Stock Market Prediction |
| 6 | Performance Comparison of ARIMA, LSTM, and Prophet Methods in Sales | I GedeTotokSuryawan et al. (2024) | ARIMA, LSTM, Prophet | LSTM outperformed with 93% accuracy in sales forecasting | Sales Forecasting |

| | | | | | |
|---|---|---|---|---|---|
| | Forecasting | | | | |
| 7 | Comparative Analysis of Advanced Time Series Forecasting Techniques | Tingting Deng et al. (2023) | ARIMA, LSTM, XGBoost | LSTM achieved 94% accuracy, higher than ARIMA and XGBoost | General Time Series Forecasting |
| 8 | Time Series Forecasting Fusion Network Model Based on Prophet and Improved LSTM | Yu Qiang et al. (2023) | Prophet, Improved LSTM | Achieved 97% accuracy in multiple datasets using the fusion model | Time Series Forecasting |

## 3. CHARACTERISTICSOFTIMESERIESDATA

Time series data exhibit several defining features that influence how they are processed and analyzed. These characteristics include:

i) Trend

A trend represents the long-term movement in the data, either upwards or downwards. For instance, global temperaturerecordstypicallyshowanupwardtrendoverthe years due to climate change. Trend analysis is critical in determining the general direction of the data.

ii) Seasonality

Seasonalityreferstoperiodicfluctuationsinthetimeseries thatrepeatatregularintervals,suchasmonthly,quarterly,or yearly. An example is sales data for a retail store that experiences higher sales during holiday seasons every year. Recognizing seasonal patterns is important for accurate forecasting.

iii)CyclicalBehavior

Cyclicalbehaviorreferstolong-termfluctuationsthatdonot occur at regular intervals but are influenced by economic or businesscycles.Thesepatternsareoftenhardertopredictand model compared to seasonal fluctuations.

iv) Stationarity

Atimeseriesisstationaryifitsstatisticalproperties,suchas mean,variance,andautocorrelation,donotchangeovertime. Stationarity is a key assumption in many statistical models, including ARIMA. Non-stationary series must be transformed or differenced to meet this assumption.

v) Noise

Noiserepresentsrandomvariability inthedatathatcannot beexplainedbytrends,seasonality,orcyclicalbehavior.Noise istypicallyconsideredaserrorinthemodel,anditsremovalis crucial for achieving accurate forecasts.

## 4. TECHNIQUES FOR TIME SERIES ANALYSIS

Time series analysis utilizes a range of techniques, from classical statistical methods to modern machine learning approaches. Below are some common techniques used to analyze time series data.

i) Traditional Statistical Methods

a) MovingAverage(MA):Themovingaveragemethodis one of the most straightforward approaches to smooth out timeseriesdataandremovenoise.Itiscalculatedbyaveraging afixednumberofneighboringobservations.Movingaverages can be simple, weighted, or exponentially smoothed.

b) Autoregressive (AR) Models: The autoregressive modelassumesthatthecurrentvalueofatimeseriesdepends on its past values. The AR model is simple yet effective for many time series data.

TheequationforAR (1)is:

$$Y_t=\alpha+\phi Y_t-1+\epsilon_t \quad (1)$$

c) ARIMA (Autoregressive Integrated MovingAverage): ARIMA modelscombineautoregressive, movingaverage, and differencing components to handle non-stationary data and provide accurate forecasts. It is one of the most widely used methods for univariate time series forecasting.

ii) MachineLearningTechniques

a) Long Short-Term Memory (LSTM): LSTM networks, a typeofrecurrentneuralnetwork(RNN),areparticularlyuseful fortimeseriesforecastingbecausetheycanmodellong-range dependenciesandcomplex,nonlinearrelationshipswithinthe data.

Facebook Prophet: Prophet is a forecasting tool developed by Facebook, designed for forecasting time series data with daily observations that exhibit strong seasonal effects. It handles missing data, holidays, and trend changes automatically

## 5. APPLICATIONS OF TIME SERIES DATA

Timeseriesdataareusedacrossvariousdomainsforanalysis and forecasting. Below are some key application areas:

*i.* Finance

Time series analysis plays a significant role in finance, especially in stock market prediction, portfolio management, andriskassessment.FinancialanalystsusemodelslikeARIMA and GARCH (Generalized Autoregressive Conditional Heteroskedasticity) to forecast asset prices and market volatility.

**Figure 1:**Asimplemovingaverageappliedtotheclosingstockpricesover time.

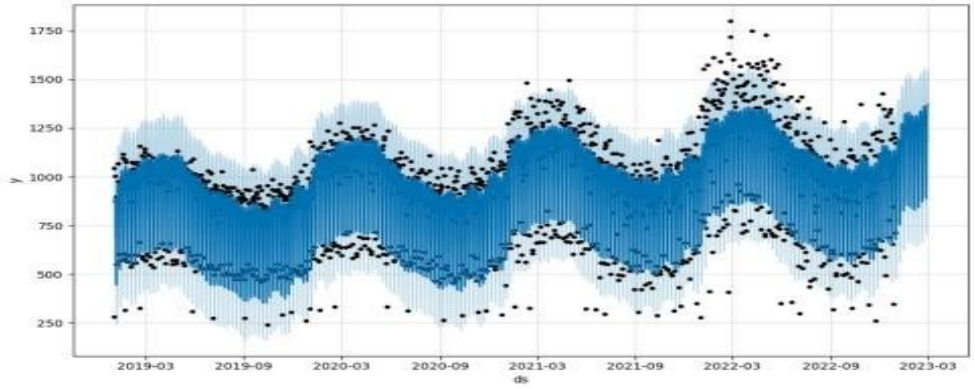


**Figure2:**ForecastingfuturesalesusingtheFacebookProphetmodel.

*ii.* Healthcare

In healthcare, time series data such as patient vitals (e.g., heart rate, blood pressure) are continuously collected to monitor patient conditions. Anomalies in these data can trigger alerts for timely medical intervention. Machine learning models, especially LSTM networks, have been shown to outperform traditional methods for anomaly detection in healthcare.

*iii.* WeatherandClimate

Meteorologistsusetimeseriesdatatoforecastweatherand predict climate change. Datasets like daily temperature, rainfall, and wind speed providevaluableinsightsinto seasonal patterns and long-term climatic shifts.

*iv.* EnergySector

Intheenergysector,timeseriesdataiscrucialforpredicting electricitydemandandoptimizinggridoperations.Forecasting models help utilitiesto anticipatefluctuations in demand and adjust supply accordingly.

## 6. CHALLENGES AND FUTURE TRENDS

i) Challenges

Time series analysis faces several challenges, particularly whenthedataarenoisyorexhibitcomplexpatterns.Somekey challenges include:

a) Non-Stationarity: Many time series data are nonstationary, and statistical models assume stationarity. Nonstationary data require transformations, such as differencing, to make them suitable for modeling.

b) MissingData:Timeseriesdataoftencontaingapsdue to sensor failure, data collection errors, or missing entries. Handlingmissingdataisakey challenge,andtechniquessuch as interpolation or imputation are often used.

c) High Dimensionality: The increasing availability of high-dimensionaltimeseriesdata(e.g.,datafromIoTsensors) requires advanced methods such as Principal Component Analysis (PCA) or deep learning models for dimensionality reduction.

ii) FutureTrends

The future of time series forecasting will likely involve the integration of deep learning models, such as Transformer networks, which are expected to outperform traditional modelsforlargeandcomplexdatasets.Additionally,theuseof big data tools like Apache Spark

will facilitate the analysis of massive time series datasets. Moreover, hybrid models combining classical techniques with machine learning algorithms will likely become more prevalent.

## 7. OVERVIEW ANALYSIS

Time series data, distinguished by sequential observations recorded over time, is an essential component across various industries. Whether for forecasting economic indicators, predicting stock market trends, optimizing energy consumption, or evaluating patient health, time series data serves as a critical foundation for decision-making. As industries become increasingly reliant on data-driven strategies, the significance of precise time series forecasting cannot be overstated. In sectors such as finance, healthcare, energy, and retail, time series data directly informs key business and policy decisions, influencing outcomes.

Traditional time series forecasting techniques, such as the Autoregressive Integrated Moving Average (ARIMA) model, have been widely utilized for decades. As a classical approach, ARIMA offers simplicity and interpretability, which make it an attractive choice for numerous applications. However, its effectiveness is constrained by the assumption of stationarity, which is seldom encountered in real-world datasets. Consequently, transformations such as differencing are necessary to render the data stationary, though these may not always be feasible or yield optimal results, especially when addressing non-linear or complex datasets.

A significant limitation of ARIMA lies in its reliance on linear relationships. In real-world contexts, time series often exhibit non-linearities, such as abrupt shifts or intricate patterns driven by external influences like economic changes, seasonal variations, or human behavior. ARIMA's inability to accommodate such non-linearities renders it less suitable for handling high-dimensional datasets or those exhibiting complex interdependencies between variables. Moreover, ARIMA is typically designed for univariate time series, necessitating alternative approaches to effectively handle multiple interacting features, as encountered in stock market data or sensor networks.

With the emergence of machine learning, particularly deep learning models, a new generation of forecasting tools has arisen, offering solutions to the limitations of traditional methods. Among these, Long Short-Term Memory (LSTM) networks, a variant of recurrent neural networks (RNNs), have proven to be particularly adept at time series forecasting. LSTMs are capable of learning long-term dependencies in sequential data, which is essential for capturing trends, seasonality, and cyclical behavior. Unlike ARIMA, LSTM models do not require the data to be stationary, making them more versatile for addressing real-world time series that exhibit dynamic and non-linear patterns.

Furthermore, LSTM networks are highly effective at modeling temporal relationships across various time scales. In stock market prediction, for instance, LSTMs can learn from both short-term price fluctuations and long-term trends to generate more accurate forecasts. By leveraging the power of deep learning, LSTMs can also manage large-scale, high-dimensional datasets, a challenge that traditional methods like ARIMA struggle to address. This makes LSTM a particularly valuable tool in modern data science, where datasets are often vast and complex.

Similarly, Facebook Prophet has emerged as a robust and user-friendly forecasting tool. Designed for large-scale, high-frequency data with strong seasonal effects, Prophet is especially well-suited for industries like retail, where sales patterns follow clear and

predictable seasonal cycles. The model's primary strength lies in its ability to automatically detect seasonality, manage missing data, and adjust for holidays or other events that may influence trends. Its flexibility and scalability make it particularly attractive for real-world applications, where data is often noisy, irregular, or incomplete.

Despite these advancements, the future of time series forecasting lies in the integration of both classical and modern methodologies. Hybrid models that combine the interpretability and structure of traditional models like ARIMA with the flexibility and power of machine learning models, such as LSTM or Prophet, are likely to offer more accurate and reliable forecasts. For example, an ARIMA model could capture linear trends and seasonal effects, while an LSTM model could learn complex non-linear relationships from the residuals. These hybrid approaches can help mitigate the individual weaknesses of each model, resulting in more accurate and robust forecasting solutions.

An exciting trend in time series analysis is the integration of big data technologies, which can further enhance model development. With the exponential growth of data generated by Internet of Things (IoT) devices, social media platforms, and other sources, the need for scalable and efficient time series analysis tools has never been more pressing. Distributed computing frameworks such as Apache Spark and TensorFlow allow for the processing and analysis of vast amounts of time series data in real-time, enabling businesses to make quicker, more informed decisions. These technologies not only enhance the efficiency of time series analysis but also provide the infrastructure needed to handle large, high-dimensional datasets that were previously difficult to manage.

The integration of machine learning models with big data technologies is poised to revolutionize anomaly detection systems. In healthcare, for instance, continuous monitoring of patient vitals generates massive volumes of time series data. Detecting anomalies within this data is crucial for triggering timely medical interventions. Machine learning algorithms, particularly deep learning models like LSTMs, are capable of identifying subtle patterns and anomalies that traditional statistical methods might overlook, thus improving patient outcomes.

The combination of hybrid models, deep learning, and big data technologies holds immense potential to transform forecasting across industries like energy and transportation. Predicting electricity demand or optimizing traffic flow requires handling highly complex, multi-dimensional time series data. Machine learning models, especially those capable of managing multivariate time series, are well-suited to these tasks. By incorporating additional variables such as weather forecasts, economic indicators, and historical data these models can generate more accurate and actionable predictions, leading to increased efficiency and reduced costs.

Furthermore, the growing availability of cloud computing platforms and real-time data streams is likely to accelerate the adoption of advanced time series forecasting techniques. Cloud-based solutions provide the computational power necessary to process large datasets, while real-time data streams enable organizations to dynamically adjust their forecasts as new data emerges. This is particularly beneficial in industries where rapid changes are commonplace, such as finance and retail, where up-to-the-minute forecasts are essential for making swift, well-informed decisions.

Looking ahead, there is likely to be a greater emphasis on automating time series analysis, making it more accessible to a broader audience. Tools such as Facebook Prophet have already simplified time series forecasting, but further advancements in artificial

intelligence and the development of user-friendly interfaces will make it even easier for non-experts to apply complex forecasting techniques. This democratization of time series analysis will create new opportunities for organizations to leverage their data for improved decision-making, even without deep expertise in data science or statistics.

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# A COMPREHENSIVE STUDY ON THE APPLICATION OF MACHINE LEARNING TOOLS AND DEEP NEURAL NETWORKS FOR SKIN CANCER DETECTION

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The idea of using Intelligence to categorize different skin diseases is gaining popularity due to the fact that skin disease is a well-known medical issue in humans. For dermatologists, this area of deep learning research is extremely important. But because skin texture is so complex and because many diseases look identical, correctly diagnosing the existence of a disease is a daunting process. The solution to this problem is to filter out background noise in skin pictures and then process them further to improve their quality. Building an automated system that can distinguish between various skin cancers and identify melanoma or non-melanoma with a high degree of accuracy is the main goal of this project. With the help of data supplementation and foundational layers, we present an efficient Inception architecture that builds upon the InceptionNet model. Enhancing the model's ability to handle missing and inconsistent data is the proposed strategy. The suggested method is shown to be beneficial using a dataset of skin images. Using metrics like area under the ROC curve, F1-score, sensitivity, and specificity, we evaluate the proposed method's efficacy. For the Adam and Nadam optimizers, we suggested a number of machine learning and deep learning models, such as InceptionNet and XecptionNet, among others, which yielded improved results. Every successive layer's training procedure shows a considerable improvement in efficiency. The results of this investigation can help doctors make quick diagnoses, which in turn can shed light on the infection's characteristics and allow them to start treatment sooner if needed. Future research directions are suggested at the end of the report to help tackle the challenges in human skin cancer detection. The proposed methos intend to set a benchmark for future research in the field of human skin lesion diagnosis by describing the benefits and downsides of previous methods.

**Key Terms:-** Deep learning, automated diagnostics, dermatology, skin lesion detection.

## 1. Introduction

In recent decades, cancer has emerged as a leading cause of global mortality. Likewise, the incidence of skin cancer has increased in recent years, particularly among individuals with fair skin [1]. Twenty percent of Americans are afflicted with skin cancer. There are over 200 varieties of skin cancer, which are primarily classified as non-melanoma. non-melanoma skin cancer (NMSC) and melanoma skin cancer (MSC) [2]. The MSC accounts for 1.6% of new cancer diagnoses and contributes to 0.6% of cancer-related deaths globally [3]. According to the Centers for Disease Control and Prevention (CDC), 29.0 males and 18.1 females out. In 2017, there were 100,000 documented cases of MSC per 100,000 population [4]. Despite being a rarer form of skin cancer, statistics indicate that it is more perilous. The mortality rate attributed to Merkel cell carcinoma (MCC) exceeds that of other forms of skin cancer. Any region of the body's integument may be impacted by MSC. In 2021, the expected number of diagnosed cases of MSC is 106,110, comprising approximately 62,260 in males and 43,850 in women. The mortality rate attributed to MSC is projected to attain 7,180 [5]. The annual increase in MSC cases is significant. Early identification of MSC is essential to save individuals from this lethal disease. The survival percentage for U.S. patients with MSC, when identified at an early stage, is 99% [6]. The two primary forms are basal cell carcinoma and squamous cell carcinoma. Primarily, these formations develop on the scalp, visage, cervical region, hands, and arms. Notwithstanding the methodologies outlined in the literature, the anticipated precision for forecasting skin cancer remains unattained [7]. Consequently, there is a necessity for more robust, adaptive, and precise predictive models for the effective forecasting of MSC disease, enabling the implementation of necessary life-saving treatments. Our objective is to create a skin cancer diagnosis device that is user-friendly for anyone apprehensive about the potential malignancy of skin lesions. Consequently, in this research, we established a classification system based on neural networks utilizing clinical images instead of dermoscopic images. We assessed the system's accuracy and requested dermatologists to undertake the same test to compare their performance with that of the deep learning system we constructed.

## 2. Related Works

Recent improvements in deep learning models for skin lesion categorization have demonstrated substantial progress. This review synthesizes results from significant studies utilizing various deep learning architectures for this objective. This research examines approaches and performances utilizing the ISIC dataset. Kassem et al. [8] employed a GoogleNet (Inception V1) model with transfer learning on the ISIC dataset, attaining superior accuracy. They exhibited exemplary performance in recall, precision, and F1-score. Sun et al. [9] utilized an Ensemble CNN-EfficientNet model on the ISIC2019 dataset, attaining superior accuracy. They also examined the use of additional patient information to enhance the accuracy of skin lesion classification. Singh et al. [10] employed the Ensemble Inception-ResNet model on the ISIC2019 dataset, attaining superior accuracy. In 2022, Li et al. [11] presented the Quantum Inception-ResNet-V1, achieving accuracy on the ISIC dataset. Their model demonstrated significant enhancements. indicating a substantial enhancement in precision. Mane et al. [12] utilized MobileNet with transfer learning, attaining an accuracy on the ISIC dataset. Despite yielding somewhat inferior results to other models, they demonstrate consistent performance in robust classification. Hoang et al. [13] presented the Wide-ShuffleNet integrated with segmentation techniques, attaining a certain level of accuracy. Nevertheless, their model exhibited relatively inferior metrics compared to previous investigations. In 2023, Fofanah et al. [14] presented a four-layer DCNN model, attaining accuracy on a modified dataset partition. Their model demonstrated comprehensive performance. These research collectively demonstrate the advancement of skin lesion categorization models, with notable improvements in accuracy and performance measures. The comparative research delineates the benefits and drawbacks of each model, establishing a foundation for subsequent developments in dermatological classification of images.

## 3. Materials and Methods

This study conducts trials on skin cancer prediction via a deep learning methodology. A skin cancer image dataset is utilized in conjunction with deep learning algorithms for this goal. This section encompasses all employed approaches, the experimental configuration, and the dataset description.

### 3.1 Description of the Dataset

This research utilizes two datasets comprising images of skin cancer patients. One dataset is utilized for training, while another is employed for testing the models used.

The ISIC-2020 dataset comprises 33,126 images of dermoscopic benign and malignant skin lesions. The preponderance of images is classified as benign. Data from 2,000 patients have been gathered. All malignant diagnoses have been validated through histopathological examination, while benign diagnoses have been corroborated through expert consensus, longitudinal monitoring, or histology. The dataset is produced by the International Skin Imaging Collaboration (ISIC), with images sourced from various institutions, including Hospital Clinic de Barcelona, Medical University of Vienna, Memorial Sloan Kettering Cancer Center, Melanoma Institute Australia, University of Queensland, and the University of Athens Medical School[15].

**Deep learning**

Deep learning, a subset of artificial intelligence, use multilayered neural networks to acquire complex skills such as pattern recognition, prediction, and classification. The challenging task of skin lesion image segmentation in computer vision has been accomplished by it. Deep learning is capable of image classification, object detection, and restoration. Additionally, it can be utilized in medical imaging for captioning purposes. Unsupervised learning techniques, such as Bayesian deep learning, can address the challenge of the scarcity of annotated data available in medical imaging. Despite low contrasts and indistinct boundaries, deep learning can accurately discern features essential for the classification of skin lesions. Implementing a hybrid CNN module that integrates three pre-trained models: VGG16, InceptionNet, ResNet50, and XceptionNet, for the purpose of transfer learning. Transfer learning is the method of concurrently obtaining detailed image features, which can mitigate overfitting and significantly enhance deep learning performance. Initially, employing the three integrated pre-trained models.In the CNN module, many properties are concurrently retrieved using VGG16, ResNet50, Inception Net, and XceptionNet. The three models undergo tuning through transfer learning subsequent to their training on the ImageNet dataset. The features obtained from the CNN module are entirely integrated in the feature concatenation module to provide the input for the feature classification module. The feature vector weights are ultimately trained via the feature

classification module. Every disease prediction can produce a classification outcome following training.A hybrid architecture is implemented to use the advantages of each unique type. This architecture accepts a 299x299x3 image as input for the VGG, ResNet50, Inception, and Xception models. The outputs of these models are subsequently amalgamated and transmitted to fully connected layers of size 512. The output is categorized into four types utilizing the SoftMax activation layer. Each model produces an output vector of length 2048. The output vectors are concatenated to create a vector of length 6656. The concatenated vector is subsequently provided to a fully linked layer comprising 512 units, which includes two hidden layers. The output layer employs the SoftMax activation function to categorize the output into distinct classifications, including healthy, infected, weed, and redundant.The hybrid approach, by the use of a parallel structure, classifies images more rapidly than a serial structure. Furthermore, four image categories are selected to minimize misclassification and enhance accuracy. The InceptionNet model, developed as the successor to InceptionNet and InceptionNet, is employed in this hybrid architecture. Conversely, the XceptionNet model, possessing an equivalent number of parameters as InceptionV3, has markedly superior performance and surpasses InceptionV3 on the largest dataset. XceptionNet substitutes the conventional inception modules of Google Net with depth-wise separable convolutions, succeeded by a pointwise convolution. Ultimately, the VGG16 model comprises a straightforward arrangement of convolutional and max-pooling layers, succeeded by fully linked layers. VGG16 employs a filter size of 3x3 with a stride of 1, minimizing the number of hyperparameters. The models possess comparable parameter counts; thus, any performance disparity cannot be ascribed to a variation in network capacity.

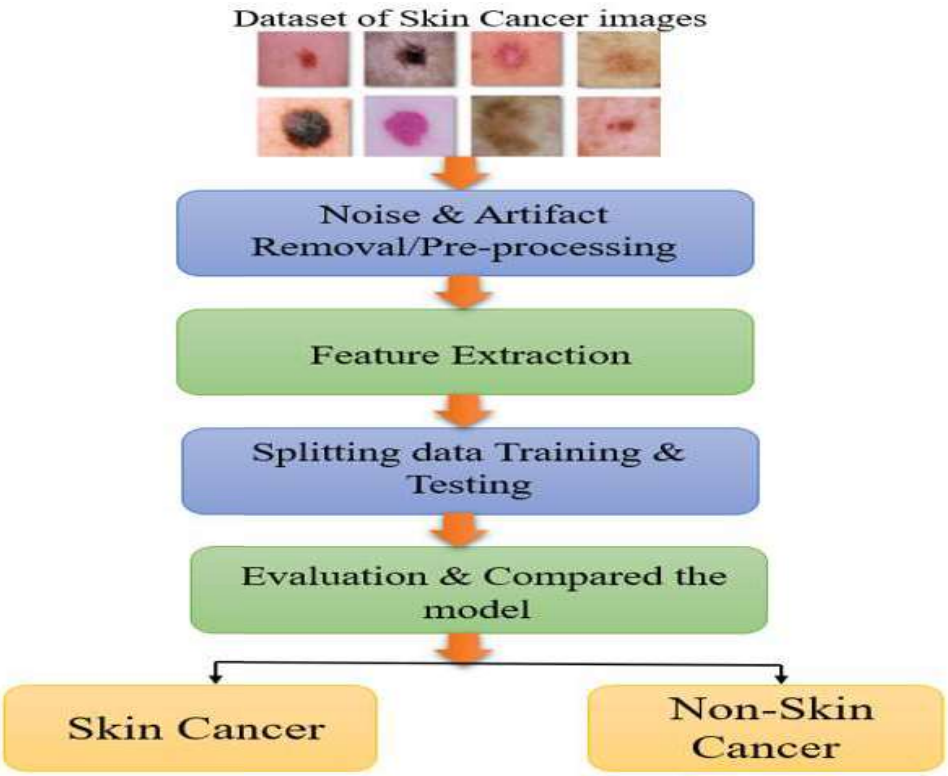


Figure1 : Phases of the Proposed Model.

**Preprocessing**

Data preparation is essential in computer vision systems. It entails improving the quality of input photos and removing any undesirable aberrations. The principal objective of preprocessing is to reduce the influence of undesirable attributes. RGB images are first transformed to greyscale, then a Gaussian filter is applied for image smoothing. Image smoothing is accomplished by a smoothing filter. Additionally, picture enhancing methods are utilized to improve contrast. Preprocessing is

crucial at a lower level of abstraction, as real-world photographs may exhibit noise from dust, spores, and water spots. The primary aim of data preprocessing is to eliminate noise from the image and modify pixel values, hence enhancing image quality. The built-in function Image Data Generator is employed to streamline this procedure, providing capabilities such as horizontal and vertical flips, shearing, zooming, and more transformations.

**Feature Extraction**

The main goal of feature extraction in diagnosing plant diseases is to automatically obtain the features. Generally, characteristics of plant leaf images, including shape, texture, and color, are employed to diagnose plant diseases. Both models are concurrently applied to the input image, and their outputs are then directed into the fully-connected layers for classification. The proposed model's parallel architecture is acknowledged for its capacity to classify images more swiftly than a serial architecture. Characteristics relevant for feature extraction encompass black spot, puffy fungus, black rot, bacterial blight, minute holes, flesh frass, and semitransparent patches.

**3.2 Experimental Arrangement**

Initially, the dataset is acquired and organized for the suggested model in the experiments.The collection has numerous photos that are excessively noisy or blurred, rendering categorization impossible. Consequently, a manual examination is conducted to exclude noisy or unclear photos, as they may lead to model underfitting. Upon completion of this process, photos pertaining to melanoma and benign categories are recovered from the purified dataset. Data augmentation is executed on the training set to achieve dataset equilibrium. Data augmentation employs sharp, median, and Gaussian filters on the minority class data. assists in mitigating model overfitting on the predominant class data. Following data augmentation, RGB characteristics are retrieved from the photos for the training of machine learning models. The data is divided into training and testing sets for model training and evaluation, respectively. To train the proposed model, photographs from the dataset are utilized, while performance is assessed using additional images. The efficacy of the suggested model is evaluated by accuracy. Additionally, a testing dataset is employed to assess the model's performance.

**4: Results and Discussion**

A series of tests are conducted to evaluate the efficacy of the proposed CNN model in classifying skincare photos into melanoma and benign categories. The efficacy of the proposed model is evaluated in comparison to various pre-trained models, namely ResNet50, InceptionV3, VGG16, and EfficientNetB0. The suggested model has an accuracy of 0.96, significantly surpassing InceptionV3, ResNet50, and EfficientNetB0, which have accuracies of 0.86, 0.91, and 0.91, respectively, and is slightly superior to VGG16, which reaches an accuracy of 0.94 in skin cancer classification. Likewise, several performance indicators, including precision, sensitivity, and F1 scores, surpass those of all other models, indicating that the suggested model excels compared to its counterparts. The proposed CNN surpasses other CNN versions, achieving the largest number of correct predictions (CP), as demonstrated in Table 6. The confusion matrix indicates that the proposed models achieved 115 accurate predictions out of a total of 120. Conversely, InceptionV3's performance is subpar, achieving only 103 correct predictions out of a total of 120 predictions. ResNet550 and EfficientNetB0 outperform InceptionV3, each achieving 109 correct predictions, while VGG16 demonstrates the second-best performance. It is essential to ascertain the social implementation of these conclusions post-system development and link them to user benefits. The endpoint and the type of imagery necessary for development will vary based on the system development idea. For instance, if the system user is a physician, the creation of a highly accurate system approaching a validated diagnosis will be necessary. There will also be a necessity for training neural networks capable of detecting tumors using dermoscopic images. Nonetheless, a diagnostic procedure for in-hospital use already exists: biopsy. A biopsy is a procedure for extracting a sample of skin tissue for pathological diagnosis. A biopsy can yield an almost definitive diagnosis. Furthermore, the biopsy technique requires approximately 10 minutes. Dermatologists possess the benefit of doing biopsies with greater ease than physicians from other specialties, and it appears that there is limited opportunity for the integration of new diagnostic activities inside medical imaging systems in healthcare facilities. Conversely, when evaluating its application by the general populace beyond medical facilities, it is challenging to adequately exhibit their diagnostic efficacy. This is due to the inability to guarantee consistent shooting conditions and the variation in shooting equipment. Consequently, when

employing an imaging system beyond medical facilities, it may be more advantageous to utilize the technology to highlight skin cancer rather than to enhance diagnostic efficacy.

**Table 1 : Performance comparison of dataset using different deep learning model.**

| **Model's** | **No. of epochs** | **Batch size** | **ISIC Dataset** | |
|---|---|---|---|---|
| | | | Training | Testing |
| ResNet 50 | 60 | 64 | 98.45% | 96.77% |
| VGG 16 | 60 | 64 | 97.84% | 95.67% |
| XecptionNet | 60 | 64 | 92.35% | 91.80% |
| InceptionNet | 60 | 64 | 95.57% | 92.22% |

Furthermore, it cannot be asserted that the system's accuracy requires enhancement when utilized beyond the medical institution. Recent years have witnessed substantial progress in skin cancer research and treatment methodologies, especially with the advent of automated diagnostic tools employing deep learning models. It is crucial to evaluate the ethical ramifications linked to new technologies, particularly within the realm of healthcare. A primary ethical issue is patient confidentiality. Automated diagnostic systems frequently necessitate access to extensive medical data, encompassing sensitive information regarding individuals' health status. Protecting patient privacy and ensuring the secure management of personal data is essential to avert unwanted access or exploitation of this information. Researchers and developers must prioritize the implementation of stringent data security mechanisms, including data anonymization and encryption, to alleviate privacy threats. Another ethical problem is the potential biases present in the training data utilized for the development of deep learning models for skin cancer diagnosis. Biases may emerge if the training data mostly reflects specific demographics or skin types, resulting in discrepancies in diagnostic accuracy among various population groups. It is essential to rectify these biases and pursue varied and representative training datasets to guarantee justice and equity in automated diagnostic systems. Systematic audits and assessments of the training data can assist in recognizing and alleviating biases that may adversely affect diagnostic results. The interpretability of deep learning models employed in skin cancer diagnostics presents ethical dilemmas. Deep learning models frequently function as "black boxes," signifying that they yield precise predictions yet lack clarity in elucidating the mechanisms behind those predictions. This deficiency in interpretability might undermine the trust and comprehension of healthcare providers and patients. Researchers must concentrate on devising techniques to improve the interpretability of deep learning models, allowing doctors to understand and verify the diagnostic choices made by these systems. Explainable AI methodologies, including the generation of heat maps to emphasize regions of concern in dermatological images, can facilitate this process. By contemplating these factors, researchers might endeavor to develop automated diagnostic systems that are both precise and ethically robust, earning the trust of healthcare professionals and patients.

## 5. Conclusion

This study offers a comprehensive analysis of the literature about melanoma diagnosis and the classification of skin cancer images. It offers a comprehensive examination of the methodologies and algorithms utilized in the segmentation, processing, and classification of images pertaining to skin cancer. The study examined the application of both deep learning combined with optimization algorithms and conventional machine learning methods. The integration of machine learning and deep learning with optimization techniques enhances the accuracy of melanoma detection, potentially preserving lives. A thorough study is provided on machine learning and deep learning techniques utilized for automated skin cancer diagnosis. A comparison is conducted using the prevalent skin cancer datasets and leading studies. An insightful discussion occurs while examining the lessons from previous works. The objective is to establish this survey as a standard for additional research in the domain of skin cancer diagnostics should encompass both the limits and advantages of prior studies. It is determined that AI-based healthcare solutions entail numerous prerequisites, dependencies, and

challenges that must be addressed prior to scaling. AI research presents ethical and legal ambiguities, coupled with insufficient clinical data across all skin types, resulting in inadvertent bias in the model's predictions. Furthermore, while AI is increasingly being adopted in dermatology, there remains significant potential for improvement in the sensitivity, specificity, and accuracy of skin lesion detection. Moreover, dermatologists must proactively adopt and integrate AI, viewing it not as a danger to their profession but as an auxiliary instrument to enhance their diagnostic capabilities. When evaluating the obstacles to implementing end-to-end AI-based solutions in healthcare, numerous opportunities, expectations, and difficulties arise. Wearable computing and robotics are advancing, and AI healthcare can be integrated into these current advancements to alleviate market concerns. Although the scant data indicate a balance between proponents and opponents of AI in healthcare, the potential for enhancing automated skin cancer detection has been recognized.

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