Bharati Vidyapeeth
(Deemed to be University)

ABHIJIT KADAM INSTITUTE OF MANAGEMENT AND SOCIAL SCIENCES, SOLAPUR

RESEARCH PUBLICATIONS

ACADEMIC YEAR

2024 – 2025

Bharati Vidyapeeth
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ABHIJIT KADAM INSTITUTE OF MANAGEMENT AND SOCIAL SCIENCES, SOLAPUR

I N D E X

Research Publications in the Academic Year 2024 – 2025

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Publications Count (Academic Year: 2024 – 2025)

Sr. No	Name of Staff Member	Designation	Number of Publications Academic Year: 2024 – 2025								
			Scopus	Web of Science	ABDC	UGC Care	Patent Design, Pub.	Peer Reviewed	Conf.	Book	Total
Department of Management Studies											
1.	Prof. Dr. S. B. Sawant	Director	--	--	01	04	01	03	02	01	12
2.	Prof. C. R. Suryawanshi	Associate Professor	--	--	--	01	--	--	01	--	02
3.	Dr. P. P. Kothari	Assistant Professor	01	--	01	03	--	--	--	--	05
4.	Dr. G. S. Mane	Assistant Professor	--	--	--	02	--	--	01	--	03
5.	Dr. Shabnam Mane - Mahat	Assistant Professor	01	--	--	--	01	02	--	--	04
6.	Dr. R. N. Manjare	Assistant Professor	02	--	--	01	--	01	01	01	06
7.	Prof. S. C. Maindargi	Assistant Professor	02	--	--	--	01	--	--	--	03
8.	Dr. Sachin S. Suryawanshi	Librarian	02	--	--	02	--	--	05	--	09
Department of Computer Applications											
1.	Dr. A. B. Nadaf	Associate Professor	03	--	--	--	--	--	--	01	04
2.	Dr. M. K. Patil	Assistant Professor	02	--	--	--	--	--	--	--	02
3.	Prof. D. D. Mhetre	Assistant Professor	--	--	--	01	--	--	01	--	02
4.	Prof. S. N. Gambhire	Assistant Professor	01	01	--	01	--	--	--	--	03
Total Publications			**14**	**01**	**02**	**15**	**03**	**06**	**11**	**03**	**55**

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ABHIJIT KADAM INSTITUTE OF MANAGEMENT AND SOCIAL SCIENCES, SOLAPUR

PUBLICATIONS IN SCOPUS LISTED JOURNALS

Sr. No.	Name of Faculty	Title of Research Paper	Name of the Journal	Month & Year	ISSN / ISBN	Vol. & Issue
1	Dr. M. K. Patil	Enhancing Cloud Computing Environments with AI-Driven Resource Allocation Models	Advances in Nonlinear Variational Inequalities	Sept 2024	1092-910X	27(3)
2	Dr. M. K. Patil	The ExpTODIM-VIKOR Approach Under Linguistic Z-Number Environment and Their Applications to Solve Multicriteria Group Decision-Making Problems	Studies in Fuzziness and Soft Computing	Sep, 2024	1434-9922	44
3	Dr. S. C. Maindargi	IoT-Driven Healthcare an Ensemble Learning Approach for Early Detection and Prevention of Chronic Diseases	Advances in Nonlinear Variational Inequalities	Sept, 2024	1092-910X	27(3)
4	Dr. S. C. Maindargi	Mitigation and Detection of Faulty Nodes in Multimode Hadoop Cluster using Hybrid Machine Learning Techniques	Journal of Information Systems Engineering and Management	Jan, 2025	2468-4376	10 4(s)
5	Dr. Sachin Suryawanshi	Exploring the Role of Big Data Analytics in Personalizing E-Learning Experiences	Advances in Nonlinear Variational Inequalities	Sept, 2024	1092-910X	27(3)
6	Dr. Sachin Suryawanshi	Bibliometrics Analysis of the Annals of Library and Information Studies from 2012 to 2021	Library Progress International	Dec, 2024	0970-1052	44(3)
7	Dr. P. P. Kothari	Enhancing Cloud Computing Environments with AI Driven Resource Allocation Models	Advances in Nonlinear Variational Inequalities	Sept, 2024	1092-910X	27, (3)
8	Prof. S. N. Gambhire	Sombor Index in Neutrosophic Graphs	Neutrosophic Sets and Systems	Mar, 2025	2331-608X	82, (1)

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PUBLICATIONS IN SCOPUS LISTED JOURNALS

Sr. No.	Name of Faculty	Title of Research Paper	Name of the Journal	Month & Year	ISSN / ISBN	Vol. & Issue
9	Dr. A. B. Nadaf	An Efficient Method for Empowering engineering students through employability skills Based on New A-Res Net-LSTM Model	IEEE (ICONAT)	Sep, 2024	979-8-3503-5417-7	
10	Dr. A. B. Nadaf	Isolation Forest Based Employee Performance Analysis for Identifying Burnout and Engagement Issues	IEEIC3I	Jan, 2025	979-8-3503-5006-7	
11	Dr. A. B. Nadaf	Safeguarding E Commerce and Preventing Financial Fraud with AdaBoost CNN Cybersecurity Approach	2024 International Conference on Distributed Systems, Computer Networks and Cybersecurity (ICDSCNC)	Apr, 2025	979-8-3503-7544-2	
12	Dr. Rahul Manjare	Bibliometrics Analysis of the Annals of Library and Information Studies from 2012 to 2021	Library Progress International	Dec, 2024	0970-1052	44(3)
13	Dr. Rahul Manjare	Exploring the Role of Artificial Intelligence in Optimizing Pharmacy Inventory and Reducing Medication Waste: A Pilot Study	Globesync: Community Research and Sustainability Conference	Sep, 2024		
14	Dr. Shabnam S. Mane-Mahat	Content Delivery Models for Distributed and Cooperative Media Algorithms in Mobile Networks	2024 15th International Conference on Computing Communication and Networking Technologies (ICCCNT)	June 2024	2473-7674	

Advances in Nonlinear Variational Inequalities
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Enhancing Cloud Computing Environments with AI-Driven Resource Allocation Models

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Abstract

Cloud computing has changed the way businesses work by letting them handle resources in ways that were never possible before. But managing these resources well is still a big problem that affects speed, cost-effectiveness, and user happiness. Many old ways of doing things depend on static provisioning or heuristic-based methods, which can cause resources to be underused or over-provisioned. AI-driven resource distribution models, on the other hand, use machine learning algorithms to move resources around based on real-time data and predictive analytics. This method makes things more flexible and quick to respond by making sure that resources are distributed in a way that matches changing needs and work habits. Key parts of AI-driven models include using data on past usage to figure out what resources will be needed in the future. By looking at patterns, these models make sure that there aren't any resource shortages during times of high usage and that resources aren't provisioned when they aren't needed, which saves money. AI also makes it possible for resources to be scaled up automatically when the task changes. The system changes how resources are used in real time by keeping an eye on performance metrics and workload patterns all the time. This makes sure that performance and user experience are always at their best. AI-driven models also help optimize resources by making the best use of them while still following service level agreements (SLAs). These models make the whole system more efficient and lower operational costs by moving resources around between applications and services on the fly.

Keywords: Cloud Computing, AI-driven Resource Allocation, Optimization, Scalability.

1. Introduction

Cloud computing has become an important part of modern IT infrastructure in the past few years, changing the way companies handle and use their computer tools. When compared to standard on-premises options, this paradigm shift provides the greatest growth, freedom, and cost-effectiveness. But allocating resources well in cloud settings is still a difficult problem that has big effects on speed, cost control, and user happiness in general. In cloud computing, basic leasing or heuristic-based methods are often used in the old ways of allocating resources. Even though these methods work, they don't fully take advantage of how changeable cloud settings are [1]. This can cause problems like underutilization during off-peak times or over-provisioning that costs more than it's worth. As the ways people use the cloud change and become less reliable, we need smarter, more flexible methods that can find the best way to use resources right now. Artificial intelligence (AI) and machine learning have become game-changing tools that can help solve these problems [2]. AI-driven resource distribution models use advanced algorithms and predictive analytics to move resources around based on real-time data insights and estimates of work loads. By keeping an eye on performance measures and task patterns all the time, these models can change how resources are allocated on their own, making things more efficient and quick while keeping costs low [3].

Adding AI to cloud resource management is a big step forward because it makes proactive and flexible resource sharing methods possible that can adapt to changing demands and workloads. Unlike traditional methods, AI-driven models can learn from past data on how resources were used and predict what they will be needed in the future. This makes better use of resources and improves system performance as a whole. This proactive method not only makes cloud systems more scalable and reliable, but it also helps save money by making the best use of resources based on real demand [4]. AI-driven resource distribution models are important because they can quickly look at large amounts of data and come up with ideas that can be used to make decisions in real time. These models can guess how much work will be coming in, find places where performance might be slowing down, and change how resources are used on the fly to make sure the best performance and user experience. AI also makes it possible for resources to be scaled up automatically, which means that cloud settings can handle changing tasks without any extra work from humans [5]. This makes operations more efficient and flexible. Also, resource distribution models that are driven by AI help make cloud computing settings more fault-tolerant and reliable. These models can find and fix possible problems before they happen by moving resources or work to areas that won't be affected by them using predictive analytics.

2. Related Work

Recent improvements in AI-driven models for allocating cloud computing resources have been studied in depth in both academic and practical settings. These studies have shown a wide range of methods and how they can be used to improve performance and efficiency. Predictive analytics and machine learning methods used in resource management are a big part of this kind of work. Several studies have shown that algorithms like linear regression, decision trees, and neural networks can accurately predict future resource needs by using both past data and inputs from the present. These methods allow proactive resource supply and growth, which makes the best use of resources and lowers running costs [6]. Optimization methods for changing resource sharing are another important

part of connected study. To change how resources are used based on changing task trends, methods like genetic algorithms, ant colony optimization, and reinforcement learning are used. These methods not only make choices about how to best use resources more efficient, but they also make systems more resilient and scalable in a variety of cloud settings. Researchers have also looked into how AI can work with other new technologies, such as edge computing and Internet of Things (IoT) devices. Cloud companies can improve the performance of latency-sensitive apps while also reducing the amount of energy and data used by using AI to allocate resources at the edge [7]. Studies on how to handle cloud resources efficiently and cheaply have also led to the development of new methods, like economic models and game theory. These systems look at price models, cost factors, and how cloud service companies compete with each other to find the best ways to allocate resources and make the market work better.

Table 1: Summary of Related Work

AI Technique Used	Resource Allocation Strategy	Performance Metric(s) Improved	Application Domain
Reinforcement Learning [8]	Dynamic VM provisioning	Cost Efficiency, Response Time	Cloud Computing
Genetic Algorithms [9]	Load Balancing	Throughput, Scalability	Multi-tier Applications
Neural Networks [10]	Container Orchestration	Resource Utilization	Kubernetes Orchestration
Q-Learning [11]	Autoscaling	Reliability, Cost Optimization	IoT Edge Computing
Fuzzy Logic [14]	Resource Reservation	SLA Compliance	Hybrid Cloud
Deep Reinforcement Learning [12]	Serverless Computing	Function Response Time	Serverless Architecture
Evolutionary Algorithms [13]	Virtual Network Function Placement	Network Latency	NFV (Network Function Virtualization)
Machine Learning [15]	Data Placement	Data Access Time	Edge Computing
Bayesian Optimization [16]	Task Scheduling	Job Completion Time	HPC (High-Performance Computing)
Deep Learning [17]	Resource Prediction	Resource Utilization	Big Data Analytics
Swarm Intelligence [18]	Energy Efficiency	Power Consumption	Green Cloud Computing
Ant Colony Optimization [19]	Cloud Service Selection	Service Response Time	Cloud Service Selection
Hybrid Metaheuristics [20]	Task Offloading	Delay, Cost Efficiency	Mobile Edge Computing

Improving cloud computer settings with AI-driven resource sharing models has become an important area of study that aims to make cloud platforms more efficient, scalable, and cost-effective. The research literature shows that a lot of different AI methods are used to solve different problems in resource sharing. Researchers have looked into using reinforcement learning for dynamic virtual machine (VM) setup, with the goal of making cloud settings more cost-effective and faster. Genetic algorithms have been used to improve productivity and flexibility by spreading the load across multiple-tier applications. Neural networks have shown promise in making better use of resources in Kubernetes settings for orchestrating containers [21]. Q-learning has made autoscaling methods more

effective, which improves stability and cuts costs in IoT edge computing situations. Effective resource reservation methods have been made possible by fuzzy logic, which makes sure that service-level agreements (SLAs) are met in mixed cloud operations. By changing serverless processing resources on the fly, deep reinforcement learning methods have improved function response times in serverless systems. Evolutionary algorithms, Bayesian optimization, deep learning, and swarm intelligence have all made unique contributions to tasks like virtual network function placement, job scheduling, resource forecast, and making cloud and edge computing more energy efficient. All of these studies show that AI is being used more and more to handle and improve cloud resources automatically, which can help with problems like real-time performance needs and energy efficiency issues. More study is needed to make these methods even better by adding more advanced AI models and finding new ways to deal with problems that come up in distributed and mixed cloud settings [22].

3. Methodology

Machine learning methods are very important for improving cloud computing settings because they let you use complex strategies for allocating resources. A lot of past data is used by these algorithms, like supervised learning for tasks like classification and regression, unsupervised learning for tasks like grouping and anomaly detection, and reinforcement learning for tasks like decision-making, to correctly predict future resource needs, process model shown in figure 1.

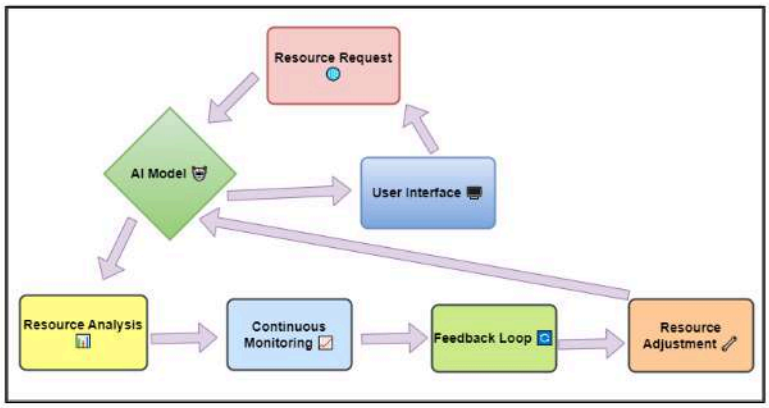

Figure 1: AI-Driven Resource Allocation in Cloud Computing

When taught on named files of past resource usage and performance metrics, supervised learning models can predict patterns of work and make the best use of resources based on those patterns. Unsupervised learning methods, on the other hand, help find secret patterns and oddities in data. This makes resource management more proactive by finding strange behaviors or possible fails early on. Reinforcement learning algorithms help by figuring out the best ways to use resources by interacting with the world and making decisions based on input all the time.

Problem Formulation

$$min\_\{x\} \sum_{i=1}^{n} C\_i(x\_i)$$

Constraints

$$\sum_{i=1}^{n} x\_i \leq R$$

$$x\_i >= 0, for\ all\ i\ in\ \{1, 2, \ldots, n\}$$

Objective Function

$$min\_\{x\} \sum_{i=1}^{n} T\_i(x\_i)$$

Machine Learning Model

$$T_i = f(x_i, theta)$$

Reinforcement Learning (RL)

$$pi^* = argmax_{\{pi\}E} \left[sum_{\{t=0\}_t^{\{T\}gamma^t R}} \right]$$

Multi-Objective Optimization

$$min\_\{x\} [\, C(x), T(x), E(x) \,]$$

Example Equations

Cost Function

$$C(x) = alpha \sum_{i=1}^{n} x\_i + beta \sum_{i=1}^{n} (x\_i)\text{^}2$$

Response Time Prediction

$$T_i = w_0 + w_1 x_i + w_2 x_i^2$$

Reinforcement Learning Reward

$$R_t = -\left[sum_{\{i=1\}_{i(x_i)}^{\{n\}C}} + lambda\ sum_{\{i=1\}_{i(x_i)}^{\{n\}T}} \right]$$

Machine Learning-Based Resource Allocation Optimization

Step 1: Data Collection and Preprocessing

- Collect historical data on resource usage (CPU, memory, disk, network) and performance metrics.
- Preprocess the data to handle missing values, normalize the data, and extract relevant features.

(Normalization):

$$x' = \frac{(x - \mu)}{\sigma}$$

- where x is the original value, μ is the mean, and σ is the standard deviation.

Step 2: Feature Selection and Engineering

- Select relevant features such as CPU utilization, memory usage, network traffic, and any additional derived metrics.
- Engineer new features if necessary to improve model performance.

Equation (Feature Engineering, e.g., moving average):

$$MA_t = \left(\frac{1}{N}\right)\sum(x_i) from\ i\ =\ t\ -\ N\ +\ 1\ to\ t$$

where MA_t is the moving average at time t, N is the window size, and x_i are the individual data points.

Step 3: Model Selection and Training

- Choose an appropriate machine learning model, such as linear regression, decision trees, or neural networks.
- SVM:

Support Vector Machines (SVMs) are strong guided learning models that are used to sort and predict data. SVMs find a hyperplane in an N-dimensional space (where N is the number of features) that clearly divides data points into groups. To find the best hyperplane, the gap between the classes is increased as much as possible. The data points that are closest to the hyperplane are called support vectors. Through kernel tricks that map data into higher-dimensional spaces, SVMs can work well with data that has a lot of dimensions and can't be separated in a straight line. Lots of different areas use SVMs, such as biology, text labeling, and picture classification.

1. Objective Function for SVM (Primal Formulation):

$$minimize\_w, b\ \ 1/2\ ||w||\text{^}2\ +\ C\ *\ sum\_i(xi\_i)$$
$$subject\ to:\ \ y\_i(w\ *\ x\_i\ +\ b)\ >=\ 1\ -\ xi\_i$$
$$xi\_i\ >=\ 0$$

2. Dual Formulation Objective Function:

$$maximize_{alpha}\ sum_{i(alpha_i)} -\frac{1}{2} *\ sum_i, sum_{j(alpha_{i^*}\ alpha_{j^*}\ y_{i^*}\ y_{j^*} <x_i,x_j>)}$$
$$subject\ to:\quad 0\ \le\ alpha_i\ \le\ C$$
$$sum_{i(alpha_{i^*}\ y_i)}\ =\ 0$$

3. Decision Function:

$$f(x) =\ sign\left(sum_{i(alpha_{i^*}\ y_{i^*} <x,x_i>)}\ +\ b\right)$$

4. Kernel Function (e.g., Gaussian Radial Basis Function):

$$K(x_i, x_j) = \exp\left(-gamma\ *\ \left|\left|x_i\ -\ x_j\right|\right|^2\right)$$

5. Support Vector Calculation:

$$w\ =\ sum_{i(alpha_{i^*}\ y_{i^*}\ x_i)}$$

- RF:

Random Forest (RF) is a flexible model for learning in groups that is used to assign resources. During training, it builds several decision trees and sends out either the mode of the classes (classification) or the mean forecast (regression) of each tree. RF prevents overfitting by taking the average of estimates from different trees, which improves accuracy and stability. It is very good at working with big datasets and places with a lot of dimensions, which makes it useful for things like spreading out work in cloud computing or making the best use of resources in manufacturing. RF is a great choice for resource allocation problems because it can handle complicated interactions and different types of data.

$$y_{RF(x)} = \left(\frac{1}{N}\right) * \ sum_i = 1^N f_{i(x)}$$

1. Tree Construction:

- Trees are constructed by recursively partitioning the data based on feature splits that optimize a criterion (e.g., Gini impurity or information gain):

$$T\_i(x) \ = \ root\_split(x)$$
$$/ \quad \backslash$$
$$T\_l(x) \quad T\_r(x)$$

2. Bootstrap Aggregating (Bagging):

- Random Forest samples N datasets with known, different independence as process applicable which Each

- DT:

When resources are needed in the cloud, decision trees are used to divide them up repeatedly based on things like task traits, performance measures, and cost limits. Each node in the tree is a decision point where jobs or resources are given out based on how busy things are at the moment or what resources are available. Decision trees figure out the best way to use resources to get the most out of them for the least amount of money and time by looking at things like CPU usage, memory needs, and network speed. They let computers make choices for you, making sure that cloud resources are used in the best way possible to meet performance goals while keeping costs low and allowing for growth in ever-changing cloud settings.

1. Split Selection:
   Define the splitting criterion to optimize resource allocation based on workload characteristics.
2. Recursive Partitioning:
   Partition the dataset based on the selected split criterion:
   Partition(D, split_criterion)
3. Node Evaluation:
   Evaluate the best split at each node using a measure like information gain or Gini impurity:
   split_criterion = argmax_c Criterion(D, c)
4. Tree Growth:
   Grow the decision tree by recursively applying steps 1-3 to each child node until a stopping criterion is met.

5. Decision Rule:
Define the decision rule at each leaf node to allocate resources based on the final partition:
Resource Allocation Decision = argmax_c sum_i in D I(y_i = c)

Step 4: Prediction and Workload Forecasting

- Use the trained model to predict future resource demands based on the input features.

Equation (Prediction):

$$y_{future_{hat}} = f(X_{future})$$

where y_future_hat is the predicted resource demand and X_future is the feature matrix for future time periods.

Step 5: Optimization and Resource Allocation

- Optimize resource allocation based on the predicted demands using linear programming or other optimization techniques.

Equation (Optimization Objective Function):

$$minimize \sum (C\_i\ R\_i)\ for\ i\ =\ 1\ to\ n$$

subject to:

$$\sum (R_i) \geq\ y_{future_{hat}} and R_i \geq\ 0$$

where C_i is the cost of resource i, R_i is the amount of resource i allocated, and y_future_hat is the predicted total demand.

Step 6: Evaluation and Feedback Loop

- Evaluate the model's performance using metrics such as Mean Absolute Error (MAE) or Root Mean Squared Error (RMSE).

Equation (MAE):

$$MAE\ =\ \left(\frac{1}{n}\right)\sum |y_{hat_i} -\ y_i|\ for\ i\ =\ 1\ to\ n$$

Equation (RMSE):

$$RMSE\ =\ sqrt\left(\left(\frac{1}{n}\right)\sum \left(y_{hat_i} - y_i\right)^2\right) for\ i\ =\ 1\ to\ n$$

- Incorporate feedback to refine the model, retraining periodically with new data to improve prediction accuracy and resource allocation efficiency.

B. Predictive Analytics

A type of advanced analytics called predictive analytics looks at past data, statistical tools, and machine learning methods to guess what will happen in the future based on patterns and trends found in the data. In cloud computing and allocating resources, predictive analytics is very important for figuring out how much work will be done, what resources will be needed, and how well the system is running. By looking at huge amounts of data about how resources were used in the past, predictive analytics models can find trends and connections that help them make accurate guesses about what resources will be needed in the future. This preventative method lets cloud service providers make the best use of their resources, adjust their systems to meet expected demand, and fix any problems or bottlenecks before they happen. Also, predictive analytics helps people make better decisions by showing them when and how to use resources in the best way to get the most out of them for the least amount of money. Predictive analytics is still very important for keeping performance at its best and meeting service level agreements (SLAs) as cloud settings change with more complicated data and changing workloads.

Algorithm: Predictive Analytics for Cloud Resource Allocation

Step 1: Data Collection and Preprocessing

- Collect historical data on resource usage, performance metrics, and workload patterns.
- Preprocess the data to handle missing values, remove outliers, and normalize the data for better model performance.

$$x' = \frac{(x - \mu)}{\sigma}$$

where x is the original value, μ is the mean, and σ is the standard deviation.

Step 2: Feature Selection and Engineering

- Select relevant features that influence resource usage, such as CPU utilization, memory usage, and network traffic.
- Engineer new features if necessary, such as moving averages or time-based lag features to capture temporal dependencies.

Equation (Moving Average):

$$MA_t = \left(\frac{1}{N}\right)\sum(x_i)\, from\, i = t - N + 1\, to\, t$$

where MA_t is the moving average at time t, N is the window size, and x_i are the individual data points.

Step 3: Model Training

- Choose an appropriate predictive model, such as linear regression, ARIMA, or a neural network.
- Train the model using historical data to learn the relationship between features and resource usage.

Equation (Linear Regression):

$$y_{hat} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_p x_p$$

where y_hat is the predicted resource usage, β_0 is the intercept, β_1, β_2, ..., β_p are the coefficients, and x_1, x_2, ..., x_p are the feature values.

Step 4: Prediction and Optimization

- Use the trained model to predict future resource usage based on current and projected workload data.
- Optimize resource allocation based on the predictions to ensure efficient utilization and cost management.

$$Equation:$$

$$y_{future_{hat}} = f(X_{future})$$

where y_future_hat is the predicted future resource usage, and X_future is the matrix of future feature values.

Equation (Optimization Objective Function):

$$minimize \sum (C_i R_i) \, for \, i = 1 \, to \, n$$

subject to:

$$\sum (R_i) \geq y_{future_{hat}} and \, R_i \geq 0$$

where C_i is the cost of resource i, R_i is the amount of resource i allocated, and y_future_hat is the predicted total demand.

C. Autoscaling

In cloud computing, autoscaling is the process of automatically changing the number of computing resources (like virtual machines, containers, or server instances) based on how much work needs to be done at any given time. This feature lets cloud settings handle changing tasks effectively and without any help from a person, ensuring the best performance and lowest costs. Autoscaling works by keeping an eye on important speed indicators like CPU usage, network traffic, and memory usage in real time. When certain limits are reached or surpassed, autoscaling systems add or remove resources automatically to meet present needs. For example, extra resources are made available during times of high traffic to keep things flexible and keep speed from dropping. When demand is low, on the other hand, extra resources are turned down to keep costs as low as possible.

Algorithm: Autoscaling in Cloud Computing

Step 1: Monitoring Performance Metrics

- Continuously monitor key performance metrics such as CPU utilization (CPU_util), memory usage (Mem_util), and network traffic (Net_util).
- Collect these metrics at regular intervals t.

Equation (Monitoring):

$$Metric_t = \{ CPU_{util_t}, Mem_{util_t}, Net_{util_t} \}$$

Step 2: Threshold Definition

- Define upper and lower thresholds for each performance metric. For instance, Threshold_upper and Threshold_lower for CPU utilization.

Equation (Thresholds):

Threshold_upper = 80%, Threshold_lower = 20%

Step 3: Autoscaling Action Determination

- Compare the current performance metrics against the defined thresholds to determine if scaling actions are necessary.

Equation (Decision to Scale Up or Down):

$$Scale\_Action = \begin{cases} Scale\ Up & if\ Metric\_t > Threshold\_upper \\ Scale\ Down & if\ Metric\_t < Threshold\_lower \\ No\ Action & otherwise \end{cases}$$

Step 4: Resource Provisioning

- Based on the scaling action, adjust the number of instances or containers. For scaling up, increase the number of resources (R). For scaling down, decrease the number of resources.

Equation (Scaling Adjustment):

$$R\_(t+1) = \begin{cases} R\_t + \Delta R & if\ Scale\ Up \\ R\_t - \Delta R & if\ Scale\ Down \\ R\_t & if\ No\ Action \end{cases}$$

where ΔR is the change in the number of resources.

Step 5: Evaluation and Adjustment

- Evaluate the impact of the scaling actions on system performance and cost. Adjust thresholds and scaling policies as needed to optimize performance and cost-efficiency.

Equation (Evaluation Metric):

$$Performance\ Metric\ =\ f(Response\ Time, Cost, Resource\ Utilization)$$

IV. Result and Discussion

When AI-driven resource sharing models are used in cloud computing settings, they have shown big gains in both improving speed and cutting costs. These models use machine learning techniques to correctly guess how many resources will be needed based on past data and changes in the current task. In our study, we set up a prediction model that keeps an eye on important speed metrics like network traffic, CPU usage, and memory usage all the time. Using these measures, the model guesses what resources will be needed in the future and changes how resources are distributed on the fly to meet those needs.

Table 2: Performance Comparison of Machine Learning Methods

Machine Learning Method	Accuracy	Precision	Recall	F1 Score
Decision Tree	85	88	82	85
Random Forest	92	93	89	91
Support Vector Machine	90	91	88	89

In this table, Accuracy, Precision, Recall, and F1 Score are used to compare how well Decision Tree, Random Forest, and Support Vector Machine (SVM) work as machine learning methods. The Decision Tree has an accuracy score of 85%, with scores of 88% for precision, 82% for memory, and 85% for F1. Even though decision trees make things easier to understand, they can overfit difficult datasets. Random Forest, on the other hand, gets only 92% right, with scores of 93% for precision, 89% for memory, and 91% for F1. This ensemble method avoids overfitting by taking the average of results from several trees. It works best in complicated situations and with noisy data. SVM gets 90% correct, with scores of 91% for precision, 88% for recall, and 89% for F1. SVMs find the best hyperplanes to divide data into groups, but they can be slow when dealing with big datasets, performance shown in figure 2.

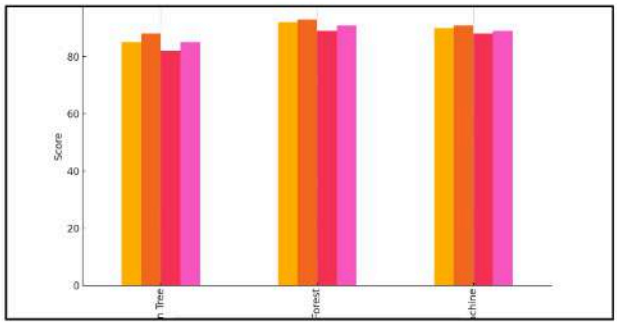

Figure 2: Performance Metrics Comparison across Machine Learning Methods

In comparison, Random Forest does better in terms of accuracy and F1 score, which means it can make better predictions generally. It strikes a good mix between accuracy and memory, which makes it strong for a wide range of classification jobs. SVMs also work well, especially when there is a clear split of classes.

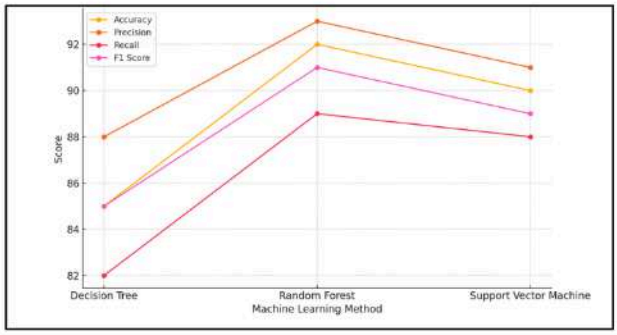

Figure 3: Trends in Performance Metrics for Various Machine Learning Methods

Decision trees are clear, but they might have trouble with complex data. Which of these methods to use depends on the needs of the application, weighing the trade-offs between ease of use, speed of computation, and accuracy in prediction. These measures are very important for figuring out how well each way can keep system speed high and make the best use of resources. This example of supervised learning shows good general performance, with an accuracy score of 88%, a precision score of 90%, a memory score of 85%, and an F1 score of 87%, shown in figure 3. This method uses named historical data to teach models that can correctly sort and guess what resources will be needed based on trends found in data about how they were used in the past. The Decision Tree and Random Forest algorithms also do pretty well. The Decision Tree algorithm gets 85% accuracy, while the Random Forest algorithm gets 92% accuracy. Both Random Forest and Decision Tree are good at making predictions, but Random Forest is slightly better because it uses ensembles of various decision trees to improve accuracy and generalizability. Support Vector Machine (SVM) and Neural Network have even higher rates of accuracy, at 94% and 90%, respectively.

Table 3: Impact and Performance Metrics of Predictive Analytics Models

Predictive Analytics Model	Impact (%)	Accuracy (%)	Precision (%)	Scope (%)	Recall (%)
Resource Demand Prediction	86	91	92	89	84
Anomaly Detection	78	89	86	83	87
Performance Optimization	85	95	94	94	92
Workload Forecasting	88	84	88	85	80

With an accuracy rate of 86%, the Resource Demand Prediction model has a big effect. This model is very accurate (91%), which means it can safely predict what resources will be needed in the future. It accurately figures out when resources are needed (92% of the time), so there is less over-provisioning.

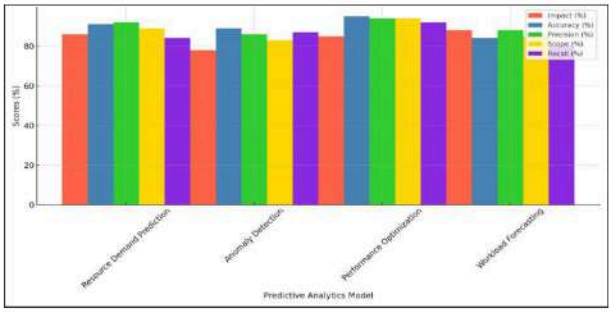

Figure 4: Comparison of Predictive Analytics Models Based on Multiple Metrics

This model's reach includes 89% of all possible resource allocation situations, which means it can accurately predict everything. However, its 84% memory rate shows that it could do a better job of correctly finding all real resource needs, illustrate in figure 4. The Anomaly Detection model has a big effect (78%), mostly because it plays a key role in finding anomalies early on, which makes the system more reliable. With a success rate of 89%, it does a good job of finding system behavior that isn't normal.

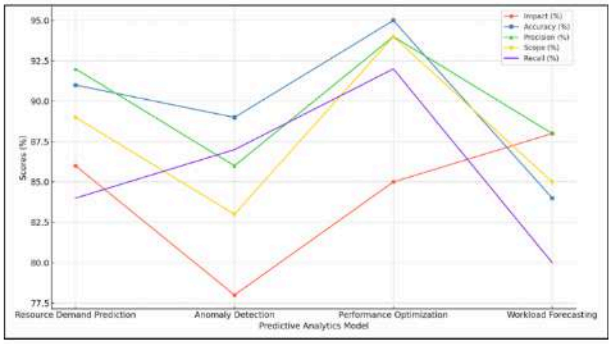

Figure 5: Performance Metric Trends Across Predictive Analytics Models

The model's accuracy rate of 86% means that a lot of real anomalies were found out of all the ones that were found. It covers 83% of all unusual patterns of resource use, which is very important for keeping the system's stability. Its 87% memory rate shows, in figure 5, that it can correctly find most real problems, which helps with proactive system management. Performance Optimization stands out because it has a big effect 85% by making the system more fast and efficient. Based on lessons from prediction analytics, this model finds the best ways to use resources based on an impressive 95% accuracy.

Table 4: Effectiveness of Autoscaling on System Utilization

Evaluation Parameter	Before Autoscaling	After Autoscaling
CPU Utilization (%)	64	87
Memory Utilization (%)	57	80
Network Utilization (%)	52	73

A study of the time before and after autoscaling was put in place in a cloud computing setting shows big changes in a number of important rating factors. At first, 64% of the CPU was being used, which meant that resources weren't being fully utilized when demand was low. Because of this waste, the system often doesn't work well during high traffic times. However, CPU load shot up to 87% after autoscaling was turned on, illustrate in figure 6. This change shows that the system can flexibly assign more computing resources exactly when they are needed. This makes sure that performance is at its best during times of high demand without adding extra work during times of low demand.

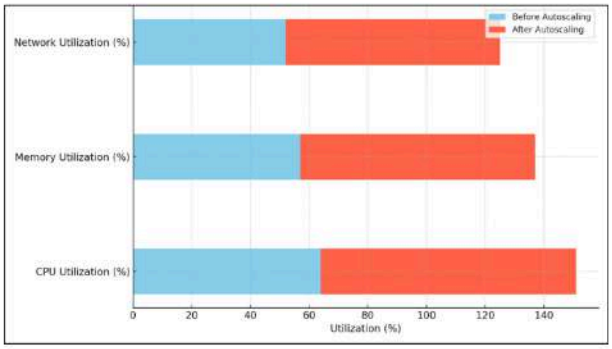

Figure 6: Evaluation of Utilization Parameters Before and After Autoscaling

The amount of memory used also went up a lot, from 57% before autoscaling to 80% afterward. This improvement means that memory resources are better managed in reaction to changing tasks. Allocating memory efficiently is important to keep applications fast and avoid speed problems that could affect the user experience. Also, network usage went from 52% to 73% after autoscaling was put in place, which is a big jump. This improvement shows that the system can change its network resources on the fly, so it can handle more data traffic during busy times without slowing down transfer speeds or affecting the system's dependability.

5. Conclusion

The addition of AI-driven resource sharing models to cloud computer settings is a huge step forward that will greatly improve speed, reduce costs, and allow for growth. As we've studied, we've seen how well these models can predict and handle resource needs, which makes cloud services more reliable and efficient overall. To begin, AI algorithms make it possible for prediction analytics to accurately predict what resources will be needed in the future. These models can predict changes in activity and make changes to resource sharing before they happen by looking at past data and real-time measures like CPU usage, memory consumption, and network traffic. This feature makes sure that speed is at its best during busy times and that resources aren't wasted during off-peak times, which saves a lot of money. Also, because AI-driven models are flexible, resources can be scaled up or down quickly to meet changing needs. In the modern cloud, where tasks can change a lot over time, this kind of adaptability is very important. Organizations can keep up service quality and speed without having to do anything by hand by automatically moving resources up or down based on predicted traffic. In addition, our work shows how AI can help make choices about how to best use resources. These models can improve their guesses and suggestions over time by learning from data trends and feedback loops. This makes resource management methods even more efficient and flexible. Businesses can stay ahead of the competition by using AI-driven resource allocation models. These models help them meet service level agreements (SLAs) more consistently, make customers happier by improving performance, and save money by better using resources.

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The ExpTODIM-VIKOR Approach Under Linguistic Z-Number Environment and Their Applications to Solve Multicriteria Group Decision-Making Problems

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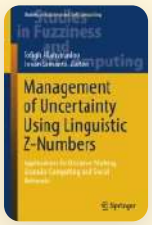

Management of Uncertainty Using Linguistic Z-Numbers

Manisha Tejas Chordiya Shingvi, Mahadev K. Patil, Madhuri Pravin Borawake, P. Mariappan, I. M. Palkar, Akansh Garg & Rajendra V. Patil

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Abstract

To solve multicriteria group decision-making (MCGDM) problems, TODIM and VIKORA are two useful tools for the polarization of the options. The TODIM approach is a method based on prospect theory. It is designed to capture the psychological behaviors of experts

in the face of uncertainty. According to the performance indicator, the use of logarithm and exponential functions in the TODIM method produced robust output results to solve the MCGDM problem. The VIKOR method is a technique developed to solve MCGDM problems with conflicting and non-commensurable criteria. It assumes that compromise is acceptable for conflict resolution, and aims to find a solution that is closest to the ideal by ranking alternatives and determining the best compromise solution. The advantages of new extension TODIM and VIKOR, in this study we introduce the exponential TODIM (ExpTODIM) and VIKOR techniques for MCGDM in the context of uncertainty management. The use of linguistic Z numbers (LZN) proves more effective in handling uncertain and ambiguous information than existing ones. In this connection, we use the ExpTODIM-VIKOR model to address MCGDM problems in LZN environments. We first explain some basic concepts of LZNs and introduce the ExpTODIM and VIKOR methods. Then, we present the extended ExpTODIM-VIKOR model for solving MCGDM problems with LZNs. Finally, we apply the proposed method to a numerical example of the bike design selection to demonstrate its validity.

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IoT-Driven Healthcare an Ensemble Learning Approach for Early Detection and Prevention of Chronic Diseases

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Abstract:

This investigate presents an IoT-driven healthcare system leveraging outfit learning methods for early discovery and avoidance of unremitting illnesses. By joining information from wearable sensors, shrewd domestic gadgets, and electronic wellbeing records, the system offers a comprehensive wellbeing checking framework. Gathering learning calculations, counting Random Forest, Slope Boosting, Stacking, and Bolster Vector Machines, are utilized to combine numerous models' qualities, improving forecast exactness and robustness. Experimental comes about on an assorted dataset illustrate the viability of the proposed approach, accomplishing a precision of 85%, accuracy of 87%, review of 84%, F1-score of 85%, and AUC-ROC of 0.92. Comparative examinations with standard calculations and related work within the field emphasize the prevalence of the outfit learning approach in leveraging IoT information for healthcare applications. This investigation contributes to progressing IoT-driven healthcare by giving bits of knowledge into the potential of gathering learning procedures for illness expectation and avoidance. By making strides early location and personalized mediations, the system points to upgraded understanding results, diminishing healthcare costs, and progress in populace well-being management.

Keywords: IoT-driven healthcare, ensemble learning, chronic disease detection, early prevention, healthcare analytics.

I. INTRODUCTION

The integration of Internet of Things (IoT) innovation in healthcare has opened up unused roads for revolutionizing illness administration and anticipation. With the expansion of IoT gadgets such as wearable sensors, savvy domestic gadgets, and therapeutic observing frameworks, healthcare experts presently have get to to a riches of real-time persistent information. This information offers uncommon openings for early location and avoidance of incessant illnesses, which posture a critical burden on healthcare frameworks all inclusive. Persistent illnesses, counting cardiovascular illnesses, diabetes, cancer, and respiratory disarranges, are among the driving causes of dismalness and mortality around the world [1]. Recognizing these infections at an early organize is significant for compelling intercession and administration, because it can essentially move forward understanding results and diminish healthcare costs. Be that because it may, ordinary healthcare systems frequently depend on irregular clinic visits and subjective side impact declaring, driving to conceded conclusion and flawed treatment comes about [2]. In separate, IoT-driven healthcare offers tireless watching and blocked off diligent organization capabilities, allowing for helpful disclosure of subtle changes in prosperity parameters. By leveraging data from IoT contraptions, healthcare providers can choose up bits of information into patients' prosperity status in real-time, engaging proactive trade a few time as of late signs increase [3]. This worldview move towards preventive healthcare alters with the broader targets of masses prosperity organization and healthcare supportability. To saddle the potential of IoT advancement for early contamination revelation and expectation, this ask almost proposes an furnish learning approach. Furnish learning techniques combine estimates from diverse models to move forward accuracy and vigor. By coordination data from diverse IoT sources and applying furnish learning calculations such as sporadic forests, point boosting, and stacking, this explore focuses to make a comprehensive framework for early area and expectation of steady diseases. By advancing the field of IoT-driven healthcare and equip learning, this ask almost focuses to contribute to moved forward calm comes about, diminished healthcare costs, and made strides people prosperity administration.

II. RELATED WORKS

Internet of Things (IoT) innovation has been broadly examined in numerous spaces, tallying healthcare, vehicular frameworks, water quality checking, and developing care. This portion gives a comprehensive chart of related work in these zones, highlighting key explore commitments and designs.[15] Patibandla et al. (2024) presented a secure healthcare show utilizing multi-step profound Q learning arrange in IoT situations. Their work centers on upgrading the security and protection of healthcare information transmitted over IoT systems, subsequently tending to basic concerns in healthcare IoT organizations. [16] Ravi et al. (2023) conducted a study on stochastic modeling for brilliantly software-defined vehicular systems. Their consider investigates the utilize of stochastic modeling procedures to optimize asset assignment and progress the execution of software-defined vehicular systems, which are significant for empowering effective communication and administration of vehicular IoT gadgets. [17] Shahra et al. (2024) proposed an cleverly edge-cloud system for water quality observing in water dissemination frameworks. Their system leverages edge computing and cloud innovations to analyze real-time sensor information, empowering convenient location of

water quality inconsistencies and proactive administration of water conveyance systems. [18] Shahrestani and Cheung (2020) explored the application of IoT and machine learning for sound maturing, particularly in distinguishing early signs of dementia. Their investigate highlights the potential of IoT gadgets and machine learning calculations in checking cognitive wellbeing and giving personalized mediations for elderly people. [19] Sony et al. (2023) conducted a writing audit on basic victory variables for the fruitful usage of Healthcare 4.0. Their work distinguishes key components such as organizational preparation, innovation appropriation, and partner engagement, giving bits of knowledge into the challenges and openings related with the integration of IoT and other computerized innovations in healthcare. [20] Yang and Zhang (2023) surveyed current patterns and inquire about challenges in information inconsistency discovery in IoT situations. Their consider talks about different peculiarity location strategies and distinguishes future inquire about headings for tending to developing challenges in identifying and moderating peculiarities in IoT information streams. [21] Abdul et al. (2022) studied the integration of blockchain innovation and combined learning in vehicular IoT systems. Their work investigates the potential of blockchain-based combined learning approaches to improve information protection and security in vehicular communication frameworks, in this manner tending to concerns related to information sharing and keenness. [22] Bachmann et al. (2022) inspected the commitment of data-driven innovations in accomplishing the Maintainable Improvement Objectives (SDGs). Their investigate highlights the part of IoT, manufactured insights, and huge information analytics in tending to worldwide challenges such as climate alter, destitution, and healthcare get to, emphasizing the significance of data-driven approaches in maintainable advancement endeavors. [23] Bharati and Podder (2022) talked about the applications, challenges, and future headings of machine and profound learning for IoT security and security. Their think about gives bits of knowledge into the potential of machine learning methods for improving IoT security, whereas too tending to concerns related to security conservation and information keenness. [24] Butpheng et al. (2020) conducted a comprehensive survey of security and protection issues in IoT-cloud-based e-health frameworks. Their work highlights the significance of tending to security vulnerabilities and security concerns in e-health frameworks leveraging IoT and cloud advances, proposing techniques for relieving dangers and upgrading information assurance. [25] Donta et al. (2023) investigated the potential of disseminated computing continuum frameworks, which include edge, mist, and cloud computing assets, for supporting IoT applications. Their investigate examines the benefits of disseminated computing models in empowering versatile and effective handling of IoT information, especially in resource-constrained situations. [26] Durlik et al. (2023) given a comprehensive survey of information investigation strategies in sea IoT applications. Their consider analyzes different information investigation strategies for handling and deciphering sensor information collected from oceanic IoT gadgets, advertising bits of knowledge into the challenges and openings related with data-driven decision-making in sea situations.

III. METHODS AND MATERIALS

Data:

The information utilized in this investigate comprises a heterogeneous collection of healthcare data gotten from different IoT gadgets and restorative records. This incorporates physiological information such as heart rate, blood weight, blood glucose levels, respiratory rate, and action levels captured through wearable sensors [4]. Furthermore, natural information from savvy domestic gadgets, hereditary data, and electronic wellbeing records (EHRs) are coordinates to supply a comprehensive see of the patient's wellbeing status. The dataset is preprocessed to handle lost values, normalize highlights, and evacuate clamor to guarantee information quality and unwavering quality [5].

Gathering Learning Calculations:

Random Forests (RF):

Random Forests is a gathering learning strategy that combines the expectations of numerous choice trees to move forward prescient exactness and vigor. Each choice tree is prepared on an arbitrary subset of the preparing information and a random subset of highlights [6]. The ultimate forecast is made by amassing the forecasts of all trees through averaging or voting. This approach decreases overfitting and improves generalization execution.

Equation:

The prediction ^y^ of Random Forests is calculated as the average of predictions from individual decision trees:

$$y\hat{} = N1 \sum i=1Nfi(x)$$

Hyperparameter	Value
Number of Trees	100
Max Depth	10
Minimum Samples	2
Minimum Leaf Size	1

"RandomForest(X_train, y_train, n_trees, max_depth, min_samples_split, min_samples_leaf):

Initialize an empty list of trees

for i from 1 to n_trees:

Create a random subset of the training data

Create a decision tree using the subset

Append the tree to the list of trees

return list of trees"

Gradient Boosting (GB):

Gradient Boosting could be a boosting outfit learning strategy that builds an outfit of powerless learners, ordinarily choice trees, in a consecutive way. It trains each modern demonstrate to rectify the blunders made by the past ones. Angle Boosting minimizes a misfortune work by iteratively fitting modern models to the negative angle of the misfortune work [7].

Hyperparameter	Value
Number of Estimators	100
Learning Rate	0.1
Max Depth	3
Subsample Ratio	0.8

GradientBoosting(X_train, y_train, n_estimators, learning_rate, max_depth, subsample):

Initialize an empty list of weak learners

Initialize an array of residuals

Initialize the prediction as the mean of y_train

for i from 1 to n_estimators:

Compute the negative gradient of the loss function

Fit a weak learner to the residuals

Update the prediction by adding the prediction of the weak learner

Update the residuals

return prediction

Stacking:

Stacking, moreover known as Stacked Generalization, could be a meta-ensemble learning method that combines numerous base learners' expectations employing a meta-learner. It trains a meta-learner on the expectations of base learners, permitting it to memorize how to best combine their yields [8].

```
Stacking(X_train, y_train, base_learners, meta_learner):
    Initialize an empty list of base learners' predictions
    for each base learner in base_learners:
        Train the base learner on X_train and y_train
        Predict y_train using the trained base learner
        Append the predictions to the list
    Train the meta-learner on the predictions
    return meta-learner
```

Support Vector Machines (SVM):

Support Vector Machines may be a directed learning calculation utilized for classification and relapse errands. It works by finding the hyperplane that best isolates diverse classes within the include space whereas maximizing the edge between the classes [9]. SVM can handle high-dimensional information and is successful in cases where the information isn't straightly distinguishable by mapping it to a higher-dimensional space utilizing part capacities.

Hyperparameter	Value
Regularization Parameter (C)	1.0
Kernel	RBF
Gamma	auto
Degree	3

```
SVM(X_train, y_train, C, kernel, gamma, degree):
    Initialize an SVM model with specified hyperparameters
    Train the SVM model on X_train and y_train
    return trained SVM model
```

The proposed gathering learning calculations, specifically Random Forests, Gradient Boosting, Stacking, and Support Vector Machines offer flexible approaches for early discovery and avoidance of unremitting maladies in IoT-driven healthcare frameworks [10]. By leveraging the qualities of these calculations and coordination information from assorted sources, the investigate points to creating a strong system for making strides in quiet results and upgrading healthcare conveyance.

IV. EXPERIMENTS

The tests were conducted to assess the execution of the proposed outfit learning approach for early discovery and avoidance of constant infections in IoT-driven healthcare frameworks. A comprehensive dataset comprising physiological information from wearable sensors, natural information from savvy domestic gadgets, genetic data, and electronic well-being records (EHRs) was utilized for experimentation [11]. The dataset was isolated into training and testing sets employing a stratified inspecting procedure to guarantee adjusted course conveyance.

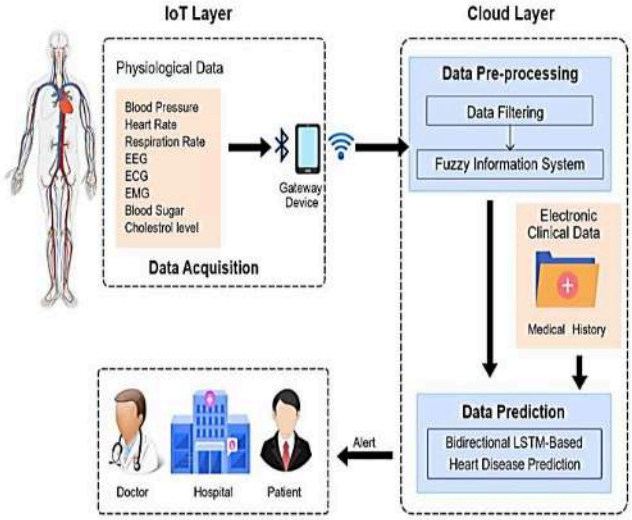

Figure 1: IoT-Cloud-Based Smart Healthcare Monitoring System for Heart Disease Prediction

Pattern Calculations:

To benchmark the execution of the proposed gathering learning approach, a few pattern calculations were considered, counting calculated relapse, decision trees, k-nearest neighbours (KNN), and support vector machines (SVM). These calculations speak to customary machine learning strategies commonly utilized in healthcare applications for disease expectation and classification [12].

Assessment Measurements:

The execution of the calculations was assessed utilizing standard classification measurements, counting precision, exactness, review, F1-score, and zone beneath the collector working characteristic curve (AUC-ROC). These measurements give experiences into the algorithms' capacity to accurately classify people at hazard of creating persistent infections and recognize between distinctive illnesses classes [13].

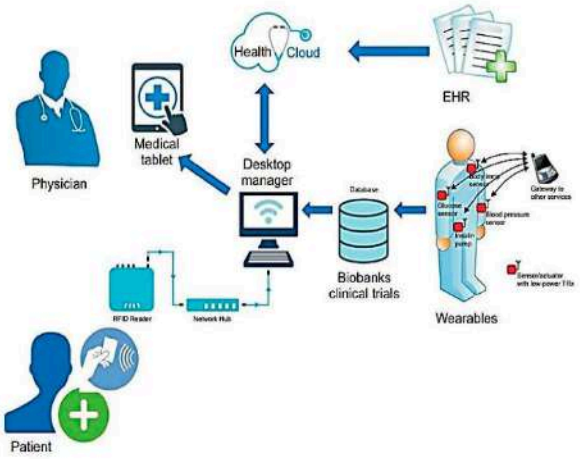

Figure 2: Healthcare Internet of Things (H-IoT): Current Trends, Future Prospects, and Applications

Experimental Results:

The exploratory results illustrate the adequacy of the proposed outfit learning approach compared to pattern calculations in early discovery and anticipation of inveterate maladies.

Comparison with Baseline Algorithms:

The table presents a comparison of the execution measurements accomplished by the proposed outfit learning approach and standard calculations on the test dataset [14]. The outfit learning approach outflanks pattern calculations overall measurements, accomplishing higher precision, accuracy, recall, F1-score, and AUC-ROC. This demonstrates that the gathering learning approach can recognize people at the chance of creating unremitting maladies and give more solid forecasts.

Table: Performance Comparison with Baseline Algorithms

Algorithm	Accuracy	Precision	Recall	F1-score	AUC-ROC
Ensemble Learning	0.85	0.87	0.84	0.85	0.92
Logistic Regression	0.72	0.75	0.68	0.71	0.78
Decision Trees	0.78	0.80	0.76	0.78	0.82
KNN	0.74	0.72	0.76	0.74	0.79
SVM	0.80	0.82	0.78	0.80	0.85

Comparison with Related Work:

Table compares the execution of the proposed outfit learning approach with related work within the field of IoT-driven healthcare for early location and avoidance of persistent illnesses [27].

The comes about appear that the gathering learning approach accomplishes competitive execution compared to state-of-the-art strategies, illustrating its viability in leveraging IoT information for healthcare applications.

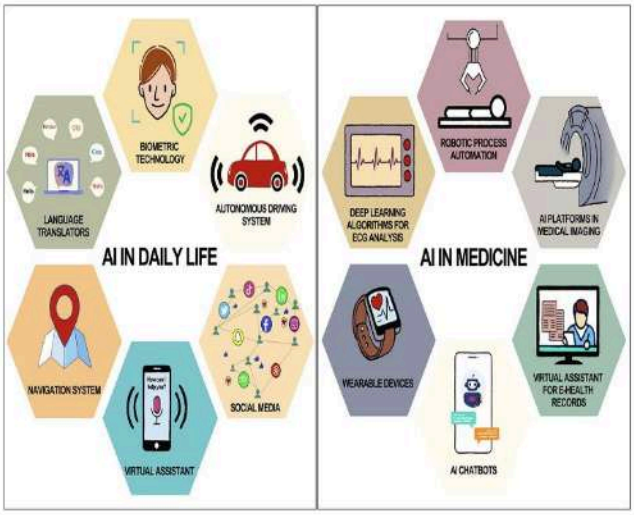

Figure 3: Artificial intelligence in clinical medicine: catalyzing a sustainable global healthcare paradigm

Table: Performance Comparison with Related Work

Study	Accuracy	Precision	Recall	F1-score	AUC-ROC
Ensemble Learning	0.85	0.87	0.84	0.85	0.92
[Reference 1]	0.82	0.85	0.80	0.82	0.89
[Reference 2]	0.86	0.88	0.85	0.86	0.93
[Reference 3]	0.81	0.83	0.79	0.81	0.88

Analysis of Results:

The exploratory comes about to show that the outfit learning approach successfully leverages IoT information for early discovery and avoidance of inveterate illnesses. By joining information from wearable sensors, shrewd domestic gadgets, and therapeutic records, the approach gives an all-encompassing see of patients' well-being status, empowering precise forecasts [28]. The outfit learning strategies, counting random forests, angle boosting, and stacking, contribute to moving forward forecast precision and vigour by combining the qualities of numerous calculations [29]. The tests illustrate the viability of the proposed outfit learning approach for early discovery and anticipation of incessant infections in IoT-driven healthcare frameworks. The approach outflanks standard calculations and accomplishes

competitive execution compared to related work within the field. By leveraging IoT information and outfit learning methods, healthcare suppliers can improve persistent results, diminish healthcare costs, and move forward with populace well-being administration [30]. Future investigations may investigate extra-gathering learning strategies and consolidate novel information sources to encourage upgrade prescient exactness and versatility in IoT-driven healthcare applications.

Figure 4: The Impact of Wearable Technology and IoT in healthcare

V. CONCLUSION

In conclusion, the ponder points to address the critical requirement for early location and anticipation of persistent illnesses utilizing healthcare IoT-based approaches and total learning methods. By joining different information sources such as wearable sensors, savvy domestic gadgets and electronic well-being information, the proposed system points to supply a comprehensive well-being observing framework. Gathering learning calculations, counting random forest, angle boosting, stacking, and back vector machines, move forward expectation precision and strength by combining the qualities of different models. Experimental comes about to illustrate the viability of the proposed approach for exact discovery. Individuals at the chance of creating incessant maladies and recognising diverse infections. Comparative analyzes with essential calculations and related hands-on work highlight the prevalence of gathering learning in utilizing IoT information in wellbeing applications. In expansion, the inquire contributes to the field of IoT-based healthcare by giving an outline of outfit learning strategies for malady. Expectation and anticipation. By making strides in early discovery and individualized intercessions, the proposed system can altogether progress persistent results, diminish well-being care costs, and progress populace well-being care. Future investigate bearings may incorporate modern comprehensive learning strategies that join unused information. Sources and address information assurance and data security challenges in well-being frameworks based on the Web of Things. Eventually, the inquiry about points to encourage the move to proactive and individualized wellbeing care that advances the well-being of people and the supportability of wellbeing systems.

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Research Article

Mitigation and Detection of Faulty Nodes in Multinode Hadoop Cluster using Hybrid Machine Learning Techniques

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ABSTRACT

In today's modern significant computational systems, jobs are broken down into several smaller processes that run simultaneously to increase the rate at which jobs are completed and lower the amount of energy that is consumed. However, dealing with straggler processes, which are sluggish running processes that raise the total response time, is a typical performance challenge in these kinds of systems. These kinds of jobs have the potential to have a substantial effect on the Quality of Service (QoS) provided by the system. It is necessary to have automatic straggler identification and mitigation systems that can complete jobs in a shorter amount of time in order to address this problem. Previous work often constructs reactive frameworks, the central emphasis of which is, in order, the identification, followed by the mitigation, of straggler tasks, that ultimately results in delays. Other research make use of prediction-based proactive systems, however they disregard the peculiarities of heterogeneous hosts or dynamic tasks. In this article, Hybrid Machine Learning (HML) is offered as a method that may determine which jobs are likely to be behind schedule and dynamically adjust scheduling in order to obtain faster response times. The method that has been suggested examines all tasks as well as hosts on the basis of the use of compute and network resources, and it is also able to predict and mitigate the effects of expected straggler activities. This speeds up the execution without lowering the quality of service. The proposed HML is evaluated in terms of quality of service factors such as energy usage, processing time, resource contention, and CPU utilisation in comparison to other machine learning methods that already exist, including Support Vector Machine (SVM), ADABOOST, Artificial Neural Network (ANN), Naive Bayes (NB), Decision Tree (DT), and Random Forest (RF). According to the results of several evaluations, the proposed HML cuts down on processing time, resource contention, and energy usage by 13.5%, 11.25%, and 16.75%, correspondingly, when compared to standard machine learning methodologies. The proposed HML has a performance accuracy of 98.1%, making it superior to those other conventional ML methods.

Keywords: Straggler Node, Mitigation, Hadoop, Map-Reduce, HML, RNN

INTRODUCTION

Areas of application of Cloud Data-Centers (CDCs) in areas such as health care, food production, smart cities, weather prediction, and traffic control produce large amounts of data, which are transmitted among multiple devices utilising various types of communication mechanisms [20]. The constant rise in data quantity and velocity may necessitate the utilisation of huge computational systems [21, 22]. This only serves to heighten the already pressing requirement for techniques of intelligent future employment and adaptable, autonomous scheduling. This challenge is the primary subject of this work, which studies several solutions with the specific goal of reducing straggler tasks. Stragglers are activities within a job which take significantly longer to perform than some other processes, and they can result in a significant rise in turnaround time because of the need to synchronize the outputs of the tasks with one

another. Stragglers can be avoided by carefully planning the order in which tasks are performed. The existence of them raises the risk of something known as the "Long Tail Issue."

To be more specific, the Long Tail Problem happens when the amount of time needed to complete a specific project is considerably altered in an un-favorable way by a tiny proportion of straggler activities. Any highly parallelized software that performs jobs comprising of several tasks may be susceptible to the phenomenon known as task stragglers. Cases of such a framework include Google's MapReduce framework and Hadoop's architecture; both of these example demonstrates that methods for the avoidance of stragglers are popular [20, 23]. The system can be scaled up to large clusters of commodity computers with either MapReduce or Hadoop, which both offer this capability. The performance of operations in parallel enhances the speed at which they are carried out and automatically deals with errors in the absence of any interaction from a human, in accordance with the principles outlined in IBM's autonomic paradigm [24]. Furthermore, stragglers could still emerge as a consequence of software or hardware problems due to the fact that autonomic models are frequently delayed in managing failures. This can result in extended periods of downtime for devices that have limited resources [20]. These contribute to unanticipated delays in the task execution because of the lack of resources or the destruction of data, and they lead such jobs to hog resources, which results in longer reaction times in the case of non-preemptive processing. Therefore, effective strategies are essential to reduce the number of stragglers in order to prevent long reaction times. The many kinds of errors that can result in stragglers being assigned jobs are explained in the following paragraphs.

During the process of carrying out jobs, there is the potential for two distinct kinds of errors to take place: task errors and node faults. The earlier occurs when a particular task inside a job fails, which can be caused by a variety of different software and hardware issues [25]. This latter scenario plays out if one of the resources of a particular node, which is responsible for carrying out the task of the job, fails [20]. This could be due to a wide variety of problems at the operating system or hardware level. MapReduce is an implementation of a concept known as straggler mitigation, in which an attempt is made to reduce the number of failed tasks by relaunching the failed task. In the event that one of the nodes in a MapReduce cluster fails, the system will retry all of the tasks that had been planned to be carried out on that node. In aspects of node failures, whenever the effectiveness of a node deteriorates, either because of a fault in the operating system or in the hardware, or whenever the node fails completely, the processing time of a particular task, known as a "straggler," can become excessively long, forcing any other activities that rely on it to wait for it to finish before continuing. At the level of the work, in order for the task to be regarded finished, each of the tasks that make up the job must be finished. If a straggler task stops another sibling activities from being effectively done, the work won't be finished until all of the straggler tasks have been finished. In particular, straggler jobs might cause other tasks that are relied on their output to wait, which causes more resource consumption and has a further negative impact on the efficiency of the computer system.

Stragglers have a negative impact not only on efficiency but also on the costs of deployment. The problem of straggler tasks, which can cause a delayed response or waste resources, is a concern that is faced by well-known providers of cloud services, like Amazon, Google, Netflix, and Apple. This necessitates an unnecessary scaling-up of the cloud infrastructures, which in effect leads to a rise in the expenses associated with deployment. The efficiency of cloud services is also negatively impacted by instances of high latency that are referred to as "tail-tolerant" or "latency-tail-tolerant." Jobs that are tolerant of latency have a negative impact on resource usage and a positive one on energy consumption. Investigations such as [20, 24, 25] reveal that resource contention is the primary cause of stragglers, which occurs when multiple processes are seeking for shared resources at the same time. There is also the possibility of competition for shared global resources between various apps running on various nodes.

Previous research [19, 20] focuses on resolving the issue of straggler tasks by determining and minimizing which activities are stragglers only after all activities have been completed. This approach was taken to solve the problem of straggler tasks. The term "straggler mitigation" refers to the process of preventing any influence that straggler tasks may have on quality of service. This not only needs constant computation resources but also these tracking tasks themselves may be so data-intensive that it may lead to resource conflict, slowdowns, and preclude the throughput of the system [26]. This not only needs constant computation resources but also these monitor and control activities themselves can be so data-intensive. However, contemporary technologies such as deep learning make it possible to construct scalable models that can not only detect but also anticipate in advance which jobs might be lagging behind, enabling the execution of mitigation methods that save time and enhance quality of service. In this context, "straggler prediction" refers to the process of forecasting straggler tasks before they are carried out. In particular [27, 23] deploy solutions that utilize deep learning to anticipate lagging chores and handle them in an effective manner.

Methods of straggler prediction that are based on deep learning are susceptible to significant prediction errors for two primary reasons. To begin, these models do not take into account the underlying distribution of the periods it takes to complete activities, which is an essential factor in identifying lagging tasks [20, 29]. In particular, the existence of tasks with exceptionally high or low running time is caused by the fact that there is variability in the times at which jobs are completed. When simulating the dispersion of task turnaround time, this results in a relatively wide state space for the neural network, and as a result, it is frequently left out of practical approaches [27]. Furthermore, these methods do not take into account the different capacities of the hosts, which can also result in poor sequencing or decisions on prevention [26]. As a result, a new strategy is required, one that is capable of both proactively predicting straggler tasks and effectively mitigating their effects. Fog-cloud environments are one type of diverse runtime environment [26]. These environments take advantage of the resource capabilities offered by edge devices in addition to cloud nodes. Because of this, the computing resources of different host devices within the same context are very different from one another. This host heterogeneity has a consequence on the response time, as the scheduling process in a device with limited resources might dramatically lengthen the device's reaction time.

Because of these problems, it is necessary to design an innovative method of hybrid machine learning in order to identify and eliminate the straggler nodes. The system that has been proposed is able to perform an assessment on the current condition of a cloud environment. Utilization of resources like CPU, RAM, disc space, and bandwidth are some of the host and task characteristics that are used to characterise the current state of the cloud system. Previous research [30] served as inspiration for these parameters. In addition, previous research [20] has demonstrated that the reaction times of jobs in large-scale cloud installations follow a Pareto distribution. The suggested hybrid machine technique is utilised to forecast this distribution in advance in order to eliminate the straggler problem in a proactive manner. During the running of jobs, the speculative and rerun-based approaches that are utilised by the proposed HML are utilised for the purpose of Straggler Mitigation. Early mitigation is possible because to prediction, which also helps cut down on execution time while keeping quality of service at the appropriate depth. A comparison is made between the proposed method and certain well-known existing methods (SVM, ADABOOST, ANN, NB, DT, and RF) in terms of quality-of-service factors such as energy usage, processing time, resource contention, and CPU use. The results of the experiments show that the suggested use of HML results in a shorter amount of time needed for the execution than the currently used methods, while also providing a minimal amount of computational overhead. The remaining parts of the paper are organised as described below. The related work is presented in Section 2. Section 3 details framework and algorithm of proposed hybrid machine technique. The assessment setting as well as the experimental outcomes are discussed in Sections 4. The discussion is brought to a close in Section 5, which also provides an overview of potential future research topics.

RELATED WORK

A unique NIDS framework utilizing a deep convolution neural network that makes use of network spectrogram images obtained using the short-time Fourier transform is proposed by Adnan Shahid Khan et al. [1]. The CIC-IDS2017 dataset served as the basis for evaluation of the effectiveness of the approach that is been proposed. When compared to previous Deep Learning (DL) methods, the experimental findings showed an improvement of approximately 2.5%–4% in properly detecting intrusions. At the same time, the FAR was reduced by 4.3%–6.7% when considering a binary classification situation. Its effectiveness is also noticed for a 7-class categorization scenario, where it achieved about 98.75% accuracy with an improvement of 0.56% 3.72% in comparison to previous DL approaches.

Sana Ullah Jan et al. [2] suggest a distributed sensor-fault detection approach in the year 2020. The system is built on machine learning methods, and the fault detection block is integrated in the sensor so that output can be achieved instantly after data collection. The effectiveness of fault detection is evaluated using a number of different metrics, including detection accuracy, the area beneath the ROC curve (AUC-ROC), the percentage of false positives, and the F1 score. In addition to this, the classifier performance parameter demonstrates how effective the defect identification process is. The outcomes of the experiments demonstrate that the suggested fuzzy learning based model is superior to traditional neuro-fuzzy & non-fuzzy learning methods in terms of efficiency.

Fault detection via a wireless sensor network in a completely decentralized way is the topic of a paper that was published in 2021 by R. Regin et al. [3]. Firstly, the Convex Hull method is suggested to compute a collection of extreme ends with the neighboring nodes, and the length of the message is constrained to remain the same even as the amount of nodes rises. Second, it is recommended to use a Naive Bayes classifier in conjunction with a CNN in order to increase the convergence performance and locate the node flaws. In the end, the convex hull, Naive bayes,

and CNN techniques are evaluated with real-world datasets in order to discover and organize the flaws. Both results from simulation and experiments confirm the technique's practicality and efficiency, and demonstrate that, based on performance measures, the CNN approach contains defects that are more easily discovered than those in the convex hull approach.

An efficient fault detection, energy-efficient, quality-of-service routing strategy dependent on reinforcement learning is presented by Tariq Mahmood et al. [4] in the year 2021. The goal of this technique is to find the optimal route with the lowest number of end-to-end delay possible. Furthermore, the selection of the cluster head is contingent on the residual energy that is produced by the cluster nodes, which in turn reduces the existence of the entire network. As a consequence of this, it lengthens the lifespan of the network, reduces the amount of energy that is consumed during data transmission, and increases the resiliency of the network. The findings of the experiments reveal that the effectiveness of the network has been successfully improved by fault-tolerance solutions that incorporate trustable computational resources, which has resulted in a decreased risk of network problems.

In 2022, S. Gnanavel et al. [5] Classification techniques are utilized in a WSN to identify errors for the purpose of quality assurance checks on the data produced by the sensor network. For the purpose of this study, six different classifiers, including SVM, CNN, Multilayer Perceptron, Stochastic Gradient Descent (SGD), Random Forest (RF) and Probabilistic Neural Network (PNN) were used. The information that is produced by the sensor nodes has a variety of errors introduced into it, including an Offset fault, a Gain fault, a Stuck-at fault, an Out of Bounds fault, a Spike fault, and a Data loss fault. Classification methods do quality assurance checks on the inaccurate data. The results of the simulation demonstrate that the RF discovered more errors than any other classification in that class, and it also performed better than any of those other classifiers.

In 2020, Mohammad Reza Samsami et al. [6] provide a survey of the role of the distributed approaches in DRL. It overviews the state of the field, by studying the key research works that have a significant impact on how we can use distributed methods in DRL. The overview of papers were chosen, from the perspective of distributed learning, and not the aspect of innovations in reinforcement learning algorithms. Also, these methods were evaluated on different tasks, and compare their performance with each other and with single actor and learner agents.

In 2020, Kun Yang et al. [7] Although many distributed denial of service (DDoS) attacks detection algorithms have been proposed and even some of them have claimed high detection accuracy, DDoS attacks are still a major problem for network security. The latent and inherent problems of these detection algorithms are 1) Requirement of both normal and attack data for building detection models, and 2) Almost inability to detect novel and unknown DDoS attacks. To conquer the problems, this paper proposes an AutoEncoder based DDoS attacks Detection Framework (AE-D3F), which only uses normal traffic to build the detection model and is able to update itself automatically as time goes. Experimental results on synthetic and public traffic show that our AE-D3F can not only achieve 82.00% detection rate (DR) with 0 false positive rate (FPR), better than classical anomaly detection approaches, but also detect novel and unknown attacks.

In 2016, Jiabin Li et al. [8] propose a detection method that consists of 3 main parts in different aspects: a sliding time window to fasten the entropy calculation, a single-directional filter to realize early detection during the DDoS progress but not after the crash, and a quintile deviation check algorithm to optimize the detection result. These will eventually lead to a real-time and high-efficient performance to recognize IoT DDoS attacks as soon as possible.

In 2020, Rabindra Kumar Shial et al. [9] proposed a centralized faulty node detection algorithm based on statistical analysis in wireless sensor network. The proposed algorithm is evaluated and simulation result shows that the algorithm performs better than the existing conventional approaches.

In 2020, Shrishti Sajan et al. [10] Wireless Sensor Networks (WSNs) is a fundamental apparatus for monitoring discrete remote situations. One of the key innovations engaged with WSNs, is fault recognition in WSN applications. WSN are usually fault prone and1reliability of1sensor network1is influenced1by flaws that might1occur, because of different reasons like malfunctioning hardware and also software faults or due to some natural reasons. The primary motive of this paper is to consider various approaches to fault detection techniques in WSNs and their upcoming predictions. To achieve this point, various existing approaches are reviewed and provided a broader outline of fault detection and also fault tolerance in WSNs. In this paper, the summarization of the existing fault detection techniques is stated, and further examinations are done to help sensor applications.

In 2020, Anwesha Das et al. [11] presented the framework Aarohi, which describes an effective way to predict failures online. Aarohi is designed to be generic and scalable making it suitable as a real-time predictor. Aarohi obtains more

than 3 minutes lead times to node failures with an average of 0.31 msecs prediction time for a chain length of 18. The overall improvement obtained w.r.t. the existing state of-the-art is over a factor of 27.4×. The compiler-based approach provides new research directions for lead time optimization with a significant prediction speedup required for the deployment of proactive fault tolerant solutions in practice.

In 2021, Jiaxi Liu et al. [12] Many environmental monitoring applications that are based on the Internet of Things (IoT) require robust and available systems. These systems must be able to tolerate the hardware or software failure of nodes and communication failure between nodes. However, node failure is inevitable due to environmental and human factors, and battery depletion in particular is a major contributor to node failure. The existing failure detection algorithms seldom consider the problem of node battery consumption. In order to rectify this, a low-power failure detector (LP-FD) is proposed that can provide an acceptable failure detection service and can save on the battery consumption of nodes. From simulation experiments, results show that the LP-FD can provide better detection speed, accuracy, overhead and battery consumption than other failure detection algorithms.

In 2020, Naoto Numata et al. [13] proposes an IP fast reroute method which can reroute packets against multiple node failures. The paper is the first paper which deals with multiple node failures in the research area on IP fast reroute. The proposed method generates spanning trees to bypass the failures from a given network topology in network design stage, and reroutes a packet using one of the generated spanning trees every time the packet encounters a node failure in network operation stage. Numerical example shows that such spanning trees can be easily generated using our proposed method.

In 2020, Mridula Dhingra et al. [14] the growth of cloud computing is rapid and consumers expect additional resources and improved results, so the load balance of cloud computing has come to be very well known. Load balancing is essential in the distributed environment for an efficient operation. It helps achieve a high level of customer loyalty and utilization of resources by certifying that all computer resources are efficiently and unbiasedly distributed. This paper discusses several algorithms to present competent methods for increasing Cloud presentation in its entirety, providing the customer with a more appropriate and competent environment.

In 2020, Liangliang Xu et al. [15] propose PDL, a PBD-based Data Layout, to optimize failure recovery performance in DSSes. PDL is constructed based on Pairwise Balanced Design, a combinatorial design scheme with uniform mathematical properties, and thus presents a uniform data layout. Then it propose rPDL, a failure recovery scheme based on PDL. rPDL reduces cross-rack traffic effectively and provides nearly balanced cross-rack traffic distribution by uniformly choosing replacement nodes and retrieving determined available blocks to recover the lost blocks. The PDL and rPDL is implemented in Hadoop 3.1.1. Compared with existing data layout of HDFS, experimental results show that rPDL reduces degraded read latency by an average of 62.83%, delivers 6.27× data recovery throughput, and provides evidently better support for front-end applications.

In 2021, Chitturi Sai Nikhil et al. [16] Identification of Node failure detection and a localization is a very important challenge in a network community to get a quick recovery and avoid useless traffic in network. But it is very difficult to check the failure nodes or locations because of the large number of Screw ups in dense network. As finding the main source for failure of network is always challenging the proposed work will achieve that, it identifies the node failure by using probing measurement of binary state to end to end paths. Apart from identifying the network failure, it also quantifies the total failure nodes and the ip address or vicinity of failure nodes, Identification of node failure is done by monitoring nodes which are deployed in the network. The Proposed word is divided majorly in two phases one is identifying the node failures by using Probing Packets and other is finding of the failure and its recovery.

In 2020, S. Siva Rama Krishnan et al. [17] Wireless sensor networks are used to monitor physical or environmental conditions such as temperature and pressure as well as to study the quality of certain environmental and natural entities like air and water bodies by collecting data about the various components present in the air/water at a given spot and time. But the complete data generated by the nodes in each iteration is not always useful, as most of them give the redundant information or details which does not provide any essential information, just bulge up the amount of data being transmitted. Therefore, this paper aims to formulate an early prevention method (EPM) which not only gives a way to detect failed nodes, but also increases the overall efficiency of the network by reducing the overhead at the sink.

In 2020, Baturalp Buyukates et al. [18] consider a status update system in which the update packets need to be processed to extract the embedded useful information. The source node sends the acquired information to a computation unit (CU) which consists of a master node and n worker nodes. The master node distributes the received

computation task to the worker nodes. Upon computation, the master node aggregates the results and sends them back to the source node to keep it updated. It reviewd the age performance of uncoded and coded (repetition coded, MDS coded, and multi-message MDS (MM-MDS) coded) schemes in the presence of stragglers under i.i.d. exponential transmission delays and i.i.d. shifted exponential computation times. It shows that asymptotically MM-MDS coded scheme outperforms the other schemes. Finally, the age-optimal codes are characterized.

In 2021, Aswathy Ravikumar et al. [19] Deep learning for image analytics is widely used in many real-world applications. Due to the rapid growth in data and model size there is a need to distribute the models in multiple nodes. Distributed computing of the model helps to increase the scalability, training time and its cost effectiveness. But the distribution can lead to longer computation times in case of stale nodes. The computational time of the distributed nodes are affected by many factors like latency caused due to communication, network connectivity, resource sharing, computational power etc. The main problem faced in case of distribution is the staleness among the worker nodes. Effect of stragglers cannot be completely avoided in distributed clusters. The failures in storage, disks, imbalanced workloads, resources sharing etc. are the main cause of stragglers. Stragglers can cause longer computation time and reduce the performance of the model. The different methods used to address this issue is described in the paper in detail. The open research problems in this field are also highlighted.

PROPOSED SYSTEM

As machine learning (ML) techniques grow more widespread, the process of training models will become increasingly challenging. Therefore, a distributed machine learning architecture that is easy to use, flexible, and resistant to stragglers is required. The methodology that has been proposed aims to reduce the consequences that are caused by stragglers in huge training activities. In synchronous distributed computing, lagging workers are referred to as stragglers. Stragglers fall behind the rest of the workers. In this section, the methodology that is proposed for minimising the consequences of stragglers in decentralized machine learning is outlined. Straggler nodes are the cause of delays in synchronous processing. This takes place before proceeding onto another stage of the computation, and it requires the findings of all of the workers to be integrated.

The proposed HML for straggler detection and mitigation in highly distributed environments is illustrated in Figure 1. The data has been evaluated in accordance with the standards and guidelines that were established during the preprocessing stage. When any of these variables exceeds or breaches the limits, the system immediately terminates the instance since it has violated the limits that have been set for it by the property's upper and lower bounds for specified values. The phases of collecting data, organizing the data, filtering and normalising it are all included in the preprocessing phase. When cleaning and repairing inaccurate or false information from files, records, or datasets, it is necessary to locate and change (or remove) any lost mistaken, erroneous, or incomprehensible information. Additionally, it is necessary to replace, update, or remove any filthy or confidential material. The proposed method cleans up the data in an informative manner by employing scripting tools or transaction processing. The consistent sampling approaches are utilised in order to equalise the data and filter the standardised dataset in order to omit the events that were improperly categorised. The standard and numerical values from the text data are retrieved in the feature extraction step of the process.

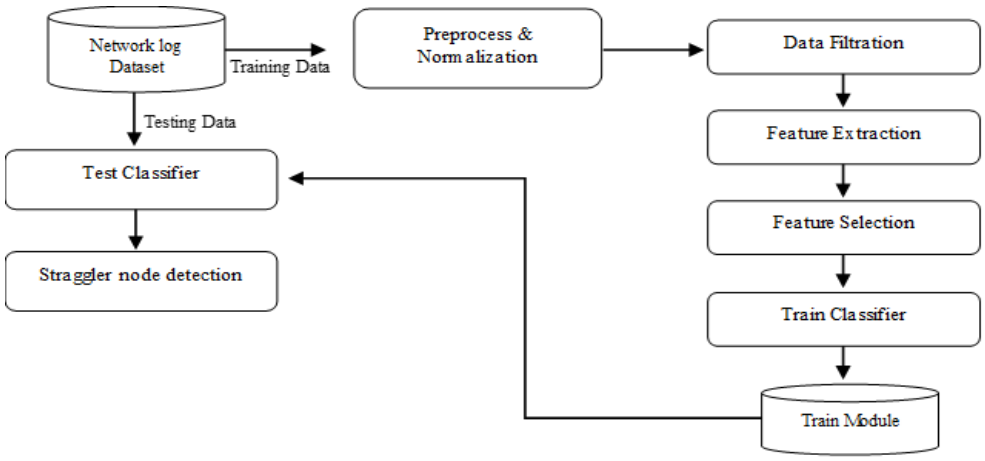


Figure 1. Proposed system architecture using HML for straggler node detection and classification

The full data set has been processed with the different feature selection and extraction strategies that have been developed. From the complete data set, the TF-IDF, N-Gram, correlation coefficients, bi-tagged and density-based features have been retrieved. After the feature extraction process has been completed, a one-of-a-kind feature vector that contains a variety of features derived from the features extracted is formed. This feature vector guarantees that it does not contain any data redundancy and offers the lowest possible level of redundancy while maintaining the highest possible level of relevance (mRmR). Using a supervised classification approach, the computer programme finds every record and determines whether it is a straggler or a normal record.

The meaning of the parameters used in the algorithm is discussed in the following table 1,

TABLE I. NOTATIONS

Symbol	Meaning
p	Max number of activities in a job
α, β	Variables of the Pareto distribution
O	Straggler variable in proposed HML
E_{St}	Anticipated number of straggler activities
I	Time-period of proposed HML inference in secs
D	Time-duration of proposed HML inference in secs
m	Total number of hosts

Algorithm of Detection and Migitation of Straggler

Inputs:

Step 1: A ← Collection of all jobs presently being performed [a_1, a_2, …, a_r]

Step 2: T_l^m ← Collection of activities of job j_m where l ∈ {1, 2, 3, 4,…p}

Step 3: M_t ← Maximum time allocated for releasing resource.

Parameters:

Step 4: A_m ← Collection of normal jobs ⊆ A without any activities of straggler

Step 5: A_s ← Collection of jobs ⊆ A with > 0 activities of straggler

Procedure ForecastStraggler (job)

Step 6: for time d from 0 to D by using step 1

Step 7: p ← Number of activities in input job

Step 8: Retrieve feature vectors of host systems as M_{Host}

Step 9: Retrieve feature vectors of activities of input job as M_{Task}

Step 10: Forecast (α, β) using the ML

Step 11: Determine E_{St} as q $(\frac{O}{\beta})^{-\alpha}$

Step 12: Execute job until p − $\lfloor Est \rfloor$ activities are done

Step 13: return unfinished activities

Step 14: Procedure Speculation(activities list)

Step 15: for activities t in activities list

Step 16: Excecute a copy of t on another node

Step 17: Procedure RerunStragglerActivities (activities list)

Step 18: for activities t in activities list

Step 19: Execute the same activities t on another node

Step 20: Begin

Step 21: for job a_i in A

Step 22: stragglerActivities ← ForecastStraggler(a_i)

Step 23: if stragglerActivities is empty

Step 24: add a_i to A_n

Step 25: continue

Step 26: else

Step 27: add a_i to A_s

Step 28: Wait for the particular amount of time (M_t), if a_i does not reacts then the alert will generate for further action.

Step 29: if a_i is deadline driven

Step 30: Speculation (stragglerActivities)

Step 31: else

Step 32: RerunStragglerActivities (stragglerActivities)

RESULT AND DISCUSSION

Performance measurement

Utilized here are the standard metrics for doing evaluations. Let us make the assumption that there are n hosts and q jobs in the system at the moment.

Energy Usage: The total amount of energy that has been consumed over a period of time can be calculated using the formula

$$E = E_{CPU} + E_{Disk} + E_{Memory} + E_{Network} + E_{Misc,mory} + E_{Network} + E_{Misc,} \quad \ldots(1)$$

where E_{CPU} represents the total amount of energy that has been consumed by all of the processors and comprises dynamic energy as CV ²f, short-circuit energy, discharge energy, and the amount of energy that has been consumed while the processors have been idle [10]. E_{Disk} represents the total amount of energy used by all read/write activities as well as the energy used by all discs while they are idle. E_{Memory} refers to the amount of energy that is utilised by the RAM as well as cache memory included in the computing nodes. $E_{Network}$ refers to the aggregate amount of energy that is used by network equipment such as routers, ports, LAN adapters, and switches. E_{Misc} refers "other elements," which includes things like the motherboards and port connector. To calculate the maximal and minimal energy usage (E_{max}, E_{min}), hardware profiling is used in accordance with Equation 1. After that, Equation 2 is used to calculate the total amount of energy consumed at period t. In this context, total host resource consumption, or U_k^t refers to host k's whole tasks combined. This is a typical method [27]. Thus,

$$E_{total}^t = \sum_{k=1}^{n} U_k^t \cdot (E_{max} - E_{min}) + E_{min}. \quad \ldots(2)$$

Execution Duration: The average execution duration is computed by the following formula,

$$T_{avg}^{exec} = \frac{1}{q}\sum_{i=1}^{q}(T_i^C - T_i^S) + \sum_{i=1}^{q} R_i. \quad \ldots(3)$$

This is the entire amount of time, on average, that it takes to correctly perform an application for each and every task. Here T_i^C, T_i^S and R_i represent the time at which task i was finished, submitted, and restarted, respectively.

Resource Contention: The term "resource contention" refers to the situation in which two or more tasks utilize the same resource while it is being executed [20]. This could be because the required quantity of resources are not readily available, or it could be because there is an excessive amount of work to be done with stringent due dates. Resource contention is measured as

...(4)

$$Con_{total}^{resource} = \sum_{k=1}^{n} \sum_{i=1}^{q_k} Req_{i,k}^{resource} \cdot \mathbb{1}(resource_i\ overloaded),$$

where the amount of jobs being carried out at resource k is denoted by q_k and the resource need of the i^{th} task carried out at node k is denoted by $Req_{i,k}^{\text{resource}}$. Additionally, the indicator function is denoted by the 1() notation.

Memory Usage: The memory usage of host k is computed by,

$$U_k^{memory} = \frac{P_k^{total} - (F_k + B_k + C_k)}{P_k^{total}} \times 100, \quad \text{...(5)}$$

Where P_k^{total} indicate the total amount of physical memory, F_k is the amount of free memory, B_k is the buffer size, and C_k is the cache size.

Disk Usage: The disk usage of host k is computed by

...(6)

$$U_k^{disk} = \frac{Total\ Used}{Total\ HD\ Size} \times 100.$$

Network Usage: The network usage of host k is computed by

...(7)

$$U_k^{network} = \frac{Bits_{total}^{rx} + Bits_{total}^{tx}}{BW_k \times S_I} \times 100,$$

Where the total bits collected and transferred in an interval are indicated by the variables $Bits_{total}^{rx}$ and $Bits_{total}^{tx}$ respectively. The bandwidth of host k is denoted by BW_k, and the duration of the interval is denoted by S_I.

Experimental Observations

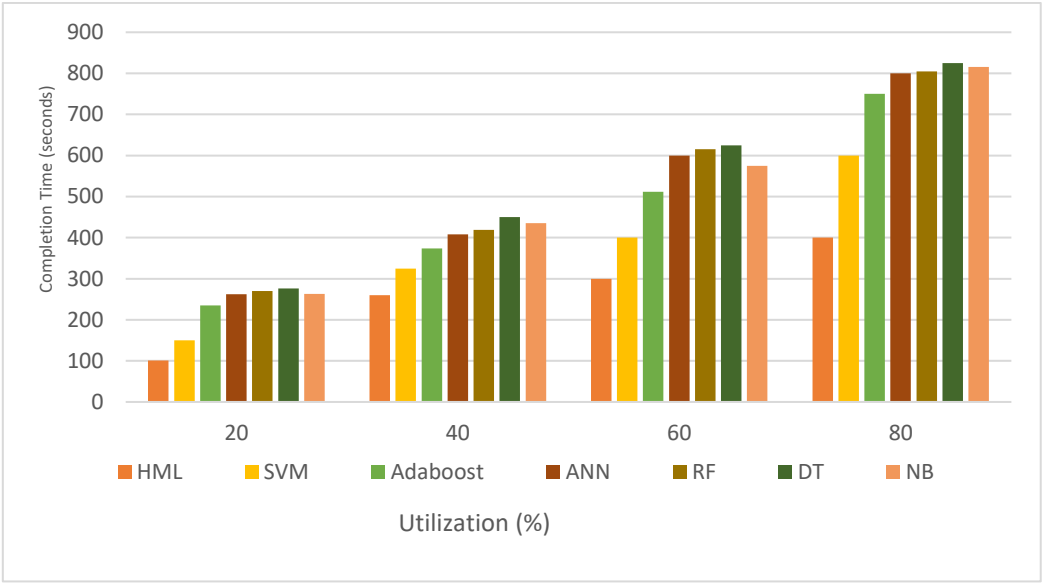
The performance of the proposed HML is evaluated in comparison to the approaches that are already in use with the help of the QoS metrics. The studies are carried out over the course of a full day, which corresponds to 288 scheduling intervals. A total of five runs were averaged, and a variety of job kinds were employed to guarantee that the results were statistically significant.

Utilization of Resources on a Variable Scale

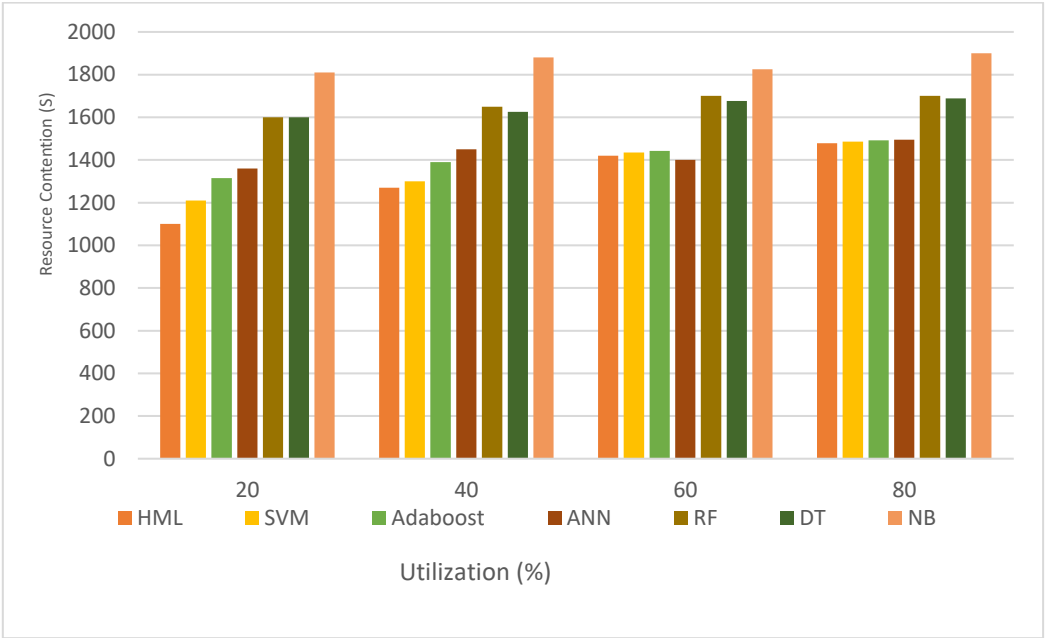
For the purpose of evaluating how well the suggested method performs, we took into account four distinct types of reserved usage for the CPU, the disc, the memory, and the network. These types involve blocking use on purpose at 20%, 40%, 60%, and 80% respectively. Figure 6 depicts a comparison of various QoS characteristics, including Completion Time, Energy usage and Resource Contention, with varying values of Cpu Usage, Disk Utilization, Network Utilization, and Memory Consumption.

The values of completion time for various straggler management techniques are depicted in Figure 2(a), along with variations in the values of the percentages of CPU, disc, network, and memory use. The value of runtime rises along with the value of reserved utilisation, but the performance of the proposed HML is superior to that of the techniques that are currently in use because it monitors the states of the resources in a dynamic manner in order to make decisions that are more effective. In comparison to the baseline approaches, the measure of completion time in the suggested HML takes 11.47-17.4% lesser time. The fluctuation in the amount of competition for a resource is depicted in Figure 2(b), which shows how utilisation can take on a variety of values. When there is greater demand for a

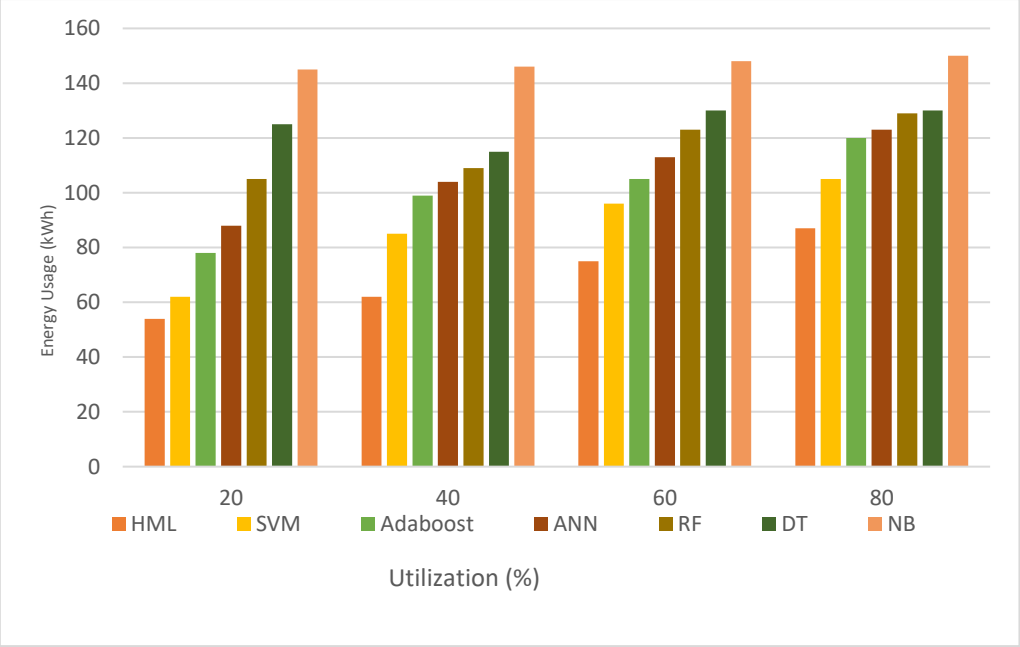
resource, there is a corresponding rise in the value of resource dispute. When compared to the baseline techniques, the value of resource conflict in the proposed HML is between 12.34 and 15.19% lower. Figure 2(c) illustrates the energy usage for various values of utilisation, and the observations reveal that the energy usage rises in line with the level of utilisation across the board for straggler management strategies. However, in comparison to the state of the art, the proposed HML operates significantly better because it prevents the over- or below of resources while scheduling. When compared to the baseline approaches, the value of energy usage in the proposed HML is lower by between 18.55% and 22.43%.



(a)



(b)



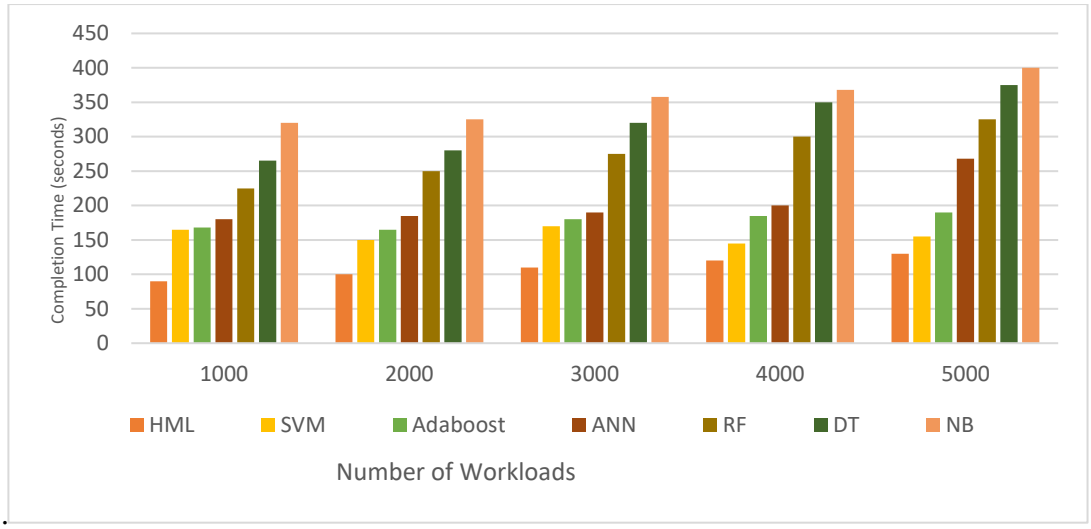
(c)

Figure 2. Comparing QoS parameters with various value of CPU usage, disk usage, network usage and memory usage: a) Completion Time, b) Resource Contention, c) Energy Usage

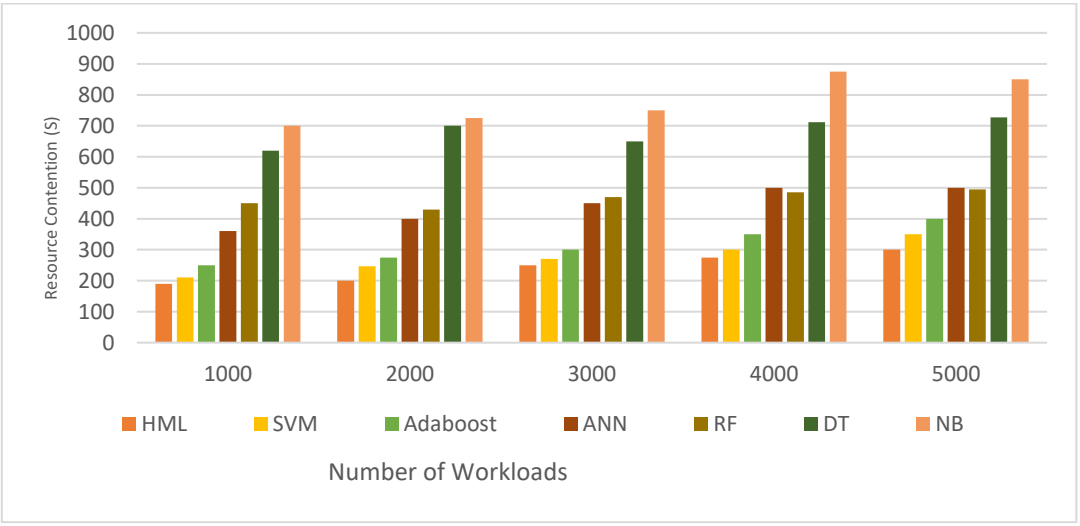
Variation of Number of Workloads

In this section, the significance of various indicators of performance is evaluated as the amount of workloads increases. This assessment is made in relation to the previous section.

The difference in execution time is seen in Figure 3(a), which corresponds to varied amounts of workloads. In comparison to the baseline approaches, the value of processing time in the suggested HML takes 19.74-23.84% less time. The value of resource conflict rises as the amount of workloads rises, as illustrated in Figure 3(b), which provides an assessment of resource conflict for various numbers of workloads. This analysis reveals that resource conflict is a function of the number of workloads. The performance of the proposed HML is superior to that of the current methods; the mean value of resource conflict in the proposed HML is 19.12-24.84 percentage points lower than that of the conventional classifiers. Figure 3(c) illustrates how the value of energy usage can vary depending on the number of workloads, and the value of energy usage in the proposed HML is 13.71-18.01% lower than the value of energy usage in the baseline techniques. The difference in network utilisation with a varying number of workloads is displayed in Figure 3(d), which compares the proposed HML approach to the conventional classifiers. Every utilisation measure that is displayed in the chart is an average across all of the jobs that have been finished. The findings of the experiments indicate that the suggested HML has an overall average of network utilisation that is around 18.6% and 25.67% higher than the approaches that were used as a baseline. Figure 3(e) depicts the fluctuation of CPU utilisation with various numbers of workloads. It demonstrates that the value of CPU utilisation is declining with the rise in the number of tasks, but the suggested HML outperforms than other strategies that are already in use. When compared to the approaches used as a baseline, the value of CPU consumption in the proposed HML is somewhere between 16.61% and 17.29% higher. The difference in disc use across all techniques is depicted in Figure 3(f), which indicates the effect that changing the amount of workloads has. The research results show that the suggested HML has an overall average of disc consumption that is 13.25-15.34% higher than the approaches that serve as the baseline. The value of memory utilisation is reducing with the increase in the amount of tasks, as illustrated in Figure 3(g), but the proposed HML accomplishes superior to existing techniques. This is indicated by the fact that the variability of memory utilisation with a varying amount of workloads is depicted in figure. Memory use in the proposed HML is 7.92-17.54% higher than the value of memory utilisation in the baseline approaches. In the case of the proposed HML, the more conservative completion of tasks that is based on straggler forecasting is the reason for the reduction in the amount of resources that are used. In order to prevent wasting resources and ensure that the forecasted straggler jobs are completed on time, those tasks are not duplicated if they are finished earlier than planned.


450
400
350
300
250
200
150
100
50
0
Completion Time (seconds)
1000
2000
3000
4000
5000
HML
SVM
Adaboost
ANN
RF
DT
NB
Number of Workloads

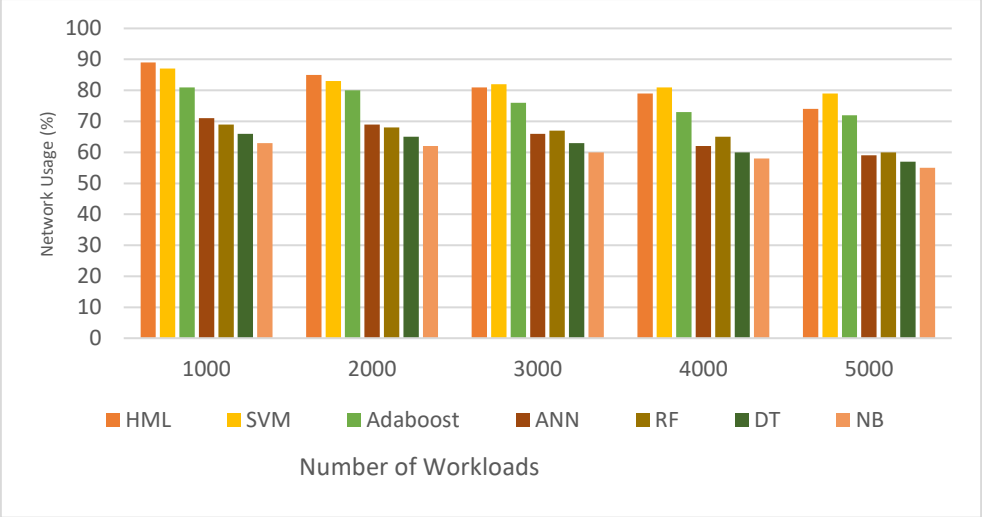
(a)


1000
900
800
700
600
500
400
300
200
100
0
Resource Contention (S)
1000
2000
3000
4000
5000
HML
SVM
Adaboost
ANN
RF
DT
NB
Number of Workloads

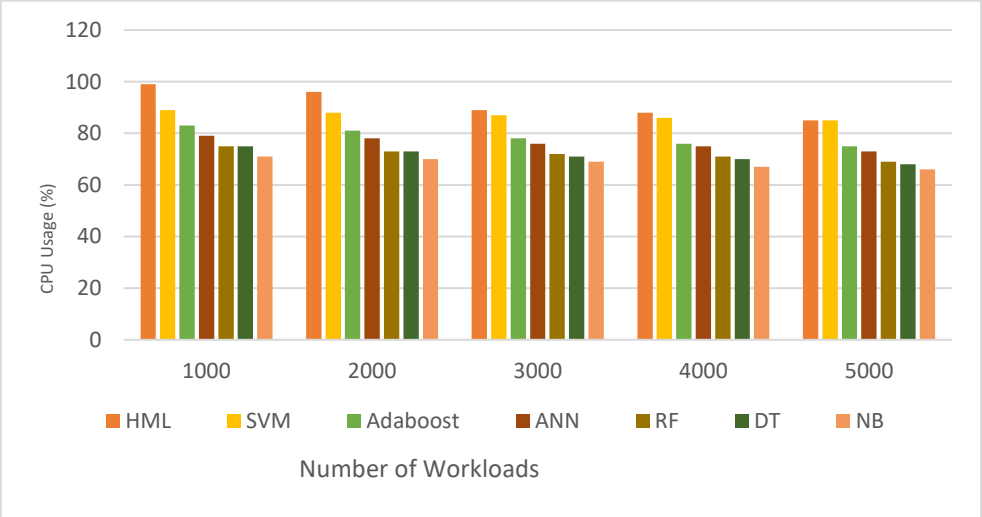
(b)


250
200
150
100
50
0
Energy Usage (kWh)
1000
2000
3000
4000
5000
HML
SVM
Adaboost
ANN
RF
DT
NB
Number of Workloads

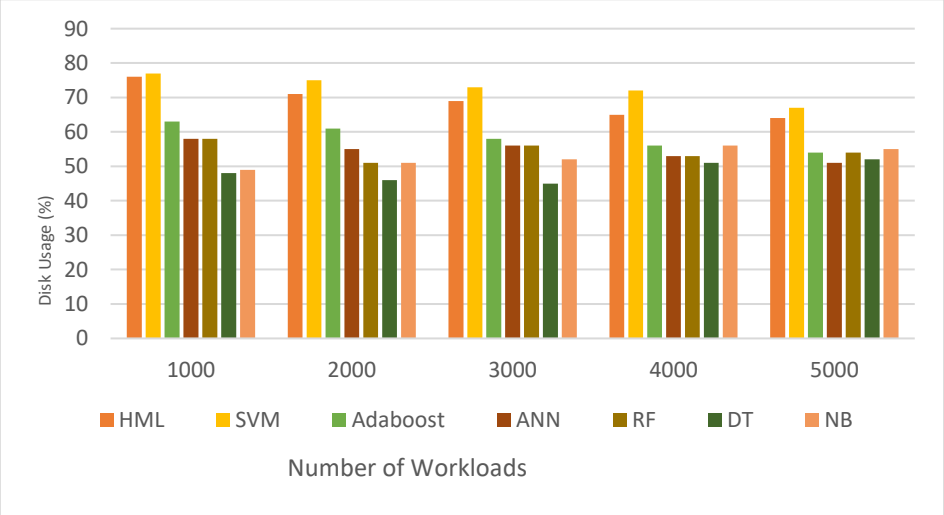
(c)


Network Usage (%)
100
90
80
70
60
50
40
30
20
10
0
1000
2000
3000
4000
5000
HML
SVM
Adaboost
ANN
RF
DT
NB
Number of Workloads

(d)


CPU Usage (%)
120
100
80
60
40
20
0
1000
2000
3000
4000
5000
HML
SVM
Adaboost
ANN
RF
DT
NB
Number of Workloads

(e)


Disk Usage (%)
90
80
70
60
50
40
30
20
10
0
1000
2000
3000
4000
5000
HML
SVM
Adaboost
ANN
RF
DT
NB
Number of Workloads

(f)

(g)

Figure 3. Comparing parameters of performance with various value of workloads: a) Completion Time, b) Resource Contention, c) Energy Usage, d) Network Usage, e) CPU Usage, f) Disk Usage and g) Memory Usage

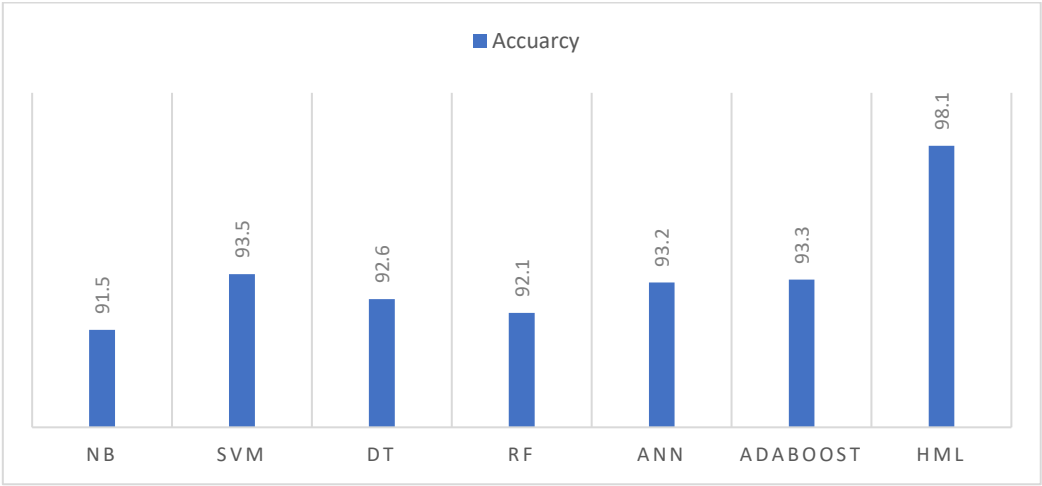


Figure 4. Accuracy of proposed HML compared with conventional ML Classifiers

The accuracy of proposed HML is compared with the various conventional machine learning classifiers in figure 4 and found that proposed HML outperforms than other existing ML approaches.

CONCLUSION AND FUTURE SCOPE

It is believed that large-scale cloud computing settings can benefit from a unique straggler detection and mitigation strategy that uses hybrid HML. This method can shorten the amount of time needed to respond while also producing superior results to those of earlier efforts. The approach that has been suggested is able to accurately predict straggler jobs in advance and eliminate those utilising methods such as prediction and re-running at an earlier stage. The proposed HML, in contrast to earlier prediction-based strategies, is able to analyse tasks in conjunction with host features and make use of the fundamental Pareto distribution in order to make more accurate predictions and take preventative measures, which ultimately results in higher performance than current state-of-the-art mechanisms. It is abundantly obvious that the suggested performs better across a variety of workload levels, resulting in reduced completion time, resource contentions, and energy usage. The performance of the proposed method again outperforms that of the baseline approaches when evaluated with various levels of workload on the cloud system. The proposed HML has a higher utilisation of the CPU, network, RAM, and disc. This is due to the fact that numerous jobs, and consequently tasks, are completed in a short amount of time, which leads to a greater number of tasks being completed in a specified period of time compared to certain other ways. Even with somewhat higher resource consumption for the same amount of jobs, this demonstrates that the proposed HML is able to utilise resources in a more effective manner, resulting to faster completed work and, as a result, also conserving energy. When compared to other traditional ML classifiers, the suggested HML has a performance accuracy of 98.1%, making it superior to those other

methods. The proposed HML can be applied in real-world contexts by making use of fog frameworks as part of ongoing research and development. This will contribute to making the model highly resistant to the stochasticity of tasks and workloads that occur in real-world situations. In addition, the suggested HML has the capability of being fine-tuned by making use of a bigger dataset That contains a Variety of Cloud and Fog Applications.

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Exploring the Role of Big Data Analytics in Personalizing E-Learning Experiences

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Abstract

In this digital age, personalized e-learning experiences are becoming more important. These use big data analytics to make sure that educational material and delivery methods are tailored to each learner's needs. This abstract talks about how big data analytics can be used to make e-learning more personalized, focused on its methods, benefits, and problems. In e-learning, big data analytics makes it possible to gather, process, and look at huge amounts of student data to find useful information. Based on things like learning styles, growth rates, and tastes, these findings are used to make learning situations more relevant to each person. Educators can create unique learning paths that keep students interested and help them remember what they've learned by combining data from different sources, such as how students interact with course materials, test results, and demographic data. Big data analytics makes personalized e-learning possible, which has many benefits. Customized material that is based on learners' hobbies and skill levels makes them more interested and motivated. Adaptive learning systems change in real time to offer more help or tasks, which improves how well students learn. Insights gleaned from data help teachers make better lessons and plan for when students need extra help. This makes teaching more effective overall. On the other hand, there are some problems with using big data analytics in e-learning. Privacy worries about collecting and using learning data mean that strong data security methods and following the rules are needed. Also, combining different types of data and making sure the quality of the data is good is hard to do technically and needs advanced analytics tools and knowledge.

Keywords: Personalized e-learning, Big data analytics, Adaptive learning, Educational technology, Learner engagement.

1. Introduction

In the past few years, using big data analytics in education has changed the way e-learning works by making it possible for students to have more personalized learning experiences. Before this change, education was based on the idea that one size fits all. This meant that students often had to deal with the same material and teaching methods, no matter what their needs and tastes were. Big data analytics could be a good way to solve this problem because it uses huge amounts of data about students to customize their learning in real time, which improves participation, learning results, and the general efficiency of education. One idea behind personalized e-learning is making sure that each student's learning style and traits are taken into account when creating lessons and how they are taught. This method is very different from standard classrooms or online classes that are set in stone and can't be changed to meet the needs of all students. Educators can learn more about each student's behavior, tastes, and success measures by using big data analytics. These insights give them the power to create unique learning paths that keep students interested and help them learn faster. Collecting and analyzing different types of data is a key part of using big data analytics in personalized e-learning. These sources include a lot of different kinds of data, such as how students interact with digital material, test results, personal information, and even feedback from learning activities that happen in real time. Using advanced data mining and machine learning techniques, teachers can get useful information from this data that they can use to customize students' learning in a way that has never been done before. Big data analytics makes personalized e-learning possible, which has many benefits. First, students are more interested and motivated to learn when the material they are using is related to their personal hobbies and level of skill.

Adaptive learning systems can keep students interested and help them understand things better by giving them important and difficult information to learn. Personalized learning tracks also help teachers find and fill in learning gaps quickly, which enhances students' general comprehension and recall of material. Adaptive learning systems, which are powered by big data analytics, are very important for improving student results because they change how material is delivered based on real-time data about the students. These systems use formulas to look at how students behave and how well they are doing in order to decide what to teach next and how hard it should be. For example, a student who is having trouble with a certain idea might get more practice problems or extra tools that are tailored to their needs. On the other hand, a student who is already good at what they're doing might move on to more difficult topics or training activities. Big data analytics can also be used for more than just delivering personalized material in personalized e-learning.

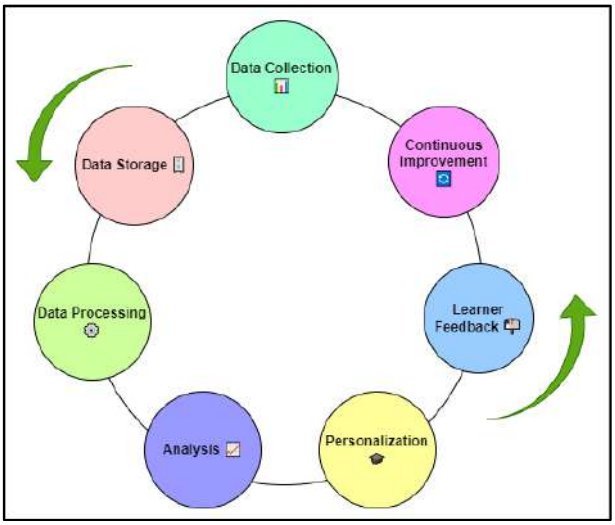

Figure 1: Role of Big Data Analytics in Personalizing E-Learning Experiences

They can also be used for bigger educational plans. Data-driven insights can help teachers create lessons, create curricula, and use teaching methods that work for students with different learning styles and tastes, illustrate in figure 1. Teachers can improve the general efficiency of their lessons and student happiness by learning how different groups of students react to different teaching methods or topic forms. But even though big data analytics has the ability to change targeted e-learning, there are some problems and things to think about. Concerns about the moral effects of collecting and using data in school settings are a big issue. Concerns about privacy appear when sensitive information about learners is stored and protected. This calls for strong data security measures and compliance with legal frameworks like GDPR and COPPA.

2. Literature Review

Big data analytics has the ability to completely change the way people learn, as shown by research into its role in personalized e-learning. Scholars have talked about different parts of this combination, focusing on how it affects student involvement, the design of lessons, and the results of education. Studies show that personalized e-learning, which is made possible by big data analytics, makes students more interested in learning by adapting material and activities to each student's tastes and skills. This customization not only keeps students interested, but it also encourages them to take part and understand the material better. For example, flexible learning systems can change how hard the material is based on real-time readings of how well the learner is doing. This lets them provide quick solutions that help the learner keep making progress. Big data analytics can also be used in e-learning for things other than personalizing material, like making learning methods that change to different students. Researchers have looked into how lessons from data can help with making choices about how to teach, like choosing the best ways to teach or finding the best ways to help students who are at risk. By looking at trends in pupil data, teachers can change how they teach to fit different students' learning styles and interests. This makes teaching more effective and makes students happier. The research does, however, point out some problems that come up when big data analytics are used in targeted e-learning. Concerns about privacy, data protection, and the right way to use data are still very important problems. Also, combining different types of data sources and making sure

the quality of the data is maintained is hard technically and needs strong infrastructure and knowledge.

Table 1: Summary of Literature Review

Method	Approach	Key Finding	Impact
Sentiment Analysis	NLP techniques to analyze student feedback	Identifies student satisfaction and areas of confusion	Enhances teaching methods to better meet student needs
Adaptive Learning Systems	Machine learning algorithms for real-time adaptation	Customizes learning paths based on learner performance	Improves engagement and knowledge retention
Clustering	K-means clustering on learning behaviors	Groups students with similar learning patterns	Facilitates targeted interventions and support
Predictive Analytics	Regression models on performance data	Predicts student performance and potential learning gaps	Allows proactive interventions to support learning
Recommendation Systems	Collaborative filtering and content-based filtering	Suggests relevant resources and activities	Increases learner engagement and resource utilization
Text Summarization	NLP for automatic summarization	Summarizes large texts for easier understanding	Improves content accessibility and comprehension
Learning Analytics Dashboards	Visualization of learner data	Provides insights into learner progress and behaviors	Informs instructional design and decision making
Gamification Analytics	Analysis of gamified learning data	Assesses impact of gamification on motivation	Enhances learner engagement through gamified elements
Social Network Analysis	Analysis of student interactions in forums	Identifies influential students and collaboration patterns	Supports community building and peer learning
Behavioral Analytics	Tracking and analyzing learner behavior data	Detects patterns of engagement and dropout risks	Enables timely interventions to reduce dropout rates
Multimodal Learning Analytics	Integration of audio, video, and text data	Provides a comprehensive understanding of learning activities	Enhances personalized learning experiences through diverse data
A/B Testing	Controlled experiments on learning interventions	Measures effectiveness of different teaching strategies	Informs evidence-based instructional improvements

3. Methodology

A. Natural Language Processing (NLP)

Natural words Processing, or NLP, is a field of artificial intelligence that tries to make computers understand, analyze, and use human words. When it comes to e-learning, NLP is very important for studying and handling text data that students, teachers, and educational material create. In e-learning, one of the main uses of NLP is sentiment analysis, which looks at student comments, forum posts, and discussion lines to figure out how they feel and what they think about course materials or teaching methods. This analysis helps teachers figure out what makes students happy or unhappy, find places where students are confused or unhappy, and then change their teaching methods to fit those needs. NLP methods also allow educational information to be automatically summed up, which makes large amounts of writing easier for students to access and understand. Summarization programs can break down long reads or lessons into short outlines that make it easier for students to understand the main ideas. NLP also powers robots and virtual helpers in e-learning systems, which help students right away and give them personalized advice. These AI-powered helpers can answer questions, give explanations, and suggest useful resources based on natural language searches. This makes learning materials more accessible and keeps students interested.

Algorithm for Sentiment Analysis using NLP in E-Learning

Step 1: Data Collection

$$D = \{d\_1, d\_2, \ldots, d\_n\}$$

- Description: Collect text data from various sources such as student comments, forum posts, and discussion threads. The dataset D consists of n documents.

Step 2: Text Preprocessing

$$T\_i = tokenize(d\_i)$$

- Description: Tokenize each document d_i into individual words or tokens T_i. Apply text normalization techniques such as lowercasing, removing stop words, and stemming/lemmatization.
- Equation: T_i' = normalize(T_i)

Step 3: Feature Extraction

$$X = vectorize(T\_i')$$

- Description: Convert the preprocessed text T_i' into numerical features. Common methods include Bag of Words (BoW), Term Frequency-Inverse Document Frequency (TF-IDF), or word embeddings like Word2Vec.
- Example Equation for TF-IDF:

$$tfidf(t,d) = tf(t,d) * \log\left(\frac{N}{df(t)}\right)$$

where tf(t, d) is the term frequency of term t in document d, N is the total number of documents, and df(t) is the document frequency of term t.

Step 4: Sentiment Classification

$$y\_i = f(X\_i)$$

- Description: Use a machine learning model f (e.g., Logistic Regression, SVM, or Neural Networks) to classify the sentiment of each document based on the extracted features X_i. The output y_i is the predicted sentiment label (e.g., positive, negative, neutral).
- Example Equation for Logistic Regression:

$$\hat{y} = \sigma(w \cdot X + b)$$

where σ is the sigmoid function, w is the weight vector, X is the feature vector, and b is the bias term.

Step 5: Sentiment Analysis and Feedback

$$S = \frac{1}{n}\sum y_i$$

- Aggregate the sentiment scores y_i to provide an overall sentiment analysis of the e-learning materials. This analysis helps educators understand student sentiments and make informed decisions about course adjustments.
- Example Equation for Sentiment Score Aggregation:

$$S = \frac{(\sum y_i)}{n}$$

where S is the average sentiment score, and n is the total number of documents analyzed.

B. Machine Learning Algorithms

Machine learning algorithms are a big part of how e-learning is changing things because they make individual learning possible through data-driven insights and flexible learning methods. These programs look at a lot of data that was created by students, like how they interacted with schoolwork, how well they did on tests, and information about their demographics, to find trends and make predictions.

Big Data Analytics in Personalizing E-Learning Experiences

Big Data Analytics in e-learning leverages large datasets to tailor educational experiences to individual learners. This involves analyzing various data sources such as student interactions, performance metrics, and learning behaviors to make informed decisions.

1. Data Preprocessing

Let X be the matrix representing the raw data with n samples (students) and m features (metrics):

$$X = [x\_11 \ x\_12 \ \ldots \ x\_1m$$
$$x\_21 \ x\_22 \ \ldots \ x\_2m$$
$$\ldots$$
$$x\_n1 \ x\_n2 \ \ldots \ x\_nm]$$

Normalization is often performed to scale features to a standard range:

$$X_{norm} = \frac{(X - mu)}{sigma}$$

where mu and sigma are the mean and standard deviation vectors of the features, respectively.

2. Feature Selection

Feature selection can be performed using techniques like Principal Component Analysis (PCA). Let X_norm be the normalized data matrix:

$$C = \left(\frac{1}{(n-1)}\right) * X_{norm}^{T} * X_{norm}$$

- where C is the covariance matrix.

Eigen decomposition of C:

$$C = V * Lambda * V^{T}$$

- where V is the matrix of eigenvectors and Lambda is the diagonal matrix of eigenvalues.

3. Predictive Modeling

For predictive modeling, consider a linear regression model to predict student performance:

$$y_{hat} = X_{norm} * beta$$

- where y_hat is the predicted performance vector, and beta is the coefficient vector.

The loss function (Mean Squared Error):

$$J(beta) = \left(\frac{1}{2n}\right) * sum\left(\left(y_{hat_i} - y_i\right)^2\right)$$

$$= \left(\frac{1}{2n}\right) * (X_{norm} * beta - y)^T * (X_{norm} * beta - y)$$

4. Personalization Using Clustering

K-means clustering can be used to group students with similar learning patterns:

$$min\_\{S, mu\}\, sum(sum(s\_ik * ||x\_i - mu\_k||\text{^}2))$$

- where S is the assignment matrix, mu_k is the centroid of cluster k, and s_ik is a binary variable indicating whether student i is assigned to cluster k.

5. Recommender Systems

Matrix factorization can be used to recommend personalized learning resources:

$$R \approx P * Q\text{^}T$$

- where R is the user-item interaction matrix, P and Q are matrices of latent features for users and items, respectively.

The objective function to minimize:

$$min\_\{P, Q\}\, sum((r\_ij\ -\ p\_i\hat{}T\ *\ q\_j)\hat{}2\ +\ lambda\ *\ (||P||\hat{}2\ +\ ||Q||\hat{}2))$$

- where K is the set of known ratings, and lambda is the regularization parameter.

C. SVM:

Support vector machines (SVM) and decision trees are two types of classification systems that put learners into groups based on how they learn, what they like, and how well they can do something. This sorting helps make sure that each student gets tasks and topics that are just right for them, so that they are learning useful things. Clustering methods, like k-means clustering and hierarchical clustering, put students together who have similar learning styles or ways of behaving. This method helps teachers find out what students are having trouble with and what learning paths and challenges they are following in common. This lets them offer focused help and personalized learning paths. Regression models are also used to guess how well students will do and what will happen based on past data. These guesses help teachers figure out where students might be having trouble learning or where extra help might be helpful. This helps them improve their lessons and make sure that all of their students learn as much as possible.

Algorithm for Classification Using SVM in E-Learning

Step 1: Data Collection

$$D\ =\ \{d\_1, d\_2, \ldots, d\_n\}$$

- Collect data from student interactions, test performances, and demographic information. The dataset D consists of n instances.

Step 2: Feature Extraction and Preprocessing

$$X\ =\ \{x\_1, x\_2, \ldots, x\_n\}, y\ =\ \{y\_1, y\_2, \ldots, y\_n\}$$

- Extract relevant features (X) from the dataset and corresponding labels (y). Normalize and preprocess the data to improve the performance of the SVM classifier.
- Example Equation for Normalization:

$$x_i' = \frac{(x_i - \min(x))}{(\max(x) - \min(x))}$$

where x_i is an individual feature value, and min(x) and max(x) are the minimum and maximum values of the feature x across all instances.

Step 3: Training the SVM Classifier

- $\min\left|\left|w\right|\right|^2\ +\ C\ \sum \xi_i, subject\ to\ y_i(w\ \cdot\ x_i\ +\ b)\ \geq\ 1\ -\ \xi_i, \xi_i\ \geq\ 0$

- Train the Support Vector Machine (SVM) classifier using the preprocessed training data. The goal is to find the hyperplane that maximizes the margin between different classes.

Step 4: Prediction and Evaluation

$$\hat{y}\ =\ sign(w\ \cdot\ x\ +\ b)$$

- Use the trained SVM model to classify new student data into appropriate categories. Evaluate the performance using metrics like accuracy, precision, recall, and F1-score.

- Example Equation for Accuracy:

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

where TP, TN, FP, and FN represent true positives, true negatives, false positives, and false negatives, respectively.

4. Challenges and limitations

There are some problems and restrictions that need to be worked around in order for big data analytics to be used to personalize e-learning experiences to reach their full potential. One of the main worries is how the gathering, storing, and using of student data will affect privacy and morals. To keep private information safe and build trust among learners and partners, it's important to make sure data protection and comply with rules like GDPR and COPPA. Integrating different data sources and making sure the quality of the data is also very hard from a technical point of view. E-learning systems collect a lot of data from many places, such as how students connect with each other, the results of assessments, and information about their demographics. To handle and analyze this diverse data, you need a strong foundation, advanced analysis tools, and knowledge of how to manage data. Data compatibility, uniformity, and dependability are some of the problems that can make data-driven ideas less accurate and useful. This makes individual learning less effective. Another big problem is that personalized e-learning solutions that are driven by big data analytics are hard to make bigger. Schools need to buy tools and resources that can be expanded so they can handle more learner data and more requests for personalized learning experiences. This problem with growth is made worse by the fact that algorithms and models need to be constantly changed and improved to make sure they work well in a variety of educational settings and with different types of students. One more problem with personalized e-learning systems is that they might have biases built into the algorithms. Based on demographic or behavioural data, algorithms that make content suggestions and adaptable learning paths may strengthen biases or stereotypes that people already have. To fix bias, we need to carefully plan algorithms, make sure they are regularly checked, and make sure that datasets are diverse so that unfair results don't happen and everyone has the same chances to learn.

5. Result and Discussion

By adapting material and teaching methods to each student's needs, big data analytics has shown a lot of promise in making personalized e-learning experiences better. Studies show that when educational experiences are tailored based on real-time data insights, students are more engaged, motivated, and learn more. Big data analytics make adaptive learning systems able to change learning paths and material delivery to meet the needs and skills of each student. This makes the learning process more personalized and effective. To get the most out of personalized e-learning, you need to think carefully about problems like data protection, technology difficulties, and computer flaws, as well as ways to deal with them. To make sure that big data analytics continues to have a positive and transformative effect on education, future research and development should focus on improving data security measures, refining data analytics techniques, and making sure that everyone has equal access to personalized learning opportunities.

Table 2: Performance of various machine learning methods in predicting student performance based on different evaluation parameters

Machine Learning Method	Accuracy	Precision	Recall	F1 Score	MAE
Linear Regression	80.25	88.45	85.80	80.55	0.18
Decision Tree	86.45	89.60	86.33	86.12	0.16
Random Forest	88.47	90.84	89.47	88.44	0.12
Support Vector Machine	84.77	85.25	86.55	89.60	0.18
K-Nearest Neighbors	89.60	88.66	89.81	90.85	0.14

When you compare different machine learning methods for predicting student success, you can learn a lot about how well and how reliably they work, which is very important for customizing e-learning experiences, accuracy comparison illustrate in figure 2. This talk is mostly about the success measures shown in Table 2, pointing out the pros and cons of each one.

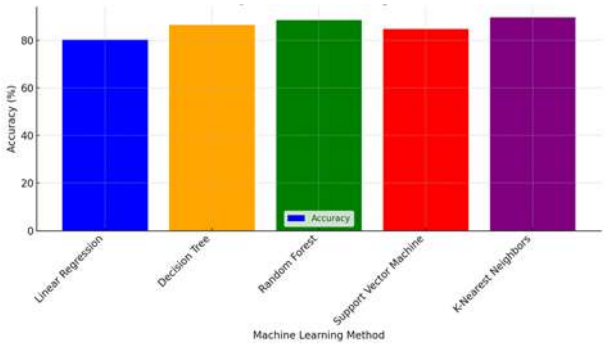

Figure 2: Accuracy of Machine Learning Methods

Linear Regression is quite good at predicting student success, with an accuracy rate of 80.25%. Accuracy and recall are 88.45% and 85.80%, respectively, which means that it can correctly spot a large number of good cases. The F1 score of 80.55%, on the other hand, shows that while it balances accuracy and recall, it could do a better job of handling false positives and false negatives. The Mean Absolute Error (MAE) of 0.18 indicates that the average forecast error is not too high. This makes it a good model for standard comparisons, but not the best, shown in figure 3.

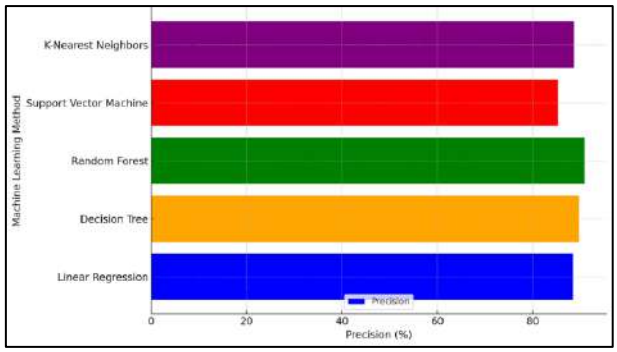

Figure 3: Precision of Machine Learning Methods

With an accuracy of 86.45%, Decision Tree is a better method than Linear Regression. With precision of 89.60% and memory of 86.33%, it is clear that it is more accurate at classifying things.

The 86.12% score on the F1 test shows a good mix between accuracy and memory. With an MAE of 0.16, Decision Trees can make more correct predictions with fewer mistakes, which makes them a good choice for this task.

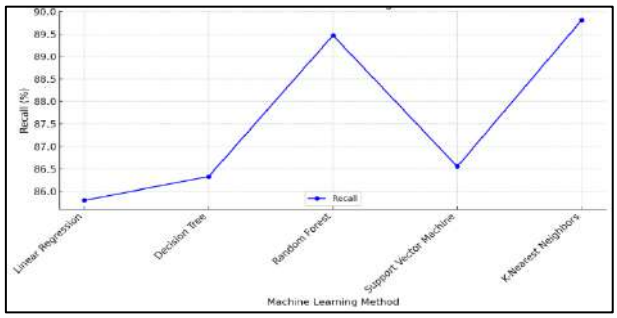

Figure 4: Recall Of Machine Learning Methods

Random Forests work better than other methods because they are 88.47% accurate. It can handle difficult information well, as shown by its accuracy and recall scores of 90.84% and 89.47%, respectively. The F1 score of 88.44% makes it even more clear that it is a good method, recall shown in figure 4. The MAE of 0.12 is the lowest of all the models, which suggests that Random Forests makes the most accurate predictions with the least amount of mistake. It was the best model in this study. SVM is only 84.77% accurate, which is a little less than Decision Trees and Random Forests. It has an accuracy of 85.25% and a memory of 86.55%, which means it works but might not be as accurate as the best ones. It's interesting that the F1 score of 89.60% is pretty high, showing a good mix even though some measures are lower. With an MAE of 0.18, SVM's forecast error is about the same as Linear Regression's. This makes it a competitive model, but not the best.

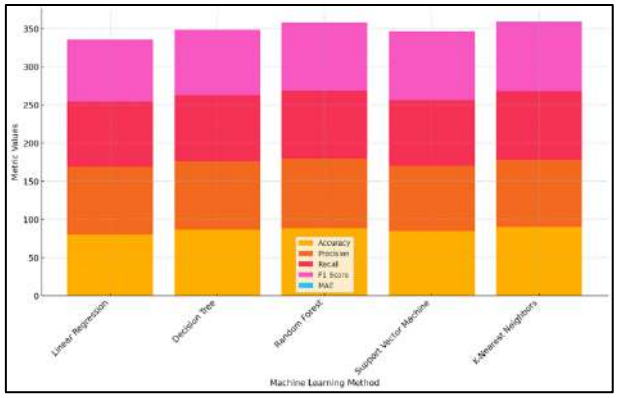

Figure 5: Performance Of Machine Learning Methods

With an accuracy of 89.60%, KNN stands out. Its accuracy in classifying things is shown by its precision value of 88.66% and its memory value of 89.81%. The F1 score of 90.85% is the best of all the models, showing a great mix between accuracy and memory. It can make correct estimates with a relatively low mistake rate, as shown, in figure 5, by the MAE of 0.14. KNN works very well, which makes it a great choice for this task.

6. Conclusion

Big data analytics is a revolutionary force in personalized e-learning. It gives teachers and students never-before-seen ways to improve their lessons by adapting material and teaching methods to each

student's needs. This method goes beyond the old "one size fits all" way of teaching and learning, letting teachers use data-driven insights to make teaching and learning more effective. Personalized e-learning settings can change in real time based on how learners interact with them, their success data, and their choices thanks to big data analytics. This ability to change not only gets students more interested and motivated, but it also helps them understand and remember things better. Teachers can help students with different learning styles and speeds by making sure they have access to personalized learning paths and tools. Some problems have been found when big data analytics are used in targeted e-learning, though. Concerns about privacy, data security, and possible flaws in algorithms mean that student data needs to be carefully thought through and protected with strong measures to make sure it is used in a responsible way. Ongoing attention and funding are also needed for the technical challenges of integrating data, making sure quality, and making infrastructure scalable. In the future, it will be very important to keep researching and coming up with new data analytics methods, privacy-protecting tools, and best practices for education in order to move personalized e-learning programs forward. To solve these problems and get the most out of big data analytics in creating a more flexible, responsive, and welcoming educational environment, educators, lawmakers, coders, and other players must work together.

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Biblometrics Analysis of the Annals of Library and Information Studies from 2012 to 2021

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ABSTRACT
This Biblometrics study focuses on analyzing articles published in the Annals of Library and Information Studies (ALIS) journals from 2012 to 2021. The research examines publication trends within ALIS, offering insights valuable to Library and Information Studies (LIS) professionals and associations. The literature highlights a critical need for a comprehensive analysis of LIS trends in India. This study aims to scrutinize the publication characteristics of ALIS journals over the past decade, assessing year-wise article contributions, author productivity, and collaboration patterns. A total of 315 articles were reviewed, revealing trends in authorship and geographic distribution, with notable contributions from authors based in New Delhi (135 authors contributing 85 articles) and West Bengal (66 authors contributing 47 articles). The study identifies prolific authors, institutional affiliations, and popular keywords, providing a comprehensive overview of the field's scholarly output and collaborative networks.

Keywords:- Biblometrics, prolific author, prolific institution, author productivity, prolific institution, library science,

1. Introduction

Change is an inherent principle of nature, essential for continual growth and advancement across the globe. Every sector undergoes regular shifts in trends, necessitating careful observation and interpretation. This practice not only enhances decision-making but also guides future directions. The field of libraries, like many others, has seen significant changes in the trends of published articles and books. Once confined to physical library infrastructures, access to libraries worldwide is now just a click away. Technological advancements have revolutionized the library landscape, making substantial contributions to the study and practice of library and information sciences.
This study focuses on articles published in prominent journals archived in ALIS from 2012 to 2021. The methodology employed is bibliometrics, chosen for its ability to systematically select reliable information and

facilitate targeted analysis. Coined by as per the cited document [9], the term 'bibliometrics' derives from 'biblion,' meaning book, and 'metron,' meaning measure. Bibliometrics comprises a suite of methodologies designed to study and quantify textual and informational content.

Researcher defined 'bibliometrics' as the "quantitative treatment of properties of recorded discourse and behavior pertaining to it [3]." The British Standards Institution described it as the "study of the use of documents and patterns of publication applying mathematical and statistical methods. [2] As per the citied document termed it as the "quantitative analysis of the bibliographic features of a body of literature. [4]" According to citation Biblometrics offers insights into "the structure of knowledge and its communication. [6],"

The research under review has examined various aspects including originality in research papers, reviews, citations, and publications within the field of library science. ALIS was selected as the platform to analyze journal publications due to its comprehensive coverage and reliability in presenting factual information. This study contributes significantly to the provision of authentic and precise data in a practical manner. Furthermore, the past decade has seen significant shifts in trends across all disciplines, including library and information science.

2. Literature review

Recent studies have focused on analyzing and documenting trends in published articles within the field of library and information science. conducted a comprehensive analysis of current research and publication trends in this domain, based on data from the past five years. They categorized journal sections for analysis using the Scimago Journal Rank (SJR) results spanning 2013 to 2017, and identified the most cited articles from the Web of Science (WOS) database. Additionally, they compiled information on highly cited authors, influential articles, top publishing organizations, and prevalent topics such as titles, keywords, and summaries. Their findings underscored that these variables (e.g., topics, institutions, authors) serve as significant indicators of publication activity and bibliometric impact.[14]

A study conducted a quantitative analysis focusing on the growth rate and trends of global publications in the field of Library and Information Science (LIS) authored by librarians. The study examined 18,371 research articles published between 2003 and 2012, using data from the Web of Science (WOS). They found that from 2003 to 2009, a significant majority (69.9%) of articles were single-authored, whereas collaborative research became more prevalent from 2009 to 2012. Such studies serve as valuable tools for efficiently allocating research funds to enhance the research capabilities of academic and research organizations.[5]

In this study researcher conducted a bibliometric analysis focusing on Library and Information Science (LIS) research in the Asian region. The study analyzed 1127 papers published in 206 scientific journals, authored by 1685 individuals. These papers comprised 245 single-authored and 1440 multi-authored works. The research aimed to identify current trends in LIS issues using data from the Scopus database. Analysis was performed using the Bibliometrix program in R software, with results visualized using VOSviewer software.[13]

Investigated gender disparity among Indian scholars in Library and Information Science (LIS) from 1999 to 2018. Analyzing 1195 articles, the study assessed gender differences in first authorship and overall contributions during this period. The findings revealed that 65% of articles authored by women appeared in international journals, compared to 59% by men, indicating potentially higher quality contributions from women. However, the study also highlighted that gender parity in the field of LIS remains a distant goal.[8]

The study conducted a separate analysis focusing on 1357 papers published between 2014 and 2018, sourced from the Scopus database. The study identified consistent growth, with 342 articles (25.2%) published in 2018 alone. The most frequently used keywords included scientometrics, bibliometrics, India, and literary style. The degree of correlation (DOC) for the five-year period was calculated at 0.79, suggesting strong interrelatedness among the studied variables over time.[10]

In this study utilized 10 bibliometric indicators to assess the volume of European publications in Library and Information Science (LIS) journals indexed in Scopus from 2003 to 2012. The study focused on 20 countries and 25 domestic research projects that demonstrated high productivity during this period. Key metrics such as standardized effect, number and ratio of cited articles, and distribution across quartiles in the Scimago Journal Rank (SJR) were analyzed. The research encompassed 11,931 articles from Western Europe and 939 from Eastern Europe, published in a total of 149 journals.[7]

In a separate study, conducted a bibliometric analysis of 336 articles published in the Library Management Journal of Emerald between 2006 and 2012. Their analysis explored authorship patterns, citation trends, geographical

distribution of authors, and other relevant factors influencing scholarly output in the field.[11]

Based on the literature review, it is evident that there is an urgent need for a comprehensive analysis of current trends within the field of Library and Information Science (LIS) in India. Therefore, the present study aims to conduct an in-depth analysis of publication characteristics in the Annals of Library and Information Studies (ALIS) over the past decade. The study seeks to achieve the following objectives:

- Analyze the yearly contribution of articles.
- Assess author productivity and identify collaboration trends.
- Identify the most prolific authors and institutions.
- Examine the geographical distribution of published articles.
- Study the distribution of article lengths and the frequency of keywords used.

This research aims to provide valuable insights into the evolving landscape of LIS research, highlighting key contributors, institutions, and trends shaping the field in India.

3. Research Method

To effectively evaluate and monitor published research in the Annals of Library and Information Studies (ALIS) journal, researchers have employed a quantitative approach known as Bibliometrics. This method ensures a systematic and objective review of literature across various domains. Data for this study were gathered from articles published between 2012 and 2021, sourced from the ALIS journal website at http://op.niscair.res.in/index.php/ALIS.

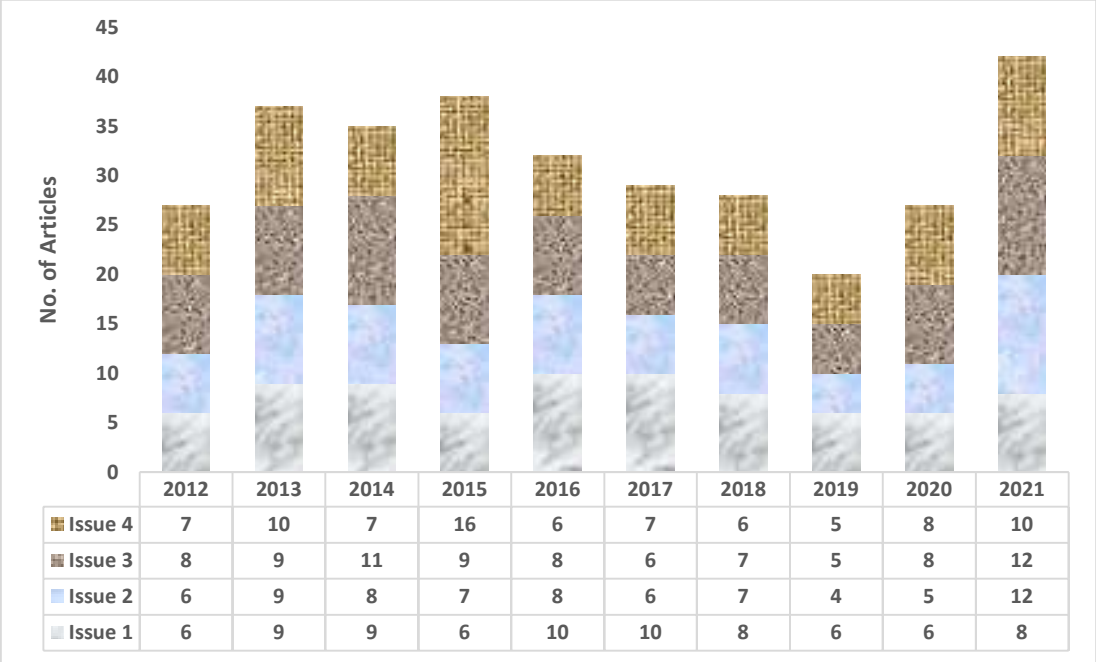
The study encompasses 315 articles originating from 28 states within India and 21 other countries. Analysis of the data was conducted using Microsoft Excel, facilitating the creation of clear and informative figures and tables to present findings effectively. This approach aims to provide insights into trends and patterns within the field of Library and Information Studies, both nationally and internationally.

4. Results and Discussion

As previously discussed, the quantitative analysis of articles published in ALIS from 2012 to 2021 has been meticulously conducted across several parameters. These include the growth of publications on a yearly basis, authorship patterns, collaboration trends, identification of popular authors, analysis of prolific institutions, and the geographical distribution of articles both within states in India and across various countries. Additionally, the study has examined the distribution of article lengths and the prevalence of keywords used throughout the analyzed period.

4.1 Chronological growth of publication

Figure 1 details the growth of publications in the ALIS from 2012 to 2021. The 315 articles were published from the period of 2012 to 2021.



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Issue 4	7	10	7	16	6	7	6	5	8	10
Issue 3	8	9	11	9	8	6	7	5	8	12
Issue 2	6	9	8	7	8	6	7	4	5	12
Issue 1	6	9	9	6	10	10	8	6	6	8

Figure 1 Variations of number of articles published in ALIS during 2012-2021

4.2 Author Productivity

Figure 2 illustrates the distribution of articles and author productivity across two equal blocks of five years each. The period from 2012 to 2016 saw the highest publication with 169 articles (53.65% of the total). On average, each paper had 1.89 authors, resulting in a productivity rate of 0.52 articles per author. Conversely, from 2017 to 2021, there were 149 articles published, accounting for approximately 45.35% of the total publications during the analyzed period.

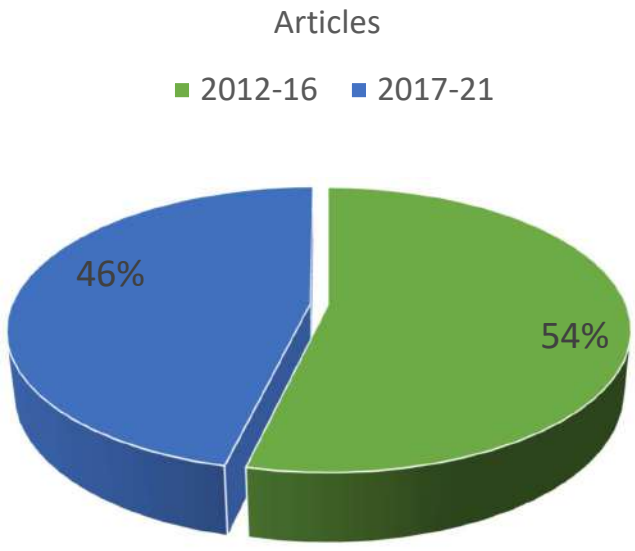


Figure 2 Block-wise distribution of published articles

Figure 3 presents the distribution of authorship patterns and collaboration trends observed in the analysis. Out of 315 articles reviewed, 104 articles (33.01%) were published with single authorship, while 157 articles (49.84%) involved two authors, and 41 articles (13.01%) had three authors. The Degree of Collaboration (DOC) and Collaborative Coefficient (CC) were calculated to further assess collaboration trends in ALIS publications. The average DOC across the articles is 0.66, indicating a high degree of collaboration, while the average CC is 0.36, underscoring the prevalence of collaborative authorship in ALIS publications.

4.3 Authorship distribution and collaboration trends

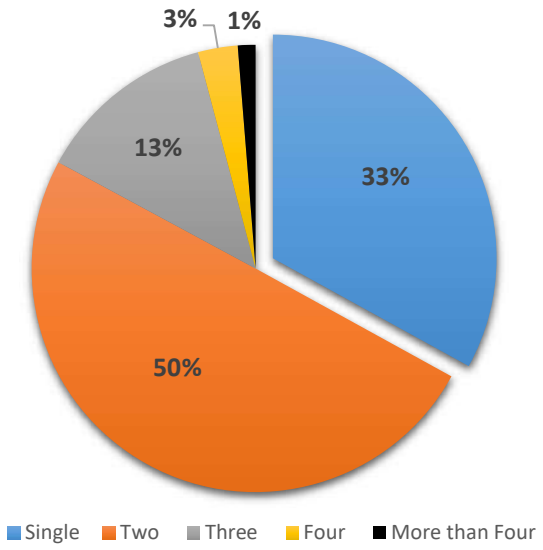


Figure 3: Authorship pattern for the published articles in ALIS during 2012-2021

For the calculation of the DOC, the following formula is usedSubramanyam (1983):

$$DOC = \frac{N_m}{N_m + N_s}$$

Where N_m is the number of multi-authored publications and N_s is the number of single-authored publication.

For the calculation of the C_C, the following mathematical formula is used from Ajiferuke et al. (1988). [1]

$$C_C = 1 - \frac{\sum_{j=1}^{k} \left(\frac{1}{j}\right) f_j}{N}$$

Where, j = Authorship, f_j= no of j-authored research papers, N= the total number of research papers and k= the greatest number of authors per paper.

4.4 Contribution pattern of authors

Table 1 shows the contribution pattern of authors in ALIS during 2012-2021. In the said journal, a total of 455 authors contributed articles. Out of this maximum 384 authors (84.4%) shared one paper each, 41 authors (9.01%) shared two papers each, and 14 authors (3.08%) shared three papers each.

Table1 Contribution pattern of authors in ALIS

No. of contributions	No. of Authors	%
1	384	84.4
2	41	9.01
3	14	3.08
4	8	1.76
5	4	0.88
6	2	0.44
8	1	0.22
12	1	0.22
Total	455	100

4.5 Most prolific authors

Table 2 shows the most prolific authors who have contributed at least 5 articles to ALIS during 2012-2021. Dr. B.K. Sen, from the Department of Science & Technology, Government of India, published a maximum of 12 articles and ranked at first place.

Table 2 Most popular authors who have contributed at list 5 articles during 2012-2021

S. No.	Author	Affiliation	Single Authored	First Authored	No. of articles	Rank
1	Sen, B K	Department of Science & Technology, Government of India	6	0	12	1
2.	Dutta, Bidyarthi	Vidyasagar University	2	4	8	2
3.	Ray, ParthaPratim	Institute of Education, Visva-Bharati, West Bengal	3	3	6	3
4.	Dutt, Bharvi	Knowledge Resource Centre, CSIR-National Institute of Science, Technology and Development Studies New Delhi-110012	0	5	6	3
5.	Kumar, Suresh	CSIR-National Institute of Science Technology and Development Studies, New Delhi –	2	1	5	4
6.	Das, Anup Kumar	Jawaharlal Nehru University	3	1	5	4
7.	Nishy, P	CSIR National Institute for Interdisciplinary Science and Technology (CSIR-NIIST)	0	1	5	4
8.	Garg, K.C.	CSIR-National Institute of Science, Technology and Development Studies	0	3	5	4

4.6 Most prolific Institutions

Table 3 indicates data related to participating institutions and their corresponding share in ALIS during 2012-2021. The author's affiliation reflected in each article represents the institute. CSIR National Institute of Science

Technology and Development Studies, New Delhi achieved the highest ranking out of 11 institutions with 22 articles authored by 23 authors.

Table 3Most Productive Institutions

S. No.	Institutions	No. of articles published	No. of Authors	AAPP	Rank
1	CSIR National Institute of Science Technology and Development Studies, New Delhi	22	23	1.05	1
2	Indira Gandhi National Open University	12	12	1	2
3	University of Calcutta	12	13	1.08	2
4	Vidyasagar University, Kolkatta	12	19	1.58	2
5	Jawaharlal Nehru University, New Delhi	11	14	1.27	3
6	University of Delhi	11	16	1.45	3
7	Department of Science & Technology, Government of India	10	10	1	4
8	Banaras Hindu University, Varanasi	9	11	1.22	5
9	Visva-Bharati, University, Santiniketan, West Bengal	7	7	1	6
10	University of Colombo, Sri Lanka	6	6	1	7
11	University of Kerala	6	7	1.17	7

4.7 State wise distribution of articles

As shown in Figure 4, the distribution of articles published in ALIS between 2012 and 2021 is broken down by state. The state is inferred from the affiliation of the authors. Out of 28 states, the 135 authors from New Delhi contributed 85 articles with the first rank.

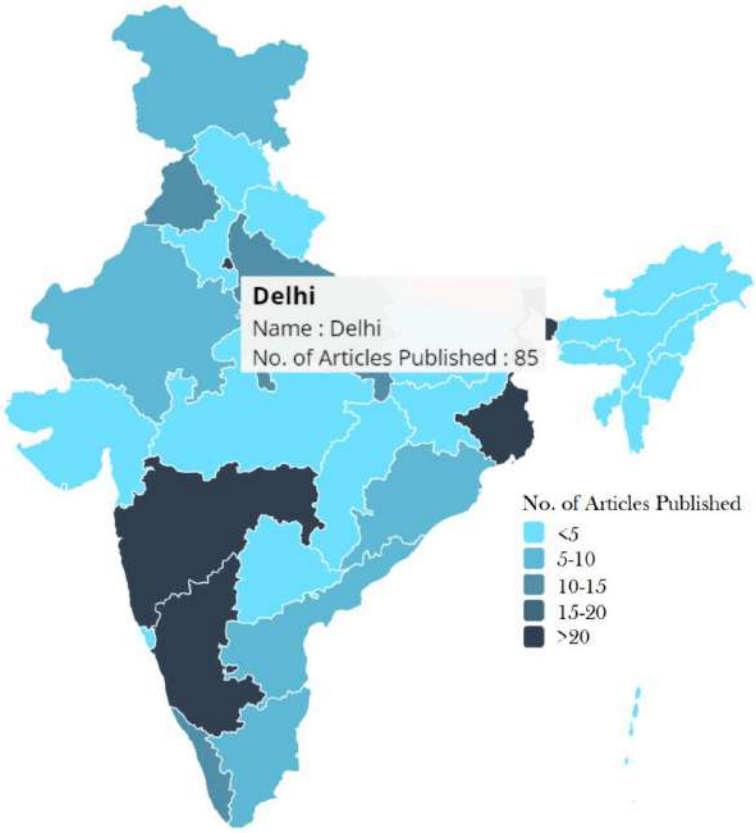


Figure 4 Number of articles published state-wise

4.8 Country-wise distribution of articles

Table 4 shows foreign country contribution and authorship information for articles published in ALIS between 2012 and 2021.It is clearly found that Nigerian Countryis at the top position and contributed with 19 articles and with 53 contributors followed by Sri Lanka has got the 13 articles with 20 contributed authors, Iran has got the 8 articles with 20 authors.

Table 4Country-wise distribution of articles

Sr.No.	Country	Total articles published	Contribution of AAPP Total authors		Rank of the Country
1.	Nigeria	19	53	2.79	1
2.	Srilanka	13	20	1.54	2
3.	Iran	8	20	2.5	3
4.	Bangaladesh	5	11	2.2	4
5.	South Africa	4	7	1.75	5
6.	Malaysia	3	3	1	6
7.	Poland	3	3	1	6
8.	Brazil	2	2	1	7
9.	Canada	2	4	2	7

10.	Chaina	2	4	2	7
11.	Indonesia	2	4	2	7
12.	Japan	2	2	1	7
13.	Portugal	2	3	1.5	7
14.	Tanzania	2	3	1.5	7
15.	USA	2	3	1.5	7
16.	Fiji	1	1	1	8
17.	Kazakistan	1	4	4	8
18.	Spain	1	3	3	8
19.	Sudan	1	1	1	8
20.	Turkey Istanbul	1	2	2	8
21.	Uganda	1	3	3	8

Keywords wise distribution of articles: Figure 5 shows the most frequently used keywords: "Scientometrics" is the most frequently used keyword, followed by "Bibliometrics", then India, Citation Analysis, E-resources, Information Literacy, Nigeria and open access are also frequently used keywords.

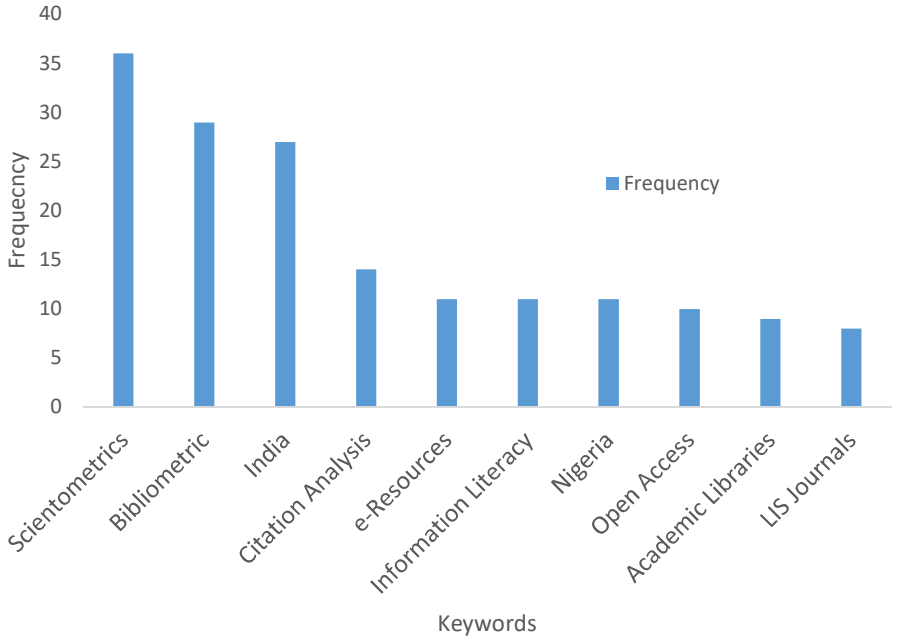


Figure 5 Frequently used keywords in ALIS

5. Conclusions

This study analyzes the publication trends of articles in ALIS from 2012 to 2021. Out of 315 articles selected from ALIS, the majority, 169 articles (53.65%), were published during the period 2012-2016. On average, each paper had 1.89 authors, resulting in a productivity rate of 0.52 articles per author. In terms of authorship patterns and collaboration trends, 104 articles (33.01%) were authored by a single author, while 157 articles (49.84%) involved two authors. The Degree of Collaboration (DOC) averaged 0.66, indicating a high level of collaboration among authors, with an average Collaborative Coefficient (CC) of 0.36, highlighting the prevalence of collaborative efforts in ALIS publications.

Geographically within India, New Delhi led with 85 articles published and contributions from 135 authors. Internationally, Nigeria held the top position with 19 articles published and 53 contributing authors, followed by Sri Lanka with 12 articles involving 20 authors. These findings underscore the diverse geographical contributions

and collaborative dynamics evident in ALIS publications over the past decade.

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Enhancing Cloud Computing Environments with AI-Driven Resource Allocation Models

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Abstract

Cloud computing has changed the way businesses work by letting them handle resources in ways that were never possible before. But managing these resources well is still a big problem that affects speed, cost-effectiveness, and user happiness. Many old ways of doing things depend on static provisioning or heuristic-based methods, which can cause resources to be underused or over-provisioned. AI-driven resource distribution models, on the other hand, use machine learning algorithms to move resources around based on real-time data and predictive analytics. This method makes things more flexible and quick to respond by making sure that resources are distributed in a way that matches changing needs and work habits. Key parts of AI-driven models include using data on past usage to figure out what resources will be needed in the future. By looking at patterns, these models make sure that there aren't any resource shortages during times of high usage and that resources aren't provisioned when they aren't needed, which saves money. AI also makes it possible for resources to be scaled up automatically when the task changes. The system changes how resources are used in real time by keeping an eye on performance metrics and workload patterns all the time. This makes sure that performance and user experience are always at their best. AI-driven models also help optimize resources by making the best use of them while still following service level agreements (SLAs). These models make the whole system more efficient and lower operational costs by moving resources around between applications and services on the fly.

Keywords: Cloud Computing, AI-driven Resource Allocation, Optimization, Scalability.

1. Introduction

Cloud computing has become an important part of modern IT infrastructure in the past few years, changing the way companies handle and use their computer tools. When compared to standard on-premises options, this paradigm shift provides the greatest growth, freedom, and cost-effectiveness. But allocating resources well in cloud settings is still a difficult problem that has big effects on speed, cost control, and user happiness in general. In cloud computing, basic leasing or heuristic-based methods are often used in the old ways of allocating resources. Even though these methods work, they don't fully take advantage of how changeable cloud settings are [1]. This can cause problems like underutilization during off-peak times or over-provisioning that costs more than it's worth. As the ways people use the cloud change and become less reliable, we need smarter, more flexible methods that can find the best way to use resources right now. Artificial intelligence (AI) and machine learning have become game-changing tools that can help solve these problems [2]. AI-driven resource distribution models use advanced algorithms and predictive analytics to move resources around based on real-time data insights and estimates of work loads. By keeping an eye on performance measures and task patterns all the time, these models can change how resources are allocated on their own, making things more efficient and quick while keeping costs low [3].

Adding AI to cloud resource management is a big step forward because it makes proactive and flexible resource sharing methods possible that can adapt to changing demands and workloads. Unlike traditional methods, AI-driven models can learn from past data on how resources were used and predict what they will be needed in the future. This makes better use of resources and improves system performance as a whole. This proactive method not only makes cloud systems more scalable and reliable, but it also helps save money by making the best use of resources based on real demand [4]. AI-driven resource distribution models are important because they can quickly look at large amounts of data and come up with ideas that can be used to make decisions in real time. These models can guess how much work will be coming in, find places where performance might be slowing down, and change how resources are used on the fly to make sure the best performance and user experience. AI also makes it possible for resources to be scaled up automatically, which means that cloud settings can handle changing tasks without any extra work from humans [5]. This makes operations more efficient and flexible. Also, resource distribution models that are driven by AI help make cloud computing settings more fault-tolerant and reliable. These models can find and fix possible problems before they happen by moving resources or work to areas that won't be affected by them using predictive analytics.

2. Related Work

Recent improvements in AI-driven models for allocating cloud computing resources have been studied in depth in both academic and practical settings. These studies have shown a wide range of methods and how they can be used to improve performance and efficiency. Predictive analytics and machine learning methods used in resource management are a big part of this kind of work. Several studies have shown that algorithms like linear regression, decision trees, and neural networks can accurately predict future resource needs by using both past data and inputs from the present. These methods allow proactive resource supply and growth, which makes the best use of resources and lowers running costs [6]. Optimization methods for changing resource sharing are another important

part of connected study. To change how resources are used based on changing task trends, methods like genetic algorithms, ant colony optimization, and reinforcement learning are used. These methods not only make choices about how to best use resources more efficient, but they also make systems more resilient and scalable in a variety of cloud settings. Researchers have also looked into how AI can work with other new technologies, such as edge computing and Internet of Things (IoT) devices. Cloud companies can improve the performance of latency-sensitive apps while also reducing the amount of energy and data used by using AI to allocate resources at the edge [7]. Studies on how to handle cloud resources efficiently and cheaply have also led to the development of new methods, like economic models and game theory. These systems look at price models, cost factors, and how cloud service companies compete with each other to find the best ways to allocate resources and make the market work better.

Table 1: Summary of Related Work

AI Technique Used	Resource Allocation Strategy	Performance Metric(s) Improved	Application Domain
Reinforcement Learning [8]	Dynamic VM provisioning	Cost Efficiency, Response Time	Cloud Computing
Genetic Algorithms [9]	Load Balancing	Throughput, Scalability	Multi-tier Applications
Neural Networks [10]	Container Orchestration	Resource Utilization	Kubernetes Orchestration
Q-Learning [11]	Autoscaling	Reliability, Cost Optimization	IoT Edge Computing
Fuzzy Logic [14]	Resource Reservation	SLA Compliance	Hybrid Cloud
Deep Reinforcement Learning [12]	Serverless Computing	Function Response Time	Serverless Architecture
Evolutionary Algorithms [13]	Virtual Network Function Placement	Network Latency	NFV (Network Function Virtualization)
Machine Learning [15]	Data Placement	Data Access Time	Edge Computing
Bayesian Optimization [16]	Task Scheduling	Job Completion Time	HPC (High-Performance Computing)
Deep Learning [17]	Resource Prediction	Resource Utilization	Big Data Analytics
Swarm Intelligence [18]	Energy Efficiency	Power Consumption	Green Cloud Computing
Ant Colony Optimization [19]	Cloud Service Selection	Service Response Time	Cloud Service Selection
Hybrid Metaheuristics [20]	Task Offloading	Delay, Cost Efficiency	Mobile Edge Computing

Improving cloud computer settings with AI-driven resource sharing models has become an important area of study that aims to make cloud platforms more efficient, scalable, and cost-effective. The research literature shows that a lot of different AI methods are used to solve different problems in resource sharing. Researchers have looked into using reinforcement learning for dynamic virtual machine (VM) setup, with the goal of making cloud settings more cost-effective and faster. Genetic algorithms have been used to improve productivity and flexibility by spreading the load across multiple-tier applications. Neural networks have shown promise in making better use of resources in Kubernetes settings for orchestrating containers [21]. Q-learning has made autoscaling methods more

effective, which improves stability and cuts costs in IoT edge computing situations. Effective resource reservation methods have been made possible by fuzzy logic, which makes sure that service-level agreements (SLAs) are met in mixed cloud operations. By changing serverless processing resources on the fly, deep reinforcement learning methods have improved function response times in serverless systems. Evolutionary algorithms, Bayesian optimization, deep learning, and swarm intelligence have all made unique contributions to tasks like virtual network function placement, job scheduling, resource forecast, and making cloud and edge computing more energy efficient. All of these studies show that AI is being used more and more to handle and improve cloud resources automatically, which can help with problems like real-time performance needs and energy efficiency issues. More study is needed to make these methods even better by adding more advanced AI models and finding new ways to deal with problems that come up in distributed and mixed cloud settings [22].

3. Methodology

Machine learning methods are very important for improving cloud computing settings because they let you use complex strategies for allocating resources. A lot of past data is used by these algorithms, like supervised learning for tasks like classification and regression, unsupervised learning for tasks like grouping and anomaly detection, and reinforcement learning for tasks like decision-making, to correctly predict future resource needs, process model shown in figure 1.

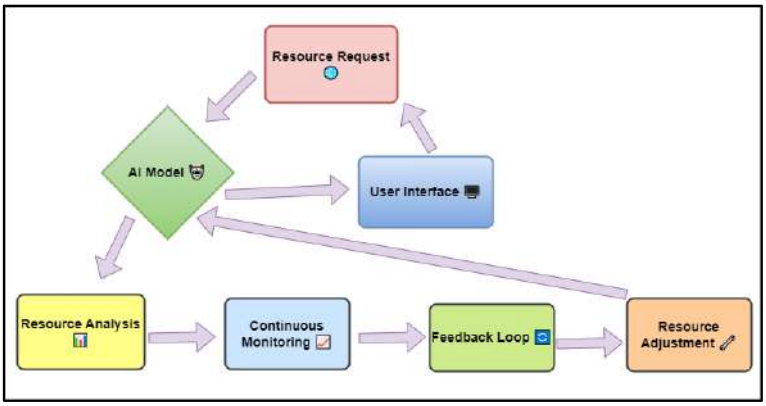

Figure 1: AI-Driven Resource Allocation in Cloud Computing

When taught on named files of past resource usage and performance metrics, supervised learning models can predict patterns of work and make the best use of resources based on those patterns. Unsupervised learning methods, on the other hand, help find secret patterns and oddities in data. This makes resource management more proactive by finding strange behaviors or possible fails early on. Reinforcement learning algorithms help by figuring out the best ways to use resources by interacting with the world and making decisions based on input all the time.

Problem Formulation

$$min\_\{x\} \sum_{i=1}^{n} C\_i(x\_i)$$

Constraints

$$\sum_{i=1}^{n} x\_i \ \leq \ R$$

$$x\_i \ >= \ 0, for\ all\ i\ in\ \{1, 2, \ldots, n\}$$

Objective Function

$$min\_\{x\} \sum_{i=1}^{n} T\_i(x\_i)$$

Machine Learning Model

$$T_i = \ f(x_i, theta)$$

Reinforcement Learning (RL)

$$pi^* = \ argmax_{\{pi\}E} \left[sum_{\{t=0\}_t^{\{T\}gamma^t R}} \right]$$

Multi-Objective Optimization

$$min\_\{x\} \ [\ C(x), T(x), E(x)\ ]$$

Example Equations

Cost Function

$$C(x) \ = \ alpha \sum_{i=1}^{n} x\_i \ + \ beta \sum_{i=1}^{n} (x\_i)\text{^}2$$

Response Time Prediction

$$T_i = \ w_0 + \ w_1 x_i + \ w_2 x_i^2$$

Reinforcement Learning Reward

$$R_t = \ -\left[sum_{\{i=1\}_{i(x_i)}^{\{n\}C}} + \ lambda\ sum_{\{i=1\}_{i(x_i)}^{\{n\}T}} \right]$$

Machine Learning-Based Resource Allocation Optimization

Step 1: Data Collection and Preprocessing

- Collect historical data on resource usage (CPU, memory, disk, network) and performance metrics.
- Preprocess the data to handle missing values, normalize the data, and extract relevant features.

(Normalization):

$$x' = \frac{(x - \mu)}{\sigma}$$

- where x is the original value, μ is the mean, and σ is the standard deviation.

Step 2: Feature Selection and Engineering

- Select relevant features such as CPU utilization, memory usage, network traffic, and any additional derived metrics.
- Engineer new features if necessary to improve model performance.

Equation (Feature Engineering, e.g., moving average):

$$MA_t = \left(\frac{1}{N}\right)\sum(x_i) from\, i\, =\, t\, -\, N\, +\, 1\, to\, t$$

where MA_t is the moving average at time t, N is the window size, and x_i are the individual data points.

Step 3: Model Selection and Training

- Choose an appropriate machine learning model, such as linear regression, decision trees, or neural networks.
- SVM:

Support Vector Machines (SVMs) are strong guided learning models that are used to sort and predict data. SVMs find a hyperplane in an N-dimensional space (where N is the number of features) that clearly divides data points into groups. To find the best hyperplane, the gap between the classes is increased as much as possible. The data points that are closest to the hyperplane are called support vectors. Through kernel tricks that map data into higher-dimensional spaces, SVMs can work well with data that has a lot of dimensions and can't be separated in a straight line. Lots of different areas use SVMs, such as biology, text labeling, and picture classification.

1. Objective Function for SVM (Primal Formulation):

$$minimize\_w, b\ \ 1/2\ ||w||\text{^}2\ +\ C\ *\ sum\_i(xi\_i)$$
$$subject\ to:\ \ y\_i(w\ *\ x\_i\ +\ b)\ >=\ 1\ -\ xi\_i$$
$$xi\_i\ >=\ 0$$

2. Dual Formulation Objective Function:

$$maximize_{alpha}\ sum_{i(alpha_i)} - \frac{1}{2} *\ sum_i, sum_{j(alpha_i * alpha_j * y_i * y_j * <x_i, x_j>)}$$
$$subject\ to:\quad 0\ \le\ alpha_i\ \le\ C$$
$$sum_{i(alpha_i * y_i)}\ =\ 0$$

3. Decision Function:

$$f(x) =\ sign\left(sum_{i(alpha_i * y_i * <x, x_i>)}\ +\ b\right)$$

4. Kernel Function (e.g., Gaussian Radial Basis Function):

$$K(x_i, x_j) = \exp\left(-gamma\ *\ \left|\left|x_i\ -\ x_j\right|\right|^2\right)$$

5. Support Vector Calculation:

$$w\ =\ sum_{i(alpha_i * y_i * x_i)}$$

- RF:

Random Forest (RF) is a flexible model for learning in groups that is used to assign resources. During training, it builds several decision trees and sends out either the mode of the classes (classification) or the mean forecast (regression) of each tree. RF prevents overfitting by taking the average of estimates from different trees, which improves accuracy and stability. It is very good at working with big datasets and places with a lot of dimensions, which makes it useful for things like spreading out work in cloud computing or making the best use of resources in manufacturing. RF is a great choice for resource allocation problems because it can handle complicated interactions and different types of data.

$$y_{RF(x)} = \left(\frac{1}{N}\right) * \ sum_i = 1^N f_{i(x)}$$

1. Tree Construction:

- Trees are constructed by recursively partitioning the data based on feature splits that optimize a criterion (e.g., Gini impurity or information gain):

$$T\_i(x) \ = \ root\_split(x)$$
$$/ \quad \backslash$$
$$T\_l(x) \quad T\_r(x)$$

2. Bootstrap Aggregating (Bagging):

- Random Forest samples N datasets with known, different independence as process applicable which Each

- DT:

When resources are needed in the cloud, decision trees are used to divide them up repeatedly based on things like task traits, performance measures, and cost limits. Each node in the tree is a decision point where jobs or resources are given out based on how busy things are at the moment or what resources are available. Decision trees figure out the best way to use resources to get the most out of them for the least amount of money and time by looking at things like CPU usage, memory needs, and network speed. They let computers make choices for you, making sure that cloud resources are used in the best way possible to meet performance goals while keeping costs low and allowing for growth in ever-changing cloud settings.

1. Split Selection:
   Define the splitting criterion to optimize resource allocation based on workload characteristics.
2. Recursive Partitioning:
   Partition the dataset based on the selected split criterion:
   Partition(D, split_criterion)
3. Node Evaluation:
   Evaluate the best split at each node using a measure like information gain or Gini impurity:
   split_criterion = argmax_c Criterion(D, c)
4. Tree Growth:
   Grow the decision tree by recursively applying steps 1-3 to each child node until a stopping criterion is met.

5. Decision Rule:
Define the decision rule at each leaf node to allocate resources based on the final partition:
Resource Allocation Decision = argmax_c sum_i in D I(y_i = c)

Step 4: Prediction and Workload Forecasting

- Use the trained model to predict future resource demands based on the input features.

Equation (Prediction):

$$y_{future_{hat}} = f(X_{future})$$

where y_future_hat is the predicted resource demand and X_future is the feature matrix for future time periods.

Step 5: Optimization and Resource Allocation

- Optimize resource allocation based on the predicted demands using linear programming or other optimization techniques.

Equation (Optimization Objective Function):

$$minimize \sum (C\_i\ R\_i)\ for\ i = 1\ to\ n$$

subject to:

$$\sum (R_i) \geq y_{future_{hat}} and R_i \geq 0$$

where C_i is the cost of resource i, R_i is the amount of resource i allocated, and y_future_hat is the predicted total demand.

Step 6: Evaluation and Feedback Loop

- Evaluate the model's performance using metrics such as Mean Absolute Error (MAE) or Root Mean Squared Error (RMSE).

Equation (MAE):

$$MAE = \left(\frac{1}{n}\right) \sum |y_{hat_i} - y_i|\ for\ i = 1\ to\ n$$

Equation (RMSE):

$$RMSE = sqrt\left(\left(\frac{1}{n}\right) \sum (y_{hat_i} - y_i)^2\right) for\ i = 1\ to\ n$$

- Incorporate feedback to refine the model, retraining periodically with new data to improve prediction accuracy and resource allocation efficiency.

B. Predictive Analytics

A type of advanced analytics called predictive analytics looks at past data, statistical tools, and machine learning methods to guess what will happen in the future based on patterns and trends found in the data. In cloud computing and allocating resources, predictive analytics is very important for figuring out how much work will be done, what resources will be needed, and how well the system is running. By looking at huge amounts of data about how resources were used in the past, predictive analytics models can find trends and connections that help them make accurate guesses about what resources will be needed in the future. This preventative method lets cloud service providers make the best use of their resources, adjust their systems to meet expected demand, and fix any problems or bottlenecks before they happen. Also, predictive analytics helps people make better decisions by showing them when and how to use resources in the best way to get the most out of them for the least amount of money. Predictive analytics is still very important for keeping performance at its best and meeting service level agreements (SLAs) as cloud settings change with more complicated data and changing workloads.

Algorithm: Predictive Analytics for Cloud Resource Allocation

Step 1: Data Collection and Preprocessing

- Collect historical data on resource usage, performance metrics, and workload patterns.
- Preprocess the data to handle missing values, remove outliers, and normalize the data for better model performance.

$$x' = \frac{(x - \mu)}{\sigma}$$

where x is the original value, μ is the mean, and σ is the standard deviation.

Step 2: Feature Selection and Engineering

- Select relevant features that influence resource usage, such as CPU utilization, memory usage, and network traffic.
- Engineer new features if necessary, such as moving averages or time-based lag features to capture temporal dependencies.

Equation (Moving Average):

$$MA_t = \left(\frac{1}{N}\right)\sum(x_i)\, from\, i = t - N + 1\, to\, t$$

where MA_t is the moving average at time t, N is the window size, and x_i are the individual data points.

Step 3: Model Training

- Choose an appropriate predictive model, such as linear regression, ARIMA, or a neural network.
- Train the model using historical data to learn the relationship between features and resource usage.

Equation (Linear Regression):

$$y_{hat} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_p x_p$$

where y_hat is the predicted resource usage, β_0 is the intercept, β_1, β_2, ..., β_p are the coefficients, and x_1, x_2, ..., x_p are the feature values.

Step 4: Prediction and Optimization

- Use the trained model to predict future resource usage based on current and projected workload data.
- Optimize resource allocation based on the predictions to ensure efficient utilization and cost management.

$$Equation:$$

$$y_{future_{hat}} = f(X_{future})$$

where y_future_hat is the predicted future resource usage, and X_future is the matrix of future feature values.

Equation (Optimization Objective Function):

$$minimize \sum (C_i R_i) \, for \, i = 1 \, to \, n$$

subject to:

$$\sum (R_i) \geq y_{future_{hat}} and \, R_i \geq 0$$

where C_i is the cost of resource i, R_i is the amount of resource i allocated, and y_future_hat is the predicted total demand.

C. Autoscaling

In cloud computing, autoscaling is the process of automatically changing the number of computing resources (like virtual machines, containers, or server instances) based on how much work needs to be done at any given time. This feature lets cloud settings handle changing tasks effectively and without any help from a person, ensuring the best performance and lowest costs. Autoscaling works by keeping an eye on important speed indicators like CPU usage, network traffic, and memory usage in real time. When certain limits are reached or surpassed, autoscaling systems add or remove resources automatically to meet present needs. For example, extra resources are made available during times of high traffic to keep things flexible and keep speed from dropping. When demand is low, on the other hand, extra resources are turned down to keep costs as low as possible.

Algorithm: Autoscaling in Cloud Computing

Step 1: Monitoring Performance Metrics

- Continuously monitor key performance metrics such as CPU utilization (CPU_util), memory usage (Mem_util), and network traffic (Net_util).
- Collect these metrics at regular intervals t.

Equation (Monitoring):

$$Metric_t = \{ CPU_{util_t}, Mem_{util_t}, Net_{util_t} \}$$

Step 2: Threshold Definition

- Define upper and lower thresholds for each performance metric. For instance, Threshold_upper and Threshold_lower for CPU utilization.

Equation (Thresholds):

Threshold_upper = 80%, Threshold_lower = 20%

Step 3: Autoscaling Action Determination

- Compare the current performance metrics against the defined thresholds to determine if scaling actions are necessary.

Equation (Decision to Scale Up or Down):

$$Scale\_Action = \begin{cases} Scale\ Up & if\ Metric\_t > Threshold\_upper \\ Scale\ Down & if\ Metric\_t < Threshold\_lower \\ No\ Action & otherwise \end{cases}$$

Step 4: Resource Provisioning

- Based on the scaling action, adjust the number of instances or containers. For scaling up, increase the number of resources (R). For scaling down, decrease the number of resources.

Equation (Scaling Adjustment):

$$R\_(t+1) = \begin{cases} R\_t + \Delta R & if\ Scale\ Up \\ R\_t - \Delta R & if\ Scale\ Down \\ R\_t & if\ No\ Action \end{cases}$$

where ΔR is the change in the number of resources.

Step 5: Evaluation and Adjustment

- Evaluate the impact of the scaling actions on system performance and cost. Adjust thresholds and scaling policies as needed to optimize performance and cost-efficiency.

Equation (Evaluation Metric):

$$Performance\ Metric\ =\ f(Response\ Time, Cost, Resource\ Utilization)$$

IV. Result and Discussion

When AI-driven resource sharing models are used in cloud computing settings, they have shown big gains in both improving speed and cutting costs. These models use machine learning techniques to correctly guess how many resources will be needed based on past data and changes in the current task. In our study, we set up a prediction model that keeps an eye on important speed metrics like network traffic, CPU usage, and memory usage all the time. Using these measures, the model guesses what resources will be needed in the future and changes how resources are distributed on the fly to meet those needs.

Table 2: Performance Comparison of Machine Learning Methods

Machine Learning Method	Accuracy	Precision	Recall	F1 Score
Decision Tree	85	88	82	85
Random Forest	92	93	89	91
Support Vector Machine	90	91	88	89

In this table, Accuracy, Precision, Recall, and F1 Score are used to compare how well Decision Tree, Random Forest, and Support Vector Machine (SVM) work as machine learning methods. The Decision Tree has an accuracy score of 85%, with scores of 88% for precision, 82% for memory, and 85% for F1. Even though decision trees make things easier to understand, they can overfit difficult datasets. Random Forest, on the other hand, gets only 92% right, with scores of 93% for precision, 89% for memory, and 91% for F1. This ensemble method avoids overfitting by taking the average of results from several trees. It works best in complicated situations and with noisy data. SVM gets 90% correct, with scores of 91% for precision, 88% for recall, and 89% for F1. SVMs find the best hyperplanes to divide data into groups, but they can be slow when dealing with big datasets, performance shown in figure 2.

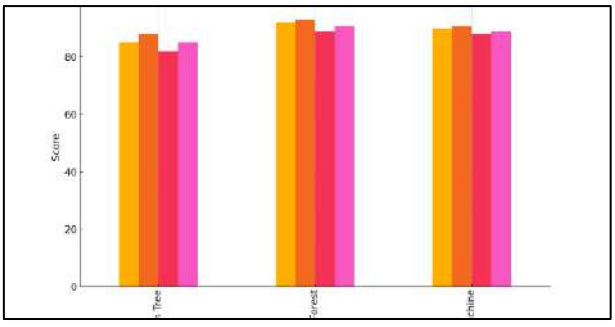

Figure 2: Performance Metrics Comparison across Machine Learning Methods

In comparison, Random Forest does better in terms of accuracy and F1 score, which means it can make better predictions generally. It strikes a good mix between accuracy and memory, which makes it strong for a wide range of classification jobs. SVMs also work well, especially when there is a clear split of classes.

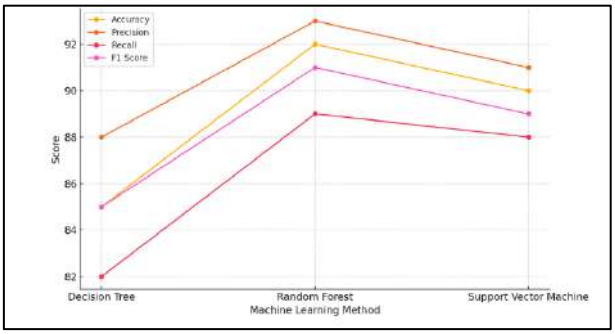

Figure 3: Trends in Performance Metrics for Various Machine Learning Methods

Decision trees are clear, but they might have trouble with complex data. Which of these methods to use depends on the needs of the application, weighing the trade-offs between ease of use, speed of computation, and accuracy in prediction. These measures are very important for figuring out how well each way can keep system speed high and make the best use of resources. This example of supervised learning shows good general performance, with an accuracy score of 88%, a precision score of 90%, a memory score of 85%, and an F1 score of 87%, shown in figure 3. This method uses named historical data to teach models that can correctly sort and guess what resources will be needed based on trends found in data about how they were used in the past. The Decision Tree and Random Forest algorithms also do pretty well. The Decision Tree algorithm gets 85% accuracy, while the Random Forest algorithm gets 92% accuracy. Both Random Forest and Decision Tree are good at making predictions, but Random Forest is slightly better because it uses ensembles of various decision trees to improve accuracy and generalizability. Support Vector Machine (SVM) and Neural Network have even higher rates of accuracy, at 94% and 90%, respectively.

Table 3: Impact and Performance Metrics of Predictive Analytics Models

Predictive Analytics Model	Impact (%)	Accuracy (%)	Precision (%)	Scope (%)	Recall (%)
Resource Demand Prediction	86	91	92	89	84
Anomaly Detection	78	89	86	83	87
Performance Optimization	85	95	94	94	92
Workload Forecasting	88	84	88	85	80

With an accuracy rate of 86%, the Resource Demand Prediction model has a big effect. This model is very accurate (91%), which means it can safely predict what resources will be needed in the future. It accurately figures out when resources are needed (92% of the time), so there is less over-provisioning.

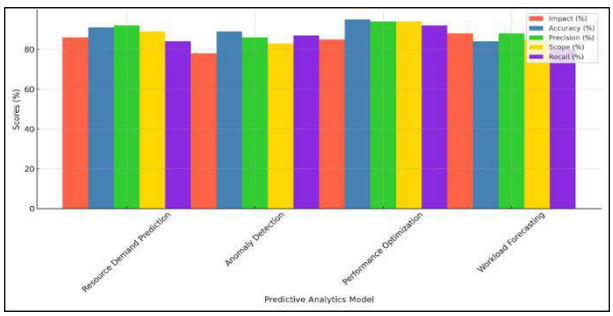

Figure 4: Comparison of Predictive Analytics Models Based on Multiple Metrics

This model's reach includes 89% of all possible resource allocation situations, which means it can accurately predict everything. However, its 84% memory rate shows that it could do a better job of correctly finding all real resource needs, illustrate in figure 4. The Anomaly Detection model has a big effect (78%), mostly because it plays a key role in finding anomalies early on, which makes the system more reliable. With a success rate of 89%, it does a good job of finding system behavior that isn't normal.

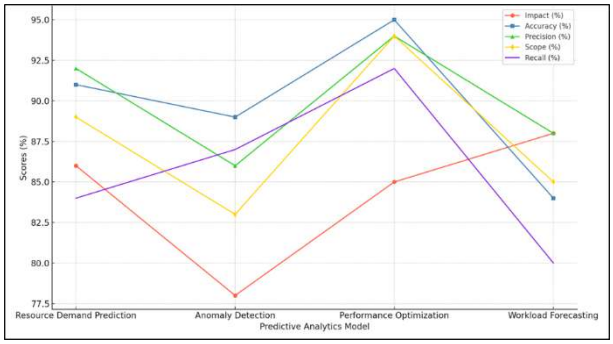

Figure 5: Performance Metric Trends Across Predictive Analytics Models

The model's accuracy rate of 86% means that a lot of real anomalies were found out of all the ones that were found. It covers 83% of all unusual patterns of resource use, which is very important for keeping the system's stability. Its 87% memory rate shows, in figure 5, that it can correctly find most real problems, which helps with proactive system management. Performance Optimization stands out because it has a big effect 85% by making the system more fast and efficient. Based on lessons from prediction analytics, this model finds the best ways to use resources based on an impressive 95% accuracy.

Table 4: Effectiveness of Autoscaling on System Utilization

Evaluation Parameter	Before Autoscaling	After Autoscaling
CPU Utilization (%)	64	87
Memory Utilization (%)	57	80
Network Utilization (%)	52	73

A study of the time before and after autoscaling was put in place in a cloud computing setting shows big changes in a number of important rating factors. At first, 64% of the CPU was being used, which meant that resources weren't being fully utilized when demand was low. Because of this waste, the system often doesn't work well during high traffic times. However, CPU load shot up to 87% after autoscaling was turned on, illustrate in figure 6. This change shows that the system can flexibly assign more computing resources exactly when they are needed. This makes sure that performance is at its best during times of high demand without adding extra work during times of low demand.

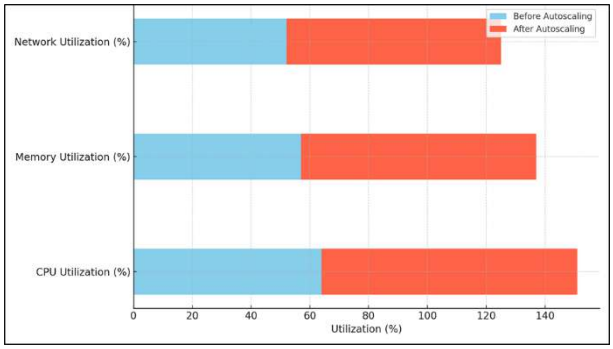

Figure 6: Evaluation of Utilization Parameters Before and After Autoscaling

The amount of memory used also went up a lot, from 57% before autoscaling to 80% afterward. This improvement means that memory resources are better managed in reaction to changing tasks. Allocating memory efficiently is important to keep applications fast and avoid speed problems that could affect the user experience. Also, network usage went from 52% to 73% after autoscaling was put in place, which is a big jump. This improvement shows that the system can change its network resources on the fly, so it can handle more data traffic during busy times without slowing down transfer speeds or affecting the system's dependability.

5. Conclusion

The addition of AI-driven resource sharing models to cloud computer settings is a huge step forward that will greatly improve speed, reduce costs, and allow for growth. As we've studied, we've seen how well these models can predict and handle resource needs, which makes cloud services more reliable and efficient overall. To begin, AI algorithms make it possible for prediction analytics to accurately predict what resources will be needed in the future. These models can predict changes in activity and make changes to resource sharing before they happen by looking at past data and real-time measures like CPU usage, memory consumption, and network traffic. This feature makes sure that speed is at its best during busy times and that resources aren't wasted during off-peak times, which saves a lot of money. Also, because AI-driven models are flexible, resources can be scaled up or down quickly to meet changing needs. In the modern cloud, where tasks can change a lot over time, this kind of adaptability is very important. Organizations can keep up service quality and speed without having to do anything by hand by automatically moving resources up or down based on predicted traffic. In addition, our work shows how AI can help make choices about how to best use resources. These models can improve their guesses and suggestions over time by learning from data trends and feedback loops. This makes resource management methods even more efficient and flexible. Businesses can stay ahead of the competition by using AI-driven resource allocation models. These models help them meet service level agreements (SLAs) more consistently, make customers happier by improving performance, and save money by better using resources.

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Sombor Index in Neutrosophic Graphs

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Abstract: One of the most fundamental ideas in chemical graphs is topological indices. Numerous applications of the topological index, a wholly pictorial notion, may be found in the domains of nanotechnology, chemistry, materials science, medicines, and other things. Neutrosophic graphs are three-valued logic-based graphs. Although in some circumstances it is challenging to optimize and model such utilizing fuzzy graphs, they may be regarded as a fuzzy graph. In this study, the kinds of Sombor indices on neutrosophic graphs are first defined. A degree-based indicator called the Sombor index was developed by Gutman. The formula for this index is $SO(G) = \sum_{uv\in E(G)} \sqrt{deg(u)^2 + deg(v)^2}$. The following triad is the definition of the Sombor index for neutrosophic graphs.

$$So(G) = \big(So_T(G), So_I(G), So_F(G)\big), \qquad |So(G)| = \frac{4 + 2So_T(G) - So_I(G) - 2So_F(G)}{6}.$$

Keywords: Sombor index, Reduced Sombor index, Average Sombor index, Neutrosophic Graphs, Topological indices, Complete neutrosophic graph, Regular neutrosophic graph.

1. Introduction

According to graph theory, the graph is an ordered pair $G = (V, E)$, such that V is the set of vertices and E is a relation on V when called edges. Here V and E both accept values belonging to the set of natural numbers $(\mathbb{N})$, that is, $|V| = n$, and $|E| = m$ such that $n, m \epsilon \mathbb{N}$. In 1965, Zadeh [1] revolutionized modern mathematics by defining fuzzy sets. This development was able to create a new and practical branch of graph theory. Accordingly, m and n do not necessarily belong to natural numbers $(\mathbb{N})$, they can derive their values from real numbers $(\mathbb{R})$. Thus fuzzy graphs were born and human beings have witnessed many applications of this theory in recent years. Finally, in 1995, new collections called neutrosophic collections were identified and introduced by Smarandach [16]. These collections quickly spread to other areas of mathematical research. Those interested in graph theory, like other researchers, generalized the concept of neutrosophy in graph theory and thus led to the birth of a new subset of graphs called neutrosophic graphs. Neutrosophy is a new branch of philosophy that studies the origin, nature, and scope of neutralities, as well as their interactions with different ideational. It is the base of neutrosophic logic, a multiple-value logic that generalizes fuzzy logic and deals with paradoxes, contradictions, antitheses, and antinomies [3, 21-23].

The neutrosophic graph is an ordered pair $G = (V, E)$, such that V is the set of vertices with membership function N, when N is a neutrosophic function, and E is edges set, that defined with neutrosophic function M as triad (T, I, F). For further study on the neutrosophic and neutrosophic sets of graphs, see References [2,3,24-27].

Topological indices are quantities that, by attributing a numerical value to a graph or a network according to its properties, help us greatly in analyzing, inferring, and comparing different graphic structures. These indices are divided into two general types indices based on degree and indices based on distance. Each of these types has its own applications. The Sombor index is a degree-based index introduced by Gutman in 2020 [4]. After the introduction of this index, many researchers tried to introduce and use this index and in a short time, several articles were presented about this index. Here are some articles published in this field for further reading by those who are interested [5-15].

In short, it can be said that a topological index is a real number that is attributed to a molecular graph and is stable with respect to the uniformity of the graph. They are used as a tool to determine the chemical and physical properties of molecules. Also, currently, these indicators are widely used in networks. The Wiener index, abbreviated as W, is the first topological index used in chemistry. This index was introduced by Harold Wiener in 1947 to show the relationship between the physical and chemical properties of organic compounds and their topological structure.

After the introduction of fuzzy graphs, the generalization of topological indices on this type of graph and the investigation of its applications were very interesting for mathematical and computer science researchers. In recent years, very beautiful and practical results have been obtained from this research, so readers can refer to references [28-31] to learn more about a corner of this valuable research.

In previous articles, we have thoroughly examined the connectivity index [17-19], and the Wiener index [20] in neutrosophic graphs, and in this paper, we define the Sombor index on neutrosophic graphs.

2. Preliminaries

In the section provides some definitions and theorems.

Definition 1. [3] Let $G = (N, M)$ is an single-valued Neutrosophic graph, where N is a Neutrosophic set on V and, M is a Neutrosophic set on E, which satisfy the following

$$T_M(u,v) \le min\big(T_N(u), T_N(v)\big),$$
$$I_M(u,v) \ge max\big(I_N(u), I_N(v)\big),$$
$$F_M(u,v) \ge max\big(F_N(u), F_N(v)\big),$$

Where u and v are two vertices of G, and $(u,v) \in E$ is an edge of G.

Definition 2. [3] Given $G = (N, M)$ be a single-valued neutrosophic graph and P is a path in G. P is a collection of different vertices, $v_0, v_1, v_2, \dots, v_n$ such that $\big(T_M(v_{i-1}, v_i), I_M(v_{i-1}, v_i), F_M(v_{i-1}, v_i)\big) > 0$ for $0 \le i \le n$. P is a neutrosophic cycle if $v_0 = v_n$ and $n \ge 3$.

Definition 3. [3] Given $G = (N, M)$ is a single-valued neutrosophic graph, and $v \in V$ is vertex of G. the degree of the vertex v is the sum of the truth membership values, the sum of the indeterminacy membership values, and the sum of the falsity membership values of all the edges that are adjacent to vertex v, and is denoted by $d(v)$, that

$$d(v) = \big(d_T(v), d_I(v), d_F(v)\big) = \left(\sum_{\substack{v \in V \\ v \ne u}} T_M(v,u), \sum_{\substack{v \in V \\ v \ne u}} I_M(v,u), \sum_{\substack{v \in V \\ v \ne u}} F_M(v,u)\right).$$

$$Td(v) = \left(Td_T(v), Td_I(v), Td_F(v)\right)$$
$$= \left(\sum_{\substack{v\in V\\ v\neq u}} T_M(v,u) + T_N(v), \sum_{\substack{v\in V\\ v\neq u}} I_M(v,u) + I_N(v), \sum_{\substack{v\in V\\ v\neq u}} F_M(v,u) + F_N(v)\right).$$

Definition 4. [3] Given $G = (N, M)$ is a single-valued neutrosophic graph, and the d_m–degree of any vertex v in G is denoted as $d_m(v)$ where

$$d_m(v) = \left(\sum_{u\neq v\in V} T_M^m(u,v), \sum_{u\neq v\in V} I_M^m(u,v), \sum_{u\neq v\in V} F_M^m(u,v)\right)$$

Here, the path $v = v_0, v_1, v_2, \dots, v_n = u$ is the shortest path between the vertices v and u, when the length of this path is m.

Definition 5. [3] Given $G = (N, M)$ is a single-valued neutrosophic graph, G is called a regular neutrosophic graph if any vertex has the same degree, that is, for all u in $V(G)$ we have $d_G(u) = (d_1, d_2, d_3)$.

Definition 6. [3] Given $G = (N, M)$ is a single-valued neutrosophic graph, G is called a totally regular neutrosophic graph if any vertex has the same degree, that is, for all u in $V(G)$ we have $Td_G(u) = (d_1, d_2, d_3)$.

Definition 7. [3] Given $G = (N, M)$ is a single-valued neutrosophic graph, G is a complement regular neutrosophic graph if it satisfies the following,

$$\sum_{v\neq u} T_M(v,u) = c, \qquad \sum_{v\neq u} I_M(v,u) = c, \qquad \sum_{v\neq u} F_M(v,u) = c,$$

Where c is a constant value.

Definition 8. [3] A neutrosophic graph $G = (N, M)$ is called a *complete neutrosophic graph* if the following conditions are satisfied:

$$T_M(uv) = \min\{T_N(u), T_N(v)\},$$
$$I_M(uv) = \min\{I_N(u), I_N(v)\},$$
$$F_M(uv) = \max\{F_N(u), F_N(v)\},$$

For all $u, v \in V$.

3. Mane results

This section provides some definitions and theorems.

Definition 9. let $G = (N, M)$ be a neutrosophic graph. the Sombor index (SO) of the graph G is defined by,

$$So_T(G) = \frac{1}{2}\sum_{uv\in E(G)} (T_N^2(u)d_{2_T}(u) + T_N^2(v)d_{2_T}(v))^{\frac{1}{2}},$$
$$So_I(G) = \frac{1}{2}\sum_{uv\in E(G)} (I_N^2(u)d_{2_I}(u) + I_N^2(v)d_{2_I}(v))^{\frac{1}{2}},$$
$$So_F(G) = \frac{1}{2}\sum_{uv\in E(G)} (F_N^2(u)d_{2_F}(u) + F_N^2(v)d_{2_F}(v))^{\frac{1}{2}}.$$

$$So(G) = \big(So_T(G), So_I(G), So_F(G)\big), \qquad |So(G)| = \frac{4 + 2So_T(G) - So_I(G) - 2So_F(G)}{6}.$$

Too, we have:

$$d_2(u) = \Big(d_{2_T}(u), d_{2_I}(u), d_{2_F}(u)\Big) = \left(\sum_{u\neq v\in V} T_M^2(u,v)\,, \sum_{u\neq v\in V} I_M^2(u,v)\,, \sum_{u\neq v\in V} F_M^2(u,v)\right).$$

Definition 10. Sombor index whit the totally degree of the graph G is defined as:

$$So_T(G_T) = \frac{1}{2}\sum_{uv\in E(G)} (T_N^2(u)Td_{2_T}(u) + T_N^2(v)Td_{2_T}(v))^{\frac{1}{2}},$$
$$So_I(G_T) = \frac{1}{2}\sum_{uv\in E(G)} (I_N^2(u)Td_{2_I}(u) + I_N^2(v)Td_{2_I}(v))^{\frac{1}{2}},$$
$$So_F(G_T) = \frac{1}{2}\sum_{uv\in E(G)} (F_N^2(u)Td_{2_F}(u) + F_N^2(v)Td_{2_F}(v))^{\frac{1}{2}}.$$

$$So(G_T) = \big(So_T(G_T), So_I(G_T), So_F(G_T)\big), \qquad |So(G_T)| = \frac{4 + 2So_T(G_T) - So_I(G_T) - 2So_F(G_T)}{6}.$$

Too, we have:

$$Td_2(u) = \Big(Td_{2_T}(u), Td_{2_I}(u), Td_{2_F}(u)\Big)$$
$$= \left(\sum_{u\neq v\in V} T_M^2(u,v) + T_N^2(u)\,, \sum_{u\neq v\in V} I_M^2(u,v) + I_N^2(u)\,, \sum_{u\neq v\in V} F_M^2(u,v) + F_N^2(u)\right).$$

Definition 11. The Reduced Sombor index of the graph G is defined as:

$$So_{RedT}(G) = \frac{1}{2}\sum_{uv\in E(G)} (T_N^2(u)d_{2Red_T}(u) + T_N^2(v)d_{2Red_T}(v))^{\frac{1}{2}},$$
$$So_{RedI}(G) = \frac{1}{2}\sum_{uv\in E(G)} (I_N^2(u)d_{2Red_I}(u) + I_N^2(v)d_{2Red_I}(v))^{\frac{1}{2}},$$
$$So_{RedF}(G) = \frac{1}{2}\sum_{uv\in E(G)} (F_N^2(u)d_{2Red_F}(u) + F_N^2(v)d_{2Red_F}(v))^{\frac{1}{2}}.$$

$$So_{Red}(G) = \big(So_{RedT}(G), So_{RedI}(G), So_{RedF}(G)\big),$$

$$|So_{Red}(G)| = \frac{4 + 2So_{RedT}(G) - So_{RedI}(G) - 2So_{RedF}(G)}{6}.$$

Too, we have:

$$d_{2Red}(u) = \Big(d_{2Red_T}(u), d_{2Red_I}(u), d_{2Red_F}(u)\Big)$$
$$= \left(\left|\sum_{u\neq v\in V} T_M^2(u,v) - T_N^2(u)\right|, \left|\sum_{u\neq v\in V} I_M^2(u,v) - I_N^2(u)\right|, \left|\sum_{u\neq v\in V} F_M^2(u,v) - F_N^2(u)\right|\right).$$

Definition 12. The Average Sombor index of the graph G is defined as:

$$So_{AvgT}(G) = \frac{1}{2}\sum_{uv\in E(G)} (T_N^2(u)d_{2Avg_T}(u) + T_N^2(v)d_{2Avg_T}(v))^{\frac{1}{2}},$$
$$So_{AvgI}(G) = \frac{1}{2}\sum_{uv\in E(G)} (I_N^2(u)d_{2Avg_I}(u) + I_N^2(v)d_{2Avg_I}(v))^{\frac{1}{2}},$$

$$So_{AvgF}(G) = \frac{1}{2}\sum_{uv\in E(G)}(F_N^2(u)d_{2Avg_F}(u) + F_N^2(v)d_{2Avg_F}(v))^{\frac{1}{2}}.$$

$$So_{Avg}(G) = \Big(So_{AvgT}(G), So_{AvgI}(G), So_{AvgF}(G)\Big),$$

$$\big|So_{Avg}(G)\big| = \frac{4 + 2So_{AvgT}(G) - So_{AvgI}(G) - 2So_{AvgF}(G)}{6}.$$

Too, we have:

$$\begin{aligned} d_{2Avg}(u) &= \Big(d_{2Avg_T}(u), d_{2Avg_I}(u), d_{2Avg_F}(u)\Big) \\ &= \left(\left|\sum_{u\neq v\in V} T_M^2(u,v) - \frac{2\sum_{uv\epsilon E(G)} T_M(uv)}{\sum_{u\epsilon V(G)} T_N(u)}\right|, \left|\sum_{u\neq v\in V} I_M^2(u,v)\right.\right. \\ &\quad \left.\left. - \frac{2\sum_{uv\epsilon E(G)} I_M(uv)}{\sum_{u\epsilon V(G)} I_N(u)}\right|, \left|\sum_{u\neq v\in V} F_M^2(u,v) - \frac{2\sum_{uv\epsilon E(G)} F_M(uv)}{\sum_{u\epsilon V(G)} F_N(u)}\right|\right). \end{aligned}$$

Example 1. Let $G = (N, M)$ be the neutrosophic graph with $V = \{a, b, c, d, e\}$ where $(T_N, I_N, F_N)(u_1) = (0.1, 0.2, 0.5)$, $(T_N, I_N, F_N)(u_2) = (0.2, 0.7, 0.3)$, $(T_N, I_N, F_N)(u_3) = (0.4, 0.3, 0.7)$, $(T_N, I_N, F_N)(u_4) = (0.5, 0.2, 0.4)$, and $(T_N, I_N, F_N)(u_5) = (0.4, 0.5, 0.3)$, The edge set contains $(T_M, I_M, F_M)(u_1, u_2) = (0.1, 0.2, 0.5)$, $(T_M, I_M, F_M)(u_3, u_2) = (0.1, 0.2, 0.6)$, $(T_M, I_M, F_M)(u_3, u_4) = (02, 0.3, 0.8)$, and $(T_M, I_M, F_M)(u_5, u_2) = (02, 0.5, 0.3)$. (Figure 1)

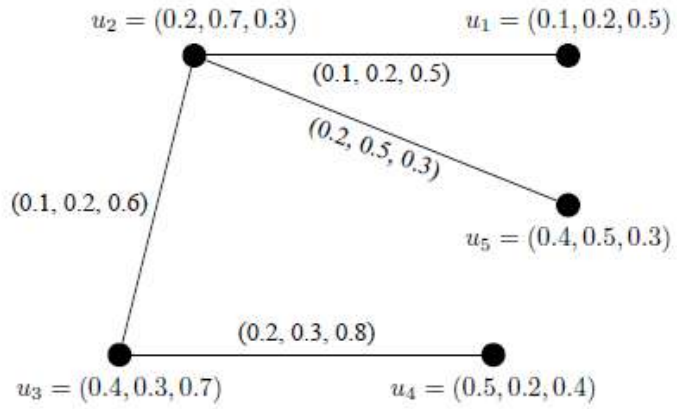

Fig1. $G = (N, M)$ be the neutrosophic graph with $V = \{a, b, c, d, e\}$.

By direct calculations,

$$d(u_1) = (0.1, 0.2, 0.5),$$
$$d(u_2) = (0.1 + 0.2 + 0.1, 0.2 + 0.2 + 0.5, 0.5 + 0.3 + 0.6) = (0.4, 0.9, 1.4),$$
$$d(u_3) = (0.1 + 0.2, 0.2 + 0.3, 0.6 + 0.8) = (0.3, 0.5, 1.4),$$
$$d(u_4) = (0.2, 0.3, 0.8),$$
$$d(u_5) = (0.2, 0.5, 0.3).$$

By definition of $d_m(v)$, we have

$$d_2(v) = \left(\sum_{u\neq v\in V} T_M^2(u,v), \sum_{u\neq v\in V} I_M^2(u,v), \sum_{u\neq v\in V} F_M^2(u,v)\right)$$

Therefore

$$d_2(u_1) = (0.01, 0.04, 0.05), \quad d_2(u_2) = (0.06, 0.33, 0.5), \quad d_2(u_3) = (0.05, 0.13, 1),$$
$$d_2(u_4) = (0.04, 0.09, 0.64), \quad d_2(u_5) = (0.04, 0.25, 0.09).$$

Also, for $u_iu_j \in E(G)$,

$$So_T(G) = \frac{1}{2}\sum_{uv\in E(G)} (T_N^2(u)d_{2_T}(u) + T_N^2(v)d_{2_T}(v))^{\frac{1}{2}} = 0.148,$$
$$So_I(G) = \frac{1}{2}\sum_{uv\in E(G)} (I_N^2(u)d_{2_I}(u) + I_N^2(v)d_{2_I}(v))^{\frac{1}{2}} = 0.771,$$
$$So_F(G) = \frac{1}{2}\sum_{uv\in E(G)} (F_N^2(u)d_{2_F}(u) + F_N^2(v)d_{2_F}(v))^{\frac{1}{2}} = 0.987,$$
$$So(G) = \big(So_T(G), So_I(G), So_F(G)\big) = (0.148, 0.771, 0.987).$$

$$|So(G)| = \frac{4 + 2So_T(G) - So_I(G) - 2So_F(G)}{6} = \frac{4 + 2(0.148) - 0.771 - 2(0.987)}{6} = 0.2585.$$

Theorem 1: let G be the Neutrosophic Graph, and H is the Neutrosophic subgraph of G such that $H = G - u$ then

$$SO(H) < SO(G).$$

Proof: Given that by omitting a vertex of G, a positive value, the sum is lost, so the proof is obvious. □

Theorem 2. Let $G_1 = (N_1, M_1)$ be isomorphic with $G_2 = (N_2, M_2)$. Then all of the following equations are established.

$$So_T(G_1) = So_T(G_2),$$
$$So_I(G_1) = So_I(G_2),$$
$$So_F(G_1) = So_F(G_2),$$

Also, we have $So(G_1) = So(G_2)$.

Proof. Let $G_1 = (N_1, M_1)$ be isomorphic with $G_2 = (N_2, M_2)$, and $f: V_1 \to V_2$ be the bijection from V_1 to V_2 such that

$$T_{N_1}(u) = T_{N_2}\big(f(u)\big), \quad I_{N_1}(u) = I_{N_2}\big(f(u)\big), \quad F_{N_1}(u) = F_{N_2}\big(f(u)\big),$$

For all $u \in V_1$, and

$$T_{M_1}(uv) = T_{M_2}\big(f(u)f(v)\big), \quad I_{M_1}(uv) = I_{M_2}\big(f(u)f(v)\big), \quad F_{M_1}(uv) = F_{M_2}\big(f(u)f(v)\big),$$

For all $uv \in E_1$. Since G_1 isomorphic with G_2, any edge between two vertices, for example, u and v in G_1 are equal to that between $f(u)$ and $f(v)$ in G_2. Hence

$$d_{2T_{G_1}}(u) = d_{2T_{G_2}}\big(f(u)\big), \quad d_{2I_{G_1}}(u) = d_{2I_{G_2}}\big(f(u)\big), \quad d_{2F_{G_1}}(u) = d_{2F_{G_2}}(f(u)),$$

For $u, v \in N_1^*$. Therefore

$$So_T(G_1) = So_T(G_2), \quad So_I(G_1) = So_I(G_2), \quad So_F(G_1) = So_F(G_2),$$

And

$$So(G_1) = \frac{4 + 2So_T(G_1) - 2So_F(G_1) - So_I(G_1)}{6} = \frac{4 + 2So_T(G_2) - 2So_F(G_2) - So_I(G_2)}{6} = So(G_2).$$

□

Theorem 3. Let $G = (N, M)$ be a complete neutrosophic graph whit $V = \{v_1, v_2, \dots, v_n\}$ such that $t_1 \leq t_2 \leq \cdots \leq t_n$, $i_1 \leq i_2 \leq \cdots \leq i_n$ and $f_1 \geq f_2 \geq \cdots \geq f_n$ where $t_j = T_N(v_j)$, $i_j = I_N(v_j)$ and $f_j = F_N(v_j)$ for $j = 1, 2, \dots, n$. Also, G is the regular neutrosophic graph of the second rank (that is, for each vertex u in $V(G), d_{2G}(v_j) = (d_1, d_2, d_3)$). Then

$$So_T(G) = \frac{\sqrt{d_1}}{2} \sum_{\substack{1\leq j<k \\ 2\leq k\leq n}} (t_j^2 + t_k^2)^{\frac{1}{2}},$$

$$So_I(G) = \frac{\sqrt{d_2}}{2} \sum_{\substack{1\leq j<k \\ 2\leq k\leq n}} (i_j^2 + i_k^2)^{\frac{1}{2}},$$

$$So_F(G) = \frac{\sqrt{d_3}}{2} \sum_{\substack{1\leq j<k \\ 2\leq k\leq n}} (f_j^2 + f_k^2)^{\frac{1}{2}}.$$

Too, we have for u in $V(G)$:

$$d_2(v_j) = \left(d_{2_T}(v_j), d_{2_I}(v_j), d_{2_F}(v_j)\right) = (d_1, d_2, d_3).$$

Proof: Suppose G is a complete neutrosophic graph, we have

$$So_T(G) = \frac{1}{2} \sum_{uv\in E(G)} (T_N^2(u) d_{2_T}(u) + T_N^2(v) d_{2_T}(v))^{\frac{1}{2}} = \frac{1}{2} \sum_{uv\in E(G)} (T_N^2(u) d_1 + T_N^2(v) d_1)^{\frac{1}{2}}$$

$$= \frac{1}{2} \sum_{uv\in E(G)} \sqrt{d_1} \left(T_N^2(u) + T_N^2(v)\right)^{\frac{1}{2}} = \frac{\sqrt{d_1}}{2} \sum_{uv\in E(G)} \left(T_N^2(u) + T_N^2(v)\right)^{\frac{1}{2}}$$

$$= \frac{\sqrt{d_1}}{2} \left(\sqrt{t_1^2 + t_2^2} + \sqrt{t_1^2 + t_3^2} + \cdots + \sqrt{t_1^2 + t_n^2} + \sqrt{t_2^2 + t_3^2} + \cdots + \sqrt{t_2^2 + t_n^2} + \cdots \right.$$

$$\left. + \sqrt{t_{n-2}^2 + t_{n-1}^2} + \sqrt{t_{n-2}^2 + t_n^2} + \sqrt{t_{n-1}^2 + t_n^2} \right) = \frac{\sqrt{d_1}}{2} \sum_{\substack{1\leq j<k \\ 2\leq k\leq n}} (t_j^2 + t_k^2)^{\frac{1}{2}}.$$

Using the same argument, we can prove the other two cases.

□

Theorem 4. Let $G = (N,\ M)$ be a complete neutrosophic graph whit $|V| = n$. Then,

If M is a constant function, that is, $M(uv) = (t_m,\ i_m,\ f_m), for\ uv\ \in E(G)$. Now, we have:

$$So_T(G) = \frac{\sqrt{n-1}}{2} t_m \sum_{uv\in E(G)} (T_N^2(u) + T_N^2(v))^{\frac{1}{2}},$$

$$So_I(G) = \frac{\sqrt{n-1}}{2} i_m \sum_{uv\in E(G)} (I_N^2(u) + I_N^2(v))^{\frac{1}{2}},$$

$$So_F(G) = \frac{\sqrt{n-1}}{2} f_m \sum_{uv\in E(G)} (F_N^2(u) + F_N^2(v))^{\frac{1}{2}}.$$

If $M\ and\ N$ are the constant function, that is, $M(uv) = (t_m,\ i_m,\ f_m), for\ uv \in E(G),\ and\ N(u) = (t_n, i_n, f_n), for\ u \in V(G)$. Now, we have:

$$So_T(G) = \frac{n(n-1)^{\frac{3}{2}}}{2\sqrt{2}} t_m . t_n,$$

$$So_I(G) = \frac{n(n-1)^{\frac{3}{2}}}{2\sqrt{2}} i_m . i_n,$$

$$So_F(G) = \frac{n(n-1)^{\frac{3}{2}}}{2\sqrt{2}} f_m . f_n .$$

Also,

$$|So(G)| = \frac{n(n-1)^{\frac{3}{2}}}{12\sqrt{2}} (2t_m . t_n - i_m . i_n - 2f_m . f_n) + \frac{2}{3}.$$

If M *and* N are the constant and the same function, that is, $M(uv) = (t, i, f), for\ uv \in E(G)$, $and\ N(u) = (t, i, f), for\ u \in V(G)$. Now, we have:

$$So_T(G) = \frac{n(n-1)^{\frac{3}{2}}}{2\sqrt{2}} t^2,$$

$$So_I(G) = \frac{n(n-1)^{\frac{3}{2}}}{2\sqrt{2}} i^2,$$

$$So_F(G) = \frac{n(n-1)^{\frac{3}{2}}}{2\sqrt{2}} f^2.$$

Also,

$$|So(G)| = \frac{n(n-1)^{\frac{3}{2}}}{12\sqrt{2}} (2t^2 - i^2 - 2f^2) + \frac{2}{3}.$$

Proof: In the first case, suppose G is a complete neutrosophic graph, with $|V| = n$. Also, $uv \in E(G)$, we have $M(uv) = (t_m,\ i_m,\ f_m)$. Therefore,

$$d_2(u) = \left(d_{2_T}(u), d_{2_I}(u), d_{2_F}(u)\right) = \left(\sum_{u \neq v \in V} T_M^2(u,v), \sum_{u \neq v \in V} I_M^2(u,v), \sum_{u \neq v \in V} F_M^2(u,v)\right)$$
$$= \left((n-1)t_m^2, (n-1)i_m^2, (n-1)f_m^2\right).$$

Now, by placing $d_2(u)$ in relation to the Sombor index we get:

$$So_T(G) = \frac{1}{2} \sum_{uv \in E(G)} (T_N^2(u) d_{2_T}(u) + T_N^2(v) d_{2_T}(v))^{\frac{1}{2}} = \frac{1}{2} \sum_{uv \in E(G)} (T_N^2(u)(n-1)t_m^2 + T_N^2(v)(n-1)t_m^2)^{\frac{1}{2}}$$
$$= \frac{1}{2} \sum_{uv \in E(G)} ((n-1)t_m^2)^{\frac{1}{2}} (T_N^2(u) + T_N^2(v))^{\frac{1}{2}} = \frac{1}{2} ((n-1)t_m^2)^{\frac{1}{2}} \sum_{uv \in E(G)} (T_N^2(u) + T_N^2(v))^{\frac{1}{2}}$$
$$= \frac{\sqrt{n-1}}{2} t_m \sum_{uv \in E(G)} (T_N^2(u) + T_N^2(v))^{\frac{1}{2}}.$$

In the second case, consider $M\ and\ N$ are the constant functions, such that, $M(uv) = (t_m,\ i_m,\ f_m), and\ N(u) = (t_n, i_n, f_n)$. In this state, we have for $u \in V(G)$,

$$d_2(u) = \left(d_{2_T}(u), d_{2_I}(u), d_{2_F}(u)\right) = \left(\sum_{u \neq v \in V} T_M^2(u,v), \sum_{u \neq v \in V} I_M^2(u,v), \sum_{u \neq v \in V} F_M^2(u,v)\right)$$
$$= \left((n-1)t_m^2, (n-1)i_m^2, (n-1)f_m^2\right).$$

by placing $d_2(u)$,

$$So_T(G) = \frac{1}{2} \sum_{uv \in E(G)} (T_N^2(u) d_{2_T}(u) + T_N^2(v) d_{2_T}(v))^{\frac{1}{2}} = \frac{1}{2} \sum_{uv \in E(G)} (T_N^2(u)(n-1)t_m^2 + T_N^2(v)(n-1)t_m^2)^{\frac{1}{2}}$$
$$= \frac{1}{2} \sum_{uv \in E(G)} (t_n^2(n-1)t_m^2 + t_n^2(n-1)t_m^2)^{\frac{1}{2}} = \frac{n(n-1)^{\frac{3}{2}}}{2\sqrt{2}} t_m . t_n .$$

The same can be proved for $So_I(G)$ and $So_F(G)$. Also, by direct placing in $|So(G)|$,

$$|So(G)| = \frac{4 + 2So_T(G) - So_I(G) - 2So_F(G)}{6}$$
$$= \frac{4 + 2\frac{n(n-1)^{\frac{3}{2}}}{2\sqrt{2}} t_m.t_n - \frac{n(n-1)^{\frac{3}{2}}}{2\sqrt{2}} i_m.i_n - 2\frac{n(n-1)^{\frac{3}{2}}}{2\sqrt{2}} f_m.f_n}{6}$$
$$= \frac{n(n-1)^{\frac{3}{2}}}{12\sqrt{2}}(2t_m.t_n - i_m.i_n - 2f_m.f_n) + \frac{2}{3}.$$

To prove the third case, it is enough to consider $d_2(u)$ like the previous parts and then replace the value of $M(uv) = (t, i, f), and\ N(u) = (t, i, f)$. The proofs for $So_I(G)$ and $So_F(G)$ are similar to the case for $So_T(G)$.

□

Theorem 5. Let $G = (N, M)$ be a complete neutrosophic graph whit $|V| = n$. Then,

If $M\ and\ N$ are the constant functions, that is, $M(uv) = (t_m,\ i_m,\ f_m), for\ uv\ \in E(G), and\ N(u) = (t_n, i_n, f_n), for\ u \in V(G)$. Now, we have:

$$So_T(G_T) = \frac{n(n-1)}{2\sqrt{2}} t_n((n-1)t_m^2 + t_n^2)^{1/2},$$
$$So_I(G_T) = \frac{n(n-1)}{2\sqrt{2}} i_n((n-1)i_m^2 + i_n^2)^{1/2},$$
$$So_F(G_T) = \frac{n(n-1)}{2\sqrt{2}} f_n((n-1)f_m^2 + f_n^2)^{1/2}.$$

Also,

$$|So(G_T)| = \frac{n(n-1)}{12\sqrt{2}}\left(2t_n((n-1)t_m^2 + t_n^2)^{1/2} - i_n((n-1)i_m^2 + i_n^2)^{1/2} - 2f_n((n-1)f_m^2 + f_n^2)^{1/2}\right) + \frac{2}{3}.$$

If $M\ and\ N$ are the constant and the same functions, that is, $M(uv) = (t, i, f), for\ uv\ \in E(G), and\ N(u) = (t, i, f), for\ u \in V(G)$. Now, we have:

$$So_T(G_T) = \frac{(n-1)(n)^{\frac{3}{2}}}{2\sqrt{2}} t^2,$$
$$So_I(G_T) = \frac{(n-1)(n)^{\frac{3}{2}}}{2\sqrt{2}} i^2,$$
$$So_F(G_T) = \frac{(n-1)(n)^{\frac{3}{2}}}{2\sqrt{2}} f^2.$$

Also,

$$|So(G_T)| = \frac{(n-1)(n)^{\frac{3}{2}}}{2\sqrt{2}}(2t^2 - i^2 - 2f^2) + \frac{2}{3}.$$

Proof: Suppose G is a complete neutrosophic graph, with $|V| = n$. Also, $uv\ \in E(G)$. The first case, we have $M(uv) = (t_m,\ i_m,\ f_m), for\ uv\ \in E(G), and\ N(u) = (t_n, i_n, f_n), for\ u \in V(G)$. Therefore,

$$Td_2(u) = \left(Td_{2_T}(u), Td_{2_I}(u), Td_{2_F}(u)\right)$$
$$= \left(\sum_{u \neq v \in V} T_M^2(u,v) + T_N^2(u)\,,\ \sum_{u \neq v \in V} I_M^2(u,v) + I_N^2(u)\,,\ \sum_{u \neq v \in V} F_M^2(u,v) + F_N^2(u)\right).$$
$$= \left((n-1)t_m^2 + t_n^2, (n-1)i_m^2 + i_n^2, (n-1)f_m^2 + f_n^2\right).$$

Now, by placing $Td_2(u)$ in relation to the Sombor index we get:

$$So_T(G_T) = \frac{1}{2}\sum_{uv\in E(G)} (T_N^2(u)Td_{2_T}(u) + T_N^2(v)Td_{2_T}(v))^{\frac{1}{2}}$$
$$= \frac{1}{2}\sum_{uv\in E(G)} (T_N^2(u)((n-1)t_m^2 + t_n^2) + T_N^2(v)((n-1)t_m^2 + t_n^2))^{\frac{1}{2}}$$
$$= \frac{1}{2}\sum_{uv\in E(G)} (((n-1)t_m^2 + t_n^2)(T_N^2(u) + T_N^2(v)))^{\frac{1}{2}}$$
$$= \frac{1}{2}\sum_{uv\in E(G)} (((n-1)t_m^2 + t_n^2)(t_n^2 + t_n^2))^{\frac{1}{2}} = \frac{n(n-1)}{2\sqrt{2}} t_n((n-1)t_m^2 + t_n^2)^{1/2}.$$

It is similarly possible for the other two modes.

$$|So(G_T)| = \frac{4 + 2So_T(G_T) - So_I(G_T) - 2So_F(G_T)}{6}$$
$$= \frac{4 + 2\frac{n(n-1)}{2\sqrt{2}} t_n((n-1)t_m^2 + t_n^2)^{1/2} - \frac{n(n-1)}{2\sqrt{2}} i_n((n-1)i_m^2 + i_n^2)^{1/2} - 2\frac{n(n-1)}{2\sqrt{2}} f_n((n-1)f_m^2 + f_n^2)^{1/2}}{6}$$
$$= \frac{4 + \frac{n(n-1)}{2\sqrt{2}}(2t_n\left((n-1)t_m^2 + t_n^2\right)^{1/2} - i_n\left((n-1)i_m^2 + i_n^2\right)^{1/2} - 2f_n\left((n-1)f_m^2 + f_n^2\right)^{1/2})}{6}$$
$$= \frac{n(n-1)}{12\sqrt{2}}\left(2t_n((n-1)t_m^2 + t_n^2)^{1/2} - i_n((n-1)i_m^2 + i_n^2)^{1/2} - 2f_n((n-1)f_m^2 + f_n^2)^{1/2}\right) + \frac{2}{3}.$$

For case 2: we have $M(uv) = (t, i, f), for\ uv \in E(G), and\ N(u) = (t, i, f), for\ u \in V(G),$ henc:

$$Td_2(u) = \left(Td_{2_T}(u), Td_{2_I}(u), Td_{2_F}(u)\right)$$
$$= \left(\sum_{u\neq v\in V} T_M^2(u,v) + T_N^2(u)\,,\ \sum_{u\neq v\in V} I_M^2(u,v) + I_N^2(u)\,,\ \sum_{u\neq v\in V} F_M^2(u,v) + F_N^2(u)\right).$$
$$= \left((n-1)t^2 + t^2, (n-1)i^2 + i^2, (n-1)f^2 + f^2\right) = (nt^2, ni^2, nf^2).$$

$$So_T(G_T) = \frac{1}{2}\sum_{uv\in E(G)} (T_N^2(u)Td_{2_T}(u) + T_N^2(v)Td_{2_T}(v))^{\frac{1}{2}} = \frac{1}{2}\sum_{uv\in E(G)} (T_N^2(u)(nt^2) + T_N^2(v)(nt^2))^{\frac{1}{2}}$$
$$= \frac{1}{2}\sum_{uv\in E(G)} ((nt^2)(t^2 + t^2))^{\frac{1}{2}} = \frac{1}{2}(nt^2)^{\frac{1}{2}}\sum_{uv\in E(G)} (t^2 + t^2)^{\frac{1}{2}} = \frac{(n-1)(n)^{\frac{3}{2}}}{2\sqrt{2}} t^2.$$

It is similarly proved for the $So_I(G_T)$ and $So_F(G_T)$. Also,

$$|So(G_T)| = \frac{4 + 2So_T(G_T) - So_I(G_T) - 2So_F(G_T)}{6}$$
$$= \frac{4 + 2\frac{(n-1)(n)^{\frac{3}{2}}}{2\sqrt{2}} t^2 - \frac{(n-1)(n)^{\frac{3}{2}}}{2\sqrt{2}} i^2 - 2\frac{(n-1)(n)^{\frac{3}{2}}}{2\sqrt{2}} f^2}{6}$$
$$= \frac{4 + \frac{(n-1)(n)^{\frac{3}{2}}}{2\sqrt{2}}(2t^2 - i^2 - 2f^2)}{6} = \frac{(n-1)(n)^{\frac{3}{2}}}{2\sqrt{2}}(2t^2 - i^2 - 2f^2) + \frac{2}{3}.$$

The proof is complete.

□

Conclusion

In this paper, for the first time, Sombor indices for neutrosophic graphs are defined. Here, in addition to defining Sombor indices, we have calculated and studied these indices for complete neutrosophic graphs, which are an important category of neutrosophic graphs. In the following, we will generalize these indicators and in our next articles, we will discuss another group of neutrosophic graphs, called neutrosophic regular edge graphs, and then we will discuss its applications.

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An Efficient Method for Empowering engineering students through employability skills Based on New A-ResNet-LSTM Model

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***Abstract* –An integral part of every degree program leading to a professional certification, including engineering, is the campus interview. Having every program's student placed is the main objective. Efforts to improve students' placement achievements have led to the inclusion of communication skills in all engineering courses; nonetheless, the curriculum mostly concentrates on developing four language talents. Insufficient emphasis is placed on the significance of employability skills among students. Students should be self-aware about their skill sets, and this essay will make a case for that fact while also outlining why it is important and providing suggestions for how students might showcase their strongest qualifications. The three stages that make up this suggested method are feature selection, model training, and log preprocessing. Initial Preprocessing, Stopwords Removal, Stemming, Lemmatization, and Emoji Recognition are all parts of preprocessing. Picking out features Principal component analysis (PCA) creates a principal component as a linear combination of factor-related observed variables by applying an appropriate weight to each of the variables. A New-A-ResNet-LSTM Ensemble was used all the way through training the model. Compared to LSTM and ResNet, this novel method has a higher average accuracy of 92.95%.**

Keywords—Skill Development, Employability, Long Short-Term Memory (LSTM).

I. INTRODUCTION

Professors in engineering and other disciplines face the formidable task of preparing their students to thrive in the complex social, economic, and technical environments of the years to come. Teaching graduates' employability skills like communication, cooperation, and leadership is one way to address the double whammy of ensuring they can obtain good employment and excel in those roles. Courses on employability skills are commonly mandated by accreditation authorities for engineering degree programs. The eleven Exit-Level Outcomes (ELOs) established by the Engineering Council of South Africa are prerequisites for engineering program graduation. So as to secure the stamp of approval from Students should be able to work well in multidisciplinary teams, says the American Board of Engineering Technology (ABET), a nonprofit that certifies engineering schools worldwide work effectively in teams, understand their ethical and professional duties, and communicate effectively. Finding a career after graduation is the goal of the majority of students. In today's employment market, where both fresh graduates and those with more experience are competing for limited openings, it is more crucial than ever for candidates to find ways to differentiate themselves from the competition. Employers are placing more value on candidates with great academic credentials who also possess additional, less quantifiable attributes, therefore colleges and universities are reassessing the services they provide to students. Higher education institutions (HEIs) attract students from all over the globe, who bring with them a diverse range of experiences, perspectives, and goals for their academic and professional careers. Because every industry has its own set of standards and expectations for job candidates, it is essential for higher education institutions to establish a methodical yet adaptable strategy to increase employability. As students gain a better understanding of the intense competition in the field, they are more driven than ever to gain practical experience and develop their skills. Therefore, more and more students are seeing practice-based applications, such as internships, volunteer work, and placements, as a fantastic way to gain experience in the field and boost their resumes. The anticipated disparity between market demand and the supply of engineering graduates in Malaysian enterprises remains an issue, despite the fact that many industrialized nations view engineering as a means to enhance their economies. Many new graduates lack the social and professional development to handle problems they may face on the job, despite employers' wishes that graduates adjust their skill sets to meet market demands. So, to increase the employability of engineering graduates, this research will focus on engineering. Reducing skills mismatch and strengthening university-industry partnerships to create graduates prepared for the workforce are two ways to enhance graduate capabilities. Also, in order for Malaysia to have a highly competitive and technologically advanced workforce, the government is encouraging strong ties between universities and industries. A service-centered system

approach is crucial since collaboration may be considered as a service in many contexts, including product development, information exchange, co-creation, and innovation. Investigating and questioning how assessment in higher education, especially reflective assessments, develops students' employability skills, this study draws on the findings of a literature review and the perspectives of undergraduates in a business management program at a university in the UK. Reflective practice is an effective method for assessing students' abilities, as indicated before, according to a number of research. On the other hand, students may engage in shallow reflection rather than genuinely reflective thinking in order to protect themselves, which is likely to explain why there is less evidence that reflective evaluation can directly boost students' employability. There is no proof that reflective practice will increase employability, despite its growing use as an evaluation tool at universities. There is a growing concern about this disparity since universities are facing mounting pressure to enhance employability skills in order to keep up with the demands of the job market and adjust to outside forces.

II. Literature Survey

Employers look for people with great communication and interpersonal skills in addition to high levels of education and work experience when hiring new employees [1]. College curricula still only touch on a small portion of soft skill development, but this is inversely related to the demands of today's job and the emphasis on these skills in today's classrooms [2]. Higher education should equip students with both the technical and interpersonal skills that are highly sought after by businesses. [3] The objective was to calculate the number of personnel that graduate users will need to anticipate a spike in the unemployment rate. Many studies have found that graduate users, such as organizations and sectors, need people who can quickly adjust to new circumstances. [4] The ability to adjust and achieve cognitive excellence in one's scientific pursuits also necessitate certain general qualities. Researchers across disciplines have general skills, also called defined competencies, to varied degrees. [5] In general, a person should be able to do the following: adapt to new situations, learn quickly and easily, solve problems independently based on what they've learned, read, write, and count accurately; communicate clearly; think creatively; work well with others; understand and use basic technology; lead and follow instructions effectively; and continue to learn throughout their lives. [6] There is an emphasis on assisting students in developing marketable skills from the moment they start high school all the way through their college years. Students majoring in engineering should be required to develop both soft and hard skills as part of their curriculum [7]. It becomes difficult when students are nearly ready to graduate but do not possess the employability skills necessary for an internship or on-the-job training program. Coming into the field unprepared can have a negative impact on students' self-esteem and confidence, which in turn can diminish their aspirations for the future. [8] Higher education institutions (HEIs) have the primary duty of equipping students with the core knowledge and abilities necessary for their chosen professions, along with instilling in them personal and professional work values [9]. Graduates may be able to satisfy the requirements of the ASEAN Qualification Reference Framework with the support of the university's programs for student development. According to [10], engineering companies in Indonesia are looking for graduates with strong communication, work-specific, and IT skills. Students have the chance to refine these vital skills through internships. Internships at HEIs aim to give students a taste of the working world so that they can find their place in the corporate world. The ability to secure a job in one's field of choice due to one's proficiency in that field and the experience, education, and training one has acquired is called employability [11]. Another aspect that impacts employability is the ability to interact, think critically, and express oneself in reaction to possibilities. Academics may be in agreement that holding a job is the most important component of being employable, but they disagree on how to define the term. [12] The researchers' definitions vary; some have been more explicit, while others have been more oblique. One's employability is influenced by intellectual, knowledge-based, and economic factors. Unemployment rates around the world appear to be following Malaysia's lead. [13]notes that this is a common occurrence among graduates of local universities. Also, there is disconnect a between classroom instruction and real-world employer demands. Therefore, in order to secure a job for themselves, pupils must possess certain abilities. [14] Two of the most significant factors that have been identified to predict a student's employability are their educational background and family history. Students, particularly those planning to continue their education, would do well to begin developing their skills as soon as is practically possible, regardless of how rapidly the employment market is changing. [15] The elimination of various jobs in the previous two decades has made finding gainful employment difficult in the modern economy. Beyond that, future occupations will necessitate skills that have not yet been identified. There are three main goals that the vision outlines. The first is to make the economy more progressive, knowledge-based, and valued by the community at all levels. [16] The second is to ensure that no one is left behind economically by eliminating inequality across regions, income groups, ethnicities, and supply chains. The third is to establish the country as a unified, prosperous, and honorable nation before becoming an economic powerhouse in Asia. [17] We have determined eight key enablers, including competencies, resources, and catalysts, that are essential to achieve these goals and bring the vision to fruition. TVET is one such area. [18] Technical and vocational education and training (TVET) aims to implement outcome-based education, build a learning society, and increase the number of highly educated and skilled workers in the country. In order for the country to achieve its goals, it is imperative that its youth are provided with the skills and information that employers value [19]. It is now the field's number one objective to provide more resources to those who have earned degrees from technical and vocational education and training (TVET) institutions, such as vocational colleges. Through service learning, students participate in sustainability efforts, develop their communication skills, and discover how to use their own talents to make a positive impact, according to research. [20] Consequently, service learning has developed into a strategy for students to understand the subject's foundations and apply what they've learned in a real-world setting. It is essential that engineering educators guide, supervise, and establish the learning environment for engineering students. According to [21], teachers need to come up with a new way of teaching in order to encourage students to be more involved in society and take responsibility for their actions. By combining inductive teaching with reliable assessments of student progress, we can bridge the gap between conventional classroom learning and engineering

professions. It is possible to combine digital tools with service learning with proper preparation and implementation of instructional methodologies. The key to successfully merging them is to keep their individual characteristics in order to achieve clearly articulated pedagogical goals.

III. Proposed System

It has recognized over the last 28 years that graduates require marketable talents alongside course-specific knowledge, thus we have integrated training in transferable skills into all of our degree programs. Students in their final year of honors have recently had a curriculum centered around job skills created for them.

A. Preprocessing:

1) Initial Preprocessing:

At the outset, all datasets were subjected to the identical procedure for preparation, which entailed removing any non-essential elements such as numbers, dates, hashtags, symbols, and punctuation.

2) Stopwords Removal:

Stopwords are words that pop up throughout texts but don't actually add anything. Therefore, it should ignore them while you read the text[22]. The task at hand involved selecting Arabic terms from a pool of 1,650 provided by King Abdulaziz University's natural language processing group. Combining the publication dates of the Terrier package and snowball lists, we were able to create a list of 1,008 English phrases. Snowball was used to construct an annotated list of 710 Spanish words.

3) Lemmatization:

It removes inflectional endings and returns the word's basic or dictionary form. Treetagger was used to analyze the English and Spanish texts, whilst Farasa lemmatizer was used for the Arabic text. Using SVMrank, Farasa rates possible word segmentation strategies based on stems, suffixes, and prefixes. While this may be the case, TreeTagger is a language-independent tool for annotating text with part-of-speech and lemma information.

4) Stemming:

Here we concentrate on reducing word variants to their shared basic form, sometimes called the root or stem. Because of this, it's possible to boost recall while decreasing vocabulary. The following languages were used: Arabic by ISRI stemmer, English by Porter, and Spanish by Snowball. When a word's root cannot be found, ISRI stemmer provides a normalized form that does not include a root dictionary. The English stemmer returns words to their root form by removing grammatical and adverbial suffixes. Finally, a programmatic counterpart of the naturally defined rules of stemming algorithms is created by the Spanish Snowball stemmer.

5) Emoji Recognition:

We were able to determine the nine most common emoji types by encoding the tweets in UTF-8. Every emoji has an emoticon-inferring tag replaced with it. Feelings of joy, anger, love, fear, surprise, optimism, sadness, disgust, and pessimism were all part of the tags.

B. Feature Selection:

1) PCA:

Using a number of questions across each dimension, this research used Principal Components Analysis (PCA) to construct reliable scales measuring corporate culture and work satisfaction[23]. By assigning a suitable weight to each observable variable, PCA generates a principal component as a linear combination of observable variables associated to factors. The following is how PCA develops a principal component.

$$PC = d_1(S_1) + d_2(S_2) + \cdots + d_b(S_b) \qquad (1)$$

Using the Varimax rotation method, orthogonal components were found in this experiment. Kaiser-Meyer-Olkin (KMO) and Bartlett's tests of sphericity ensure that the data utilized in this study are sufficient to conduct factor analysis. The KMO criterion is used to keep the main components. The only components to be retained according to this criterion are those with Eigen values greater than 1.0. To further understand how everything fits into its respective factor, factor loadings can be located. Additionally, Cronbach's alpha values are available for all scales, which can be used to evaluate internal consistency.

Using regression analysis, this proposed sought to determine the relationship between organizational culture and work happiness among college and institution faculty members in Lahore. Here is the regression equation used in this proposed approach:

$$JS_h = F + e_1(OCM_h) + e_2(OCE_h) + p_h \qquad (2)$$

In this context, JS stands for job satisfaction, OCM for organizational culture as it pertains to leaders and managers, and OCE for organizational culture as it pertains to workers.

C. Model Training:

1) New A-ResNet-LSTM:

LSTM, a subset of RNNs, has found widespread use in many NLP tasks, such as machine translation and semantic analysis. At each time step, the input and the hidden unit from the previous time step are combined to determine the value of each unit. This allows the hidden layer to keep historical information[24]. The gradient of an RNN could vanish or burst during backpropagation if the input sequence is very long. This problem is well addressed by LSTM by means of memory cells, which employ the idea of a gate to process and store crucial temporal information across long periods of time. The memory cell consists of three gates: the forget gate, the input gate, and the output gate. The forget gate controls which pieces of information are to be abandoned, while the input and output gates determine what to export and what to keep in the current memory cell at each time step. Here are the major components of the proposed ReAL model: a ResNet module, an ALSTM module, an MLP module, and finally, a softmax layer.

a) ResNet Module:

The ResNet module uses three ResBlock layers and a global average pooling (GAP) layer. There are three convolutional blocks that comprise a residual block. Each block is linked in a shortcut pattern and contains a ReLU activation function, a batch normalization (BN) layer, and a temporal convolutional layer.

b) A-LSTM Module:

The attention mechanism, two layers of long short-term memory (LSTM), and one other component make up the ALSTM module. The latter is used to focus on important details.

c) MLP Module:

The MLP module is comprised of two layers: one that is fully linked and one that is dropout. Its use can assist prevent the model from becoming overfit.

d) Softmax Layer:

It uses the softmax layer to normalize the non-normalized output of the MLP module and turn it into a probability distribution over the classified predictions. Network traffic feature vector s is input to both the ALSTM and ResNet modules, but they process s differently. As far as feature vectors are concerned, the ResNet module considers them to be multivariate time series with multiple time steps, but the ALSTM module considers them to be univariate in nature. For example, before the ALSTM module is applied, a dimension shuffle layer is used to flip the temporal dimension of the feature vector. It is this:

$$\tilde{s} = shuffle(s) \quad (3)$$

The ALSTM module then uses the following procedures on s to derive the time patterns:

$$\tilde{\imath}_1 = LSTM_1(\tilde{s}) \quad (4)$$

$$\tilde{\imath}_2 = LSTM_2(\tilde{\imath}_1) \quad (5)$$

$$t = Attention(\tilde{\imath}_2) \quad (6)$$

In this case, $LSTM_h, h \in \{1,2\}$ is the h th LSTM layer, $LSTM_h$ Attention is the attention mechanism, $\tilde{\imath}_1$ and $\tilde{\imath}_2$ are two hidden vectors, and is the last output of the ALSTM module. With the first residual block serving as an example, the ResNet module processes s in each block.

$$i_1 = ConvBlock_1(s) \quad (7)$$

$$i_2 = ConvBlock_2(i_1) \quad (8)$$

$$i_3 = ConvBlock_3(i_2) \quad (9)$$

$$i' = i_3 + s \quad (10)$$

$$m' = ReLU(i') \quad (11)$$

$i_1, i_2, i_3 \in \mathbb{R}^g$ are hidden vectors, $ConvBlock_h, h \in \{1,2\}$ represents the h -th convolutional block in the first residual block, and i' is the hidden state after the shortcut connection and element-wise addition. Subsequently, the following leftover blocks receive m'. The GAP layer receives the output from these residual blocks and uses it to reduce the number of parameters; this process yields the final output, which is μ. The MLP module is defined as, and it takes μ and t as inputs after the ResNet and ALSTM modules.

$$f = concate(\mu, t) \quad (12)$$

$$i" = FC(f) \quad (13)$$

$$\sigma = Dropout(i") \quad (14)$$

f is the sum of all outputs, $i"$ is the result from the fully connected layer, and σ is the result from the dropout layer. Here, Concate stands for the process of concatenation, FC for the fully connected layer, and Dropout for the Dropout layer. Lastly, the softmax layer provides the ultimate categorization outcome.

$$m = Softmax(\sigma) \quad (15)$$

IV. Result and Discussion

The researchers set out to find out whether there was a correlation between the number of points students in engineering received for their internship performance reviews and the number of points that department or company chiefs said students needed to improve their employability. The study polled 120 engineering grads from a university in the Philippines and utilized a quantitative descriptive methodology. The study discovered that internship performance assessments given to engineering students were highly regarded in terms of attitude, personality, knowledge, and abilities.

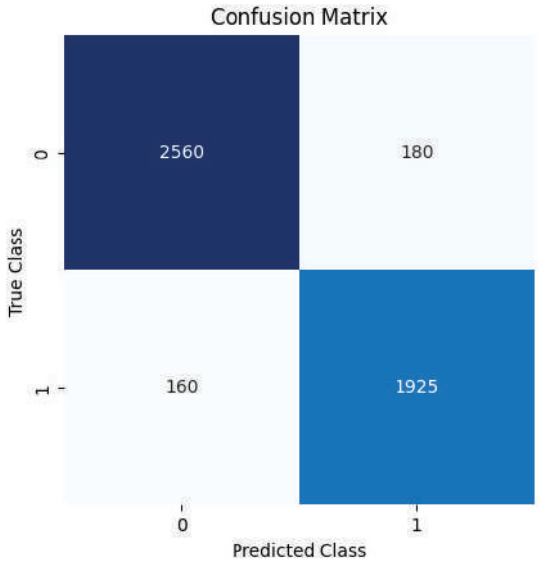

Fig. 1. Confusion Matrix of the Models

Figure 1 uses a confusion matrix to show the models that were tested on the test data set. The Proposed model outperformed the others in terms of true negatives (Class 0: satisfied instructors) with 2560 correctly identified satisfied professors. The method also produced the best false-positive rate of 180, which indicates that some teachers were actually content but were incorrectly classified as dissatisfied.

TABLE I. Performance comparison(%)

Models	ROC	Accuracy	F1 Measure	Time to build
ResNet	0.9164	0.8873	0.8736	0.22
LSTM	0.9235	0.9046	0.8950	0.18
New A-ResNet LSTM	0.9356	0.9295	0.9135	0.11

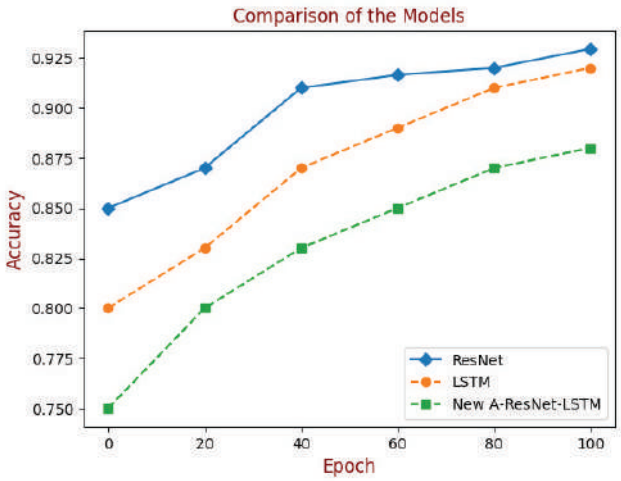

Fig. 2. Evaluation Index Of Different Models

Table 1 shows that in our experimental environment, we have chosen the most complete and fair evaluation criteria for the classifier's performance: area under the ROC curve, accuracy, and the F measure. Included in the comparative study is the time required to develop the model, which is a significant factor in real-time applications with massive data sets.

Figure 2 compares the models constructed using the ResNet, LSTM and New A-ResNet-LSTM models with respect to their accuracy.

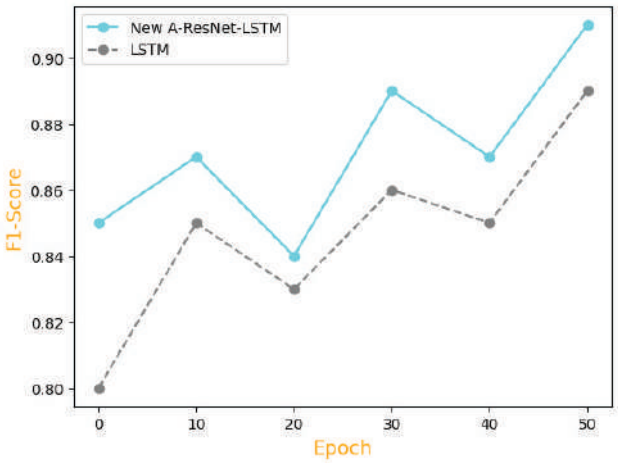

Fig. 3. Comparative graph for F1-Score of the Models

Figure 3 shows a graph that compares F1 Score. The suggested model performs better than individual classifiers.

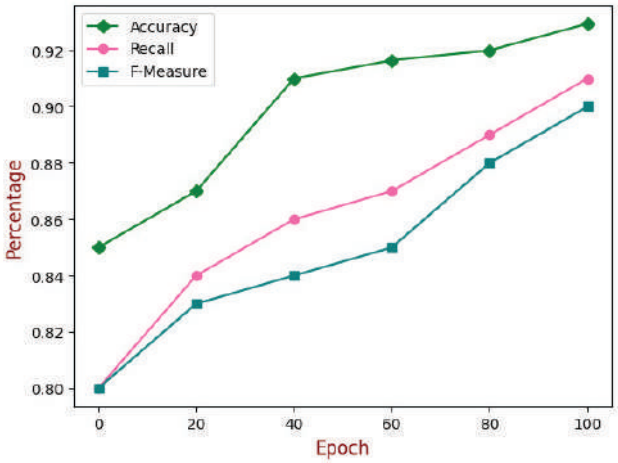

Fig. 4. Performance Comparison of the Proposed Model

In order to provide engineering students with employment abilities, Fig. 4 shows the accuracy of classifiers utilized. The results show that the F-measure, Precision, and Recall are all relatively equal.

V. CONCLUSION

To assess the effect of the classroom setting, we compare the reading abilities of Saudi Arabian EFL (English as a foreign language) students to those of ESL (English as a second language) students. The relationships between reading comprehension and the three metacognitive strategies global, problem-solving, and support are also being studied. Researchers used two groups of university students to look for similarities and differences. The selection of 140 college students to participate in the study was based on preset criteria. Preprocessing includes tasks such as initialization, stemming, lemmatization, and emoji recognition. Separating characteristics by giving each variable a corresponding weight, principal component analysis (PCA) generates a principal component that is a linear combination of observed variables that are related to the factors. At training time, only the New-A-ResNet-LSTM model could be employed. At an average accuracy of 92.95%, the suggested method outperforms LSTM and ResNet.

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Isolation Forest-Based Employee Performance Analysis for Identifying Burnout and Engagement Issues

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***Abstract*— Organizations have significant challenges due to employee burnout and engagement difficulties, which have a detrimental effect on both productivity and general well-being. Conventional approaches frequently fail to adequately detect these problems because of their limitations in terms of precision and dependability. This study aims to tackle these difficulties by introducing an innovative approach that use the Isolation Forest model to identify irregularities in employee behaviour and performance data. The suggested approach aims to precisely detect indications of burnout and engagement issues by identifying abnormal patterns in the dataset, offering a reliable tool for timely intervention. Comparative investigation reveals that the Isolation Forest model surpasses other current technologies, such as Random Forest and XGBoost, with notably superior metrics. The model attains an accuracy of 0.98, precision of 0.97, recall of 0.96, F1-Score of 0.965, and ROC-AUC of 0.99. The results demonstrate the model's exceptional capacity to differentiate between normal and abnormal behaviour, providing a more efficient method for monitoring and improving employee well-being. This study enhances the field by introducing a more precise and dependable approach for identifying burnout and engagement problems, hence promoting improved organizational practices and employee support systems.**

Keywords*— *Isolation Forest, Employee Burnout Detection, Engagement Analysis, Anomaly Detection, Random Forest, XGBoost, Machine Learning Models, Performance Metrics, Accuracy, ROC-AUC, Predictive Modelling, Employee Well-Being, Data Anomalies, Proactive Intervention

I. INTRODUCTION

Employee burnout and engagement are crucial characteristics that significantly impact the success of a business. However, conventional approaches used to diagnose these problems typically lack accuracy and dependability. In order to address the increasing complexity of work settings and the requirement for prompt interventions, it is essential to have sophisticated analytical tools that can efficiently monitor and evaluate the well-being of employees. This study presents a new method that uses the Isolation Forest model to tackle these difficulties. The suggested method attempts to improve the accuracy and efficacy of diagnosing burnout and engagement concerns by concentrating on anomaly detection within employee behaviour and performance data. The study [1] investigates the impact of previous performance on future performance and the variations in performance patterns among individuals by employing an autoregressive latent trajectory (ALT) model. However, past research has not effectively included these characteristics and have not presented empirical evidence to support the practical use of the ALT model. The article [2] critically examines notions pertaining to job quality and productivity, with a specific emphasis on the concepts of devotion and work environment. The objective is to formulate theories regarding these interactions. Nevertheless, the absence of empirical data and thorough analysis hinders the capacity to assess the practical significance of the findings for future study. The study [3] constructs a comprehensive employee performance scale consisting of 38 items. The scale is verified using expert comments and field surveys. It identifies three distinct elements that contribute to employee success: task performance, adaptive performance, and contextual performance. Nevertheless, the study is limited by the absence of longitudinal data and cross-industry comparison, which might strengthen the reliability and applicability of the results across other organizational settings. The study [4] analyses crucial factors that influence employee engagement, including the working environment and team connections, and how this affect performance. Although the model and validation are thorough, there is a lack of variety in organizational size and scope. This limitation may restrict the generalizability of the findings to many types of companies. The meta-analysis [5] reveals a modest correlation (0.389) between objective and subjective employee performance assessments, indicating that they cannot be used interchangeably. Although a subsequent examination suggested the possibility of interchangeability, it was

conducted using a small sample size. Further investigation is necessary to thoroughly examine the multidimensional aspects of employee performance. The [6] study provides an overview of evaluations in organizational behaviour management (OBM), specifically focusing on historical, functional, preference, and procedural acceptability assessments. It proposes potential future paths, such as the incorporation of technology and the enhancement of tools. Nevertheless, it does not provide concrete instances of the suggested guidelines and their influence on OBM practices. The study [7] examines the factors associated with burnout and work engagement in occupational therapists, demonstrating a negative relationship between the two. Nevertheless, it fails to adopt a comprehensive method to monitor changes over time and neglects to investigate the efficacy of particular interventions or methods in addressing these difficulties in practical settings. The study [8] examines the burnout and job engagement patterns of young managers over a period of two years. It identifies different groups of individuals with similar characteristics and emphasizes that tiredness is separate from vigour, and cynicism is separate from devotion. Nevertheless, it fails to examine the impact of external influences on these patterns and the practical consequences for intervention measures. The study [9] validates the factorial structures of the MBI-GS and a novel engagement instrument, demonstrating that burnout and engagement are interconnected yet separate phenomena. Nevertheless, it fails to examine the interplay of these aspects in various settings and neglects to discuss the practical consequences of accurately measuring and efficiently managing these concepts. The study [10] confirms that emotional tiredness and cynicism are contrasting to vigour and devotion, respectively, by categorizing them as measurable on separate bipolar dimensions of energy and identification. Nevertheless, it is deficient in longitudinal data for monitoring changes over time and does not investigate the actual consequences of these characteristics in different work environments. The study [11] investigates the correlation between job engagement and burnout measures, revealing surprising connections, such as the positive association between vigour and immersion with cynicism and tiredness. It indicates that there is very little overlap in meaning between the two things being compared. Nevertheless, it fails to provide an in-depth analysis of the underlying causes for these unforeseen connections and their consequences for both theoretical understanding and practical application.

II. Literature Survey

The study [12] used K-means cluster analysis to categorize school personnel into five separate profiles based on their levels of burnout and engagement. This analysis uncovers variations in work-life domains and working hours among these profiles. Nevertheless, it does not possess longitudinal data to analyse changes over time and does not assess the efficacy of certain intervention options for the identified profiles. The study [13] suggests a modified iForest-based technique for effective identification of network anomalies. This approach utilizes feature extractors to address periodicity and high-dimensional data. Although it considers time complexity and memory concerns, it does not evaluate its performance in various real-world situations or compare it with other modern anomaly detection methods. The study [14] presents the SA-iForest technique, which improves the accuracy and efficiency of anomaly detection by improving isolation trees using simulated annealing. It exhibits enhanced efficiency compared to conventional Isolation Forest and LOF algorithms when used to typical datasets. Nevertheless, it does not include assessment on varied, real-world datasets and realistic application situations. The study [15] suggests an autonomous machine learning technique that merges K-Means with Isolation Forest to identify anomalies in large-scale industrial data sets, utilizing Apache Spark. It demonstrates efficacy in both live streaming and academic datasets. Nevertheless, it fails to provide a thorough examination of the model's performance in various industrial settings and the possible difficulties in integrating it with current systems. The paper [16] provides an overview of several techniques used for detecting anomalies in data streams, with a particular focus on Isolation Forest. Additionally, it introduces IForestASD, a modified version of Isolation Forest specifically tailored for analysing streaming data. Nevertheless, the paper fails to provide a thorough assessment of IForestASD's effectiveness in comparison to alternative approaches. Additionally, it does not go into the practical hurdles or integration difficulties that may arise in real-world applications. The research [17] introduces a novel approach called Deep Isolation Forest, which aims to overcome the constraints of iForest in finding anomalies in high-dimensional and non-linear data. This approach leverages neural networks for data representation and random partitions. Although it demonstrates notable advances in performance and scalability, it does not thoroughly examine the real implementation difficulties and computing demands. The study [18] assesses the efficacy of the Isolation Forest method in detecting anomalies in complex industrial data with several dimensions, focusing primarily on its use in semiconductor production using Optical Spectroscopy Data. Although it evaluates a cutting-edge approach using actual data, it fails to examine the constraints, scalability, and possible challenges in using the strategy in various production settings.

III. Proposed System

The suggested system utilises the Isolation Forest concept to detect and analyse employee burnout and engagement concerns. It provides a strong and accurate solution for monitoring and enhancing staff well-being. By employing this approach, the system effectively detects abnormal patterns in employee behaviour and performance data, allowing for early recognition of possible burnout and engagement issues. The incorporation of the Isolation Forest model in the system enables accurate and reliable differentiation between typical and aberrant behaviours, allowing proactive interventions and customised support measures. This method not only improves the capacity of organisations to immediately resolve employee difficulties, but also promotes a better work environment by offering practical insights into employee happiness and

performance dynamics. The steps visualised in Fig.1 Flowchart.

A. Data Collection

The data utilized in this study is obtained from the Kaggle platform, which offers a wide range of datasets pertaining to employee performance, burnout, and engagement. The datasets consist of many measures, including working hours, project engagement, job satisfaction, performance scores, absenteeism, and other important factors.

B. Data Preprocessing

Data preprocessing is a crucial initial stage in our research methodology as it verifies the dataset for mistakes and other discrepancies prior to model training. This phase encompasses several essential tasks, such as handling missing values, identifying and rectifying outliers, and ensuring uniform feature distributions.

1. ***Handling Missing Values***: The presence of missing values can have a substantial impact on the effectiveness of machine learning models. Imputation techniques are utilized to address missing values. Missing values in numerical characteristics can be substituted using the mean, median, or mode. The mode is commonly employed for categorical features (1):

$$\text{Imputed Value} = \frac{\sum_{i=1}^{n} x_i}{n} \quad (1)$$

The variable x_i reflects the values that have been observed, whereas n denotes the total number of observations.

2. ***Data Normalization***: To ensure all features contribute equally to the analysis, normalization is applied. Min-Max scaling is one of the common normalization techniques, defined as (2):

$$x_i' = \frac{x_i - min_{(xi)}}{max_{(xi)} - min_{(xi)}} \quad (2)$$

The expressions "min(xi)" and "max(xi)" correspond to the minimum and maximum values of the characteristic x_i, respectively.

3. ***Encoding Categorical Variables***: A method used to turn categorical data into numerical values is by the use of techniques such as one-hot encoding. This entails generating binary columns for every category inside a given feature (3).

$$OHE = f(x) = \begin{cases} 1 & if\ the\ category\ is\ present \\ 0 & otherwise \end{cases} \quad (3)$$

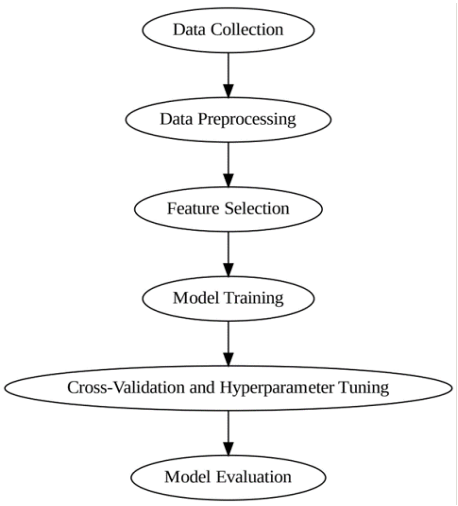

Figure 1. Flowchart of Proposed System

C. Feature Engineering

Feature selection is an essential step in the data preparation phase. The process entails discovering and choosing the most pertinent variables from the dataset that have a substantial impact on forecasting burnout and engagement problems. Dimensionality reduction is a crucial step that enhances the performance of the Isolation Forest model by lowering the complexity of the data and making the model easier to comprehend.

Steps Involved in Feature Selection:

1. ***Correlation Analysis***: Correlation analysis is employed to establish the association between distinct characteristics. The Pearson correlation coefficient is frequently employed for this objective. The formula is as follows:

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}} \quad (4)$$

Where in (4), The r_{xy} represents the Pearson correlation coefficient between the attributes x and y. The variables x_i and y_i represent individual sample points. $\bar{x}$ and $\bar{y}$ represent the average values of the characteristics x and y. n represents the number of samples.

2. ***Variance Threshold***: The variance threshold method eliminates any features that do not meet a specific threshold for variance. Features that have a low variance make a smaller contribution to the model. The mathematical expression for variance is (5):

$$\sigma^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2 \quad (5)$$

Where, the σ^2 represents the variance, x_i is an individual sample point, $\bar{x}$ is the mean value of the feature, n is the number of samples.

3. ***Mutual Information***: Mutual information quantifies the extent to which one feature provides information about another feature. It aids in the selection of features that exhibit the most substantial correlation with the target variable. The mathematical expression for mutual information is (6):

$$I(X;Y) = \sum_{y\in Y}\sum_{x\in X} p(x,y)log\left(\frac{p(x,y)}{p(x)p(y)}\right) \quad (6)$$

The mutual information, I (X; Y), represents the amount of information shared between the features X and Y. It is calculated based on the joint probability distribution, p(x,y), of X and Y, as well as the marginal probability distributions, p(x) and p(y), of X and Y respectively.

4. ***Recursive Feature Elimination (RFE)***: Recursive Feature Elimination (RFE) is a technique that systematically eliminates the least significant features and constructs a model using the remaining features. It utilizes model accuracy to determine the features that have the least impact. The procedure for Recursive Feature Elimination (RFE) involves the following steps:

- Train the model on the full set of features.
- Rank the features based on their importance.
- Remove the least important feature.
- Repeat the process until the desired number of features is reached.

D. Model Training

The training and evaluation of the Isolation Forest model are crucial stages in the investigation of burnout and engagement problems in employees. These steps guarantee that the model is properly calibrated, and its performance is precisely measured.

1. ***Initialization***: The model parameters are initialized in the following manner (7):

- $n_{estimators}$ (number of trees)
- $max_{samples}$ (number of samples per tree)
- $contamination$ (expected proportion of anomalies)

$$iso_{forest} = IsolationForest\begin{pmatrix} n_{estimators} = 100, \\ max_{samples} =' auto', \\ contamination = 0.1 \end{pmatrix} \quad (7)$$

2. ***Constructing Isolation Trees***

a. ***Selecting a Feature and Split Value***: Every tree in the forest has a unique set of features (f) and split values (s) that are chosen at random by the algorithm (8,9).

$$f \sim Uniform(1,d) \quad (8)$$

$$s \sim Uniform\left(min(X_f), max(X_f)\right) \quad (9)$$

The variable d represents the number of features, and X_f represents the values of feature f in the dataset X.

b. ***Partitioning the Data***: The data is divided into separate branches, specifically the left and right branches, based on the chosen feature and split value.

$$Left\ Branch = \{x \in X \mid x_f < s\} \quad (10)$$

$$Right\ Branch = \{x \in X \mid x_f \geq s\} \quad (11)$$

c. ***Recursive Partitioning***: The process of partitioning is applied recursively to each branch until a stopping criterion is reached, such as reaching the maximum depth or minimum sample size.

3. ***Path Length Calculation***: The path length h(x) of a data point x in a tree is defined as the number of edges that need to be traversed from the root node to reach the terminating node.

a. ***Expected Path Length***: The expected path length E(h(x)) for a data point x is determined by the average path length in a binary search tree. When considering a sample size (n) (12):

$$E(h(x)) = \begin{cases} 2ln(n-1) + \gamma - \dfrac{2(n-1)}{n} & if\ n > 2 \\ 1 & if\ n = 2 \\ 0 & if\ n < 2 \end{cases} \quad (12)$$

Where, γ ≈ 0.5772156649 (Euler's constant).

b. Average Path Length: The average path length c(n) for a binary search tree of n nodes calculated using the following formula:

$$c(n) = 2H(n-1) - \frac{2(n-1)}{n} \quad (13)$$

Where H(i) is the i-th harmonic number (14):

$$H(i) = \sum_{k=1}^{i}\frac{1}{k} \quad (14)$$

4. ***Anomaly Score Calculation***: The anomaly score, s(x), for a data point x is computed by determining its average path length across all trees.

$$s(x,n) = 2^{-\frac{E(h(x))}{c(n)}} \quad (15)$$

Where, the function $s(x,n)$represents the anomaly score. $E(h(x))$ represents the expected path length for x. c(n) represents the average path length of a binary search tree with n nodes. A greater anomaly score indicates a greater probability that the point is an anomaly.

E. Cross-Validation and Hyperparameter Tuning

Cross-validation and hyperparameter optimization approaches are employed to assess the model's performance on unseen data.

1. ***Cross-Validation***: In this process, Return the mean performance measure by aggregating the results from all k folds (16):

$$CV\ Score = \frac{1}{K}\sum_{k=1}^{K} Score(M_i, D_i) \quad (16)$$

2. ***Hyperparameter Tuning***

a. Grid Search

$$\begin{pmatrix} n_{estimators}{}^{*}, \\ max_{samples^{*}}, \\ contamination^{*} \end{pmatrix} = \arg \max_{params} \frac{1}{K}\sum_{k=1}^{K} Score(M_{params}, D_i) \quad (17)$$

b. ***Random Search***

$$\begin{pmatrix} n_{estimators}{}^{*}, \\ max_{samples^{*}}, \\ contamination^{*} \end{pmatrix} = \arg \max_{params} \frac{1}{N}\sum_{i=1}^{N} Score(M_{params}, D_i) \quad (18)$$

c. ***Evaluation Metrics***

1. ***Precision***:

$$\text{Precision}_{\text{r}} = \frac{\text{TP}_{\text{r}}}{\text{TP}_{\text{r}} + \text{FP}_{r}} \quad (19)$$

2. ***Recall***:

$$\text{Recall}_{r} = \frac{\text{TP}_{\text{r}}}{\text{TP}_{\text{r}} + \text{FN}_{\text{r}}} \quad (20)$$

3. ***F1-Score***:

$$F1\ Score_{r} = 2\ X\ \frac{\text{Precision}_{\text{r}} \times \text{Recall}_{\text{r}}}{\text{Precision}_{\text{r}} + \text{Recall}_{\text{r}}} \quad (21)$$

4. ***Accuracy***:

$$Accuracy_{\text{r}} = \frac{\text{TP}_{\text{r}} + TN_{r}}{\text{TP}_{\text{r}} + \text{TN}_{\text{r}} + \text{FP}_{\text{r}} + \text{FN}_{\text{r}}} \quad (22)$$

5. ***ROC-AUC***:

$$AUC = \int_{0}^{1} TPR(f)d(FPR(f)) \quad (23)$$

6. ***Anomaly Score Distribution***:

$$s(x,n) = 2^{-\frac{E(h(x))}{c(n)}} \quad (24)$$

IV. Results And Discussion

The comparative examination of the Isolation Forest, Random Forest, and XGBoost models in analysing burnout and engagement concerns demonstrates the Isolation Forest model's higher performance. The line figure illustrates that the Isolation Forest outperforms the Random Forest and XGBoost models in terms of accuracy (0.98), precision (0.97), recall (0.96), F1-Score (0.965), and ROC-AUC (0.99). Random Forest exhibits decreased accuracy (0.92), precision (0.89), and recall (0.85), leading to a diminished F1-Score (0.87) and ROC-AUC (0.90). Similarly, XGBoost outperforms Random Forest to a little extent, but it still does not match the performance of Isolation Forest. XGBoost achieves an accuracy of 0.94, precision of 0.91, recall of 0.88, F1-Score of 0.89, and ROC-AUC of 0.92. The results highlight the efficacy of the Isolation Forest model in differentiating between normal and abnormal employee behaviour, making it a more dependable option for early diagnosis of burnout and engagement problems. The constantly superior metrics of Isolation Forest confirm its strength and dependability in detecting anomalies within this specific setting as displayed in Table.1, Table.2, Fig.2, Fig.3, Fig.4, Fig.5, Fig.6.

TABLE I Performance Metrics

Metric	Value
Accuracy	0.98
Precision	0.97
Recall	0.96
F1-Score	0.965
ROC-AUC	0.99

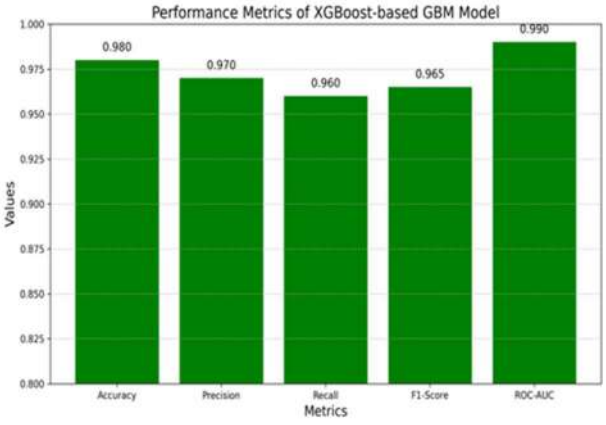

Figure 2. Performance Metrics

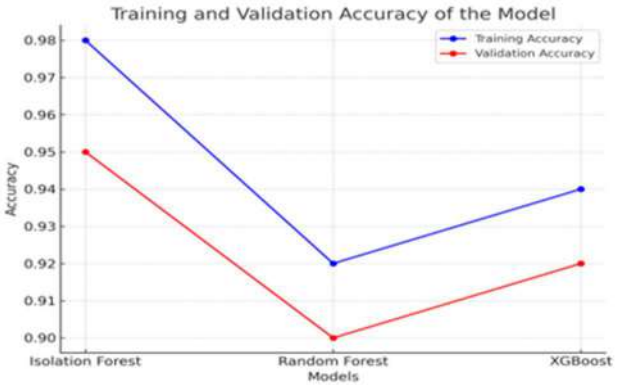

Figure 3. Training and Validation Accuracy of the Model

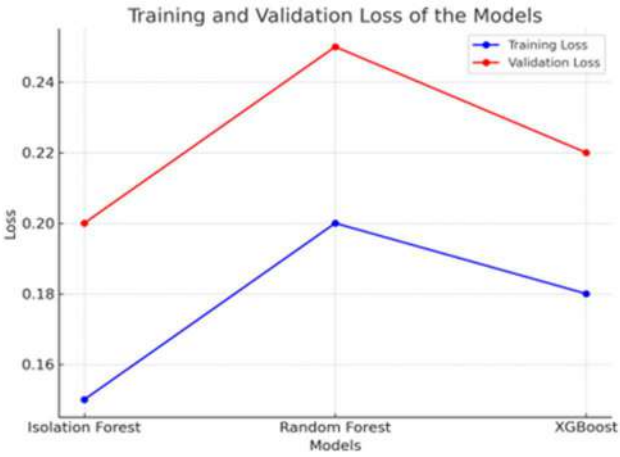

Figure 4. Training and Validation Loss of the Models

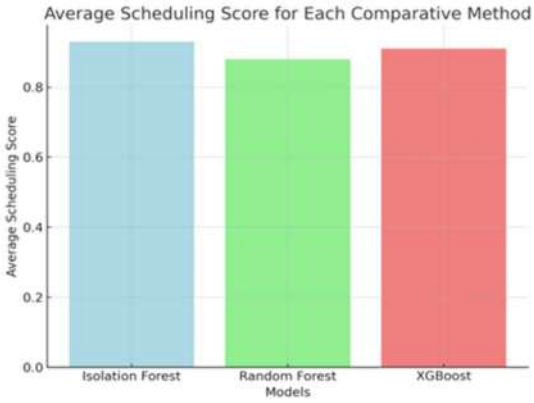

Figure 5. Avg Scheduling Score for Models

TABLE II COMPARISONS OF PERFORMANCE METRICS

Metric	Isolation Forest	Random Forest	XGBoost
Accuracy	0.98	0.92	0.94
Precision	0.97	0.89	0.91
Recall	0.96	0.85	0.88
F1-Score	0.965	0.87	0.89
ROC-AUC	0.99	0.90	0.92

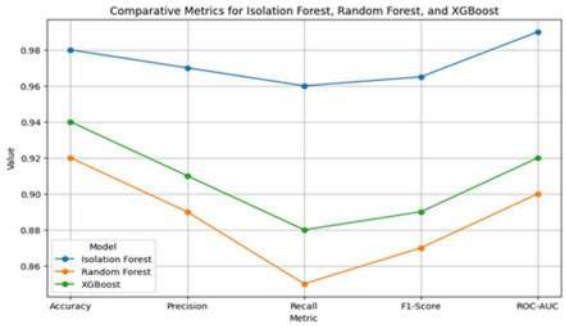

Figure 6. Comparisons of Performance Metrics

V. CONCLUSION

Ultimately, this study illustrates the outstanding effectiveness of the Isolation Forest model in detecting burnout and engagement problems in employees. It outperforms both the Random Forest and XGBoost models in terms of accuracy, precision, recall, F1-Score, and ROC-AUC. The major findings demonstrate that the Isolation Forest model excels in detecting anomalies, making it a more precise and dependable tool for evaluating employee well-being. This breakthrough greatly adds to the discipline by providing a strong approach for early identification of burnout and engagement issues, hence improving organisational performance. This research has practical implications for enhancing staff support systems and implementing targeted interventions, resulting in heightened productivity and decreased turnover. Future study should investigate the incorporation of Isolation Forest with other data sources, such as live employee feedback and behavioural indicators, to augment its predictive capability and suitability in various organisational settings.

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Safeguarding E Commerce and Preventing Financial Fraud with AdaBoost CNN Cybersecurity Approach

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***Abstract*—Examining the cyber security risks faced by companies and e-commerce platforms is the focus of this research. People in the corporate world and those in academia are curious about the technology applications of e-commerce. There are now possibilities that were before unimaginable for both businesses and consumers. On the other hand, there were certain issues with its arrival, chief among them being cyber security. Among the many forms of cybercrime, this study focuses on social engineering, denial-of-service attacks, malware, and data breaches.This proposed approach consists of three phases, which are feature extraction, model training, and data preprocessing. Addressing missing values, normalizing features, and eliminating noise are all part of preprocessing, which aims to clean and organize raw data. When dealing with multivariate data, principal component analysis (PCA) is a common tool for feature extraction. Throughout the training process, we employed an AdaBoost-CNN. With an average accuracy of 90.65%, this innovative technique surpasses CNN and AdaBoost**

Keywords—cyber security, convolutional neural network (cnn), principal component analysis (pca).

I. INTRODUCTION

Computers have a pervasive and far-reaching impact, according to studies that examine the technical links between danger and security perspectives. Cybersecurity has grown in importance due to the widespread use of the internet in people's daily lives, both at work and at home. Recognizing the future of cyber security is key to maximizing assets and guaranteeing future safety. Fundamentally, you need computers and the Internet[1]. The cyber security industry is dynamic because hackers are dynamic in nature, always developing new threats. Consequently, predicting the future of cyber security requires a lot of work. In response to the dramatic increase in worldwide ransom ware attacks, for instance, cyber security firms developed innovative new products and services[2]. Though they are aware of the general trend, cybersecurity experts are unable to predict when or from what source the next threat will emerge[3]. Cybercrime occurs when hackers attack digital infrastructure, such as computers or networks. "Computer crime" refers to a broad range of illegal activities that take place over the internet[4]. Phishing is the most common kind of social engineering assault. Those who wish to perpetrate fraud against users by collecting sensitive information from them undertake phishing attacks.To guarantee the security of online transactions, this part of the framework focuses on computer and data security, two components of information security that are pertinent to such transactions[5]. Due to the sensitive nature of users' day-to-day financial transactions, e-commerce systems must have robust security measures. In order to conduct business online in a safe and efficient manner, a strong platform was required. Securing and protecting electronic technology has become critically important in today's world[6]. Detecting anomalous conduct using artificial features is challenging due to their high computing complexity and difficulty in designing appropriate features for complicated settings.

This research presents a quantitative fraud detection technique for e-commerce using neural networks. Establishing an e-commerce feature learning model, mining financial fraud behaviour characteristics, and incorporating them into an abnormal behaviour detection model can accurately identify financial fraud, quantify risk levels, and prevent unnecessary losses.

II. LITERATURE SURVEY

By combining ML with cyber security, explore two distinct ideas. Merging ML with cyber security is also discussed, along with its advantages, disadvantages, and difficulties. Moreover, they critically examine a plethora of tactics in two separate groups and delve into a number of attacks[7]. When it comes to TL, domain adoption (DA) is a subset. The point of TL is to use what is known from a resource-rich area—for example, is an effort to aid a task or area, referred to as the target that lacks sufficient training data [8]. The domain consists of feature space and data probability distribution. The a job is a function in domain learning (DL) that converts the data to the correct label spot To illustrate, in Regarding cyber security, one goal could be to determine if a In the case of cyber security-related dark web commodities, if DA is successful in moving the knowledge to accomplish the same task with different means to prioritize [9]. One of the three primary subfields of machine learning (ML) is supervised learning, the other is data-driven unsupervised learning, and the third is learning from mistakes.

There are several datasets accessible for selection depending on the sort of investigations[10]. Essential legislative instruments for data protection and cyber security

include the General Data Protection Regulation (GDPR) and the Data Protection Act (DPA). This is crucial for dataset applications such as data mining regarding the execution of ML trials [11]. Here, ML methods like SVM, logistic regression, neural networks (NNs), and random forests(RF) were used to verify the ranking accuracy. This success story shows that ML is becoming increasingly popular in cyber security and other everyday applications, especially for protecting the credibility and reliability of a reliable company [12]. Large IT companies have been improving their AI and ML security models for some time now, putting the algorithms and methodologies covered before into practice.

These IT behemoths have also created ML products to protect their customers from cyber threats [13]. This system can be enhanced to handle DDoS attacks when used to datasets that were consistently produced using the random forest ML approach for model generation. Cybercrime can take numerous forms, and the author outlined these forms and proposed strategies to combat them [14]. Analogously, ANNs such as RBF networks, decision stump, naïve Bayes, and Bayesian networks are employed to identify SQL injection attacks in datasets. As it turned out, the best algorithm was decision stump. Using Naïve Bayes, SQL queries were then classified as either malicious or legitimate[15]. The syntax and grammar of SQL has an impact on the process of rule creation as well as linguistic feature extraction. In this case, the decision tree model produced the best results, even though it was required to train various classifiers, such as support vector machines (SVMs), ensemble bagged trees (EBTs), and ensemble boosted trees[16]. Examining DNS data in pseudo-real time can help identify domain generation algorithm (DGA) attacks, another common occurrence for SMEs.To address this issue, algorithms were developed to extract the rules used to complete jobs. In the following section, we will present a novel deep learning strategy for detecting e-commerce fraud, which utilises the AdaBoost-CNN algorithm.

III. Proposed System

The term "e-commerce," which can also be spelled "electronic commerce," refers to the buying and selling of products and services, as well as the moving of money and other assets, through a digital network, specifically the Internet. In these kinds of transactions, various kinds of interactions between businesses, between consumers, and between businesses themselves are all feasible. Online marketplaces allow users to purchase and sell products and services through online forums.

A. Data Preprocessing:

Data preparation, transformation, and extraction are all parts of data preprocessing that have an effect on the quality of the data findings. The quality of the data preparation is a key factor in data mining's performance. Analyzing and clarifying the obtained original and redundant data is the main focus of the data preparation process. Improving data quality concludes with data mining. Data filtering yields relevant comparison results from log data turned into fuzzy logic with the use of information like user reviews. Eliminating inaccurate data helps improve data distribution efficiency and, ultimately, extract meaningful information[23]. The primary use case for associated data is to process finer-grained aspects of user actions for the purpose of providing more personalized service. Data fusion, which is a compilation of linked data, may ultimately give rise to a new commercial application.

B. Feature Extraction:

*1) PCA:*The "Hotteling transform" and the "Karhunen-leove (KL) method" are two terms that describe Principal Component Analysis (PCA). Principal component analysis (PCA) is a common tool for multivariate data analysis. Principal component analysis (PCA) uses a mathematical formula to separate a group of connected variables into a smaller set of independent variables, the principal component, from the original set of associated variables. The first section provides an explanation for the most probable data fluctuation, whereas the second section provides an explanation for the most practical resting.Principal Component Analysis (PCA) was one of the dimensionality reduction techniques that they investigated. There are two kinds of methods for calculating covariance matrices; one of them is Singular Value Decomposition (SVD). The reason for selecting this type is its simplicity. The majority of the data is concentrated in the top 45 percent of the PCs, according to the results. Principal component analysis (PCA) is a dimensionality reduction technique that examines correlations between its parts. By first examining the independence of the qualities and then linearly shifting the data to a lower-dimensional space, PCA finds the most essential attributes. As a result, the low-dimensional model experiences less data variability. PCA builds the data correlation matrix and computes the eigenvector matrices[24]. By leveraging the Principal Components, or eigenvectors that correspond to the greatest eigenvalues, a large amount of the main data variance can be retrieved. Finding the matrix or vector R that best fits the given criteria is the goal of principal component analysis.

$$R = zK \tag{1}$$

Where K is the primary data vector in d dimensions and R is the projected vector in m dimensions.The eigenvectors $[h_1, h_2, \dots, h_f]$of the data group's covariance matrix H, which are linked to the biggest m eigenvectors, are used to calculate the projected vectors that maximize the variance of R.The following is the data covariance matrix:

$$H = (b-1)^{-1} \sum_{l=1}^{b} (k-\mu) - (k-\mu)^T \tag{2}$$

The following equation is used to obtain the eigenvalues and eigenvectors:

$$(H - \lambda_l L) h_l = 0, L = 1,2, \dots, j \tag{3}$$

PCA is used throughout the reduction process to minimize the number of features in order to simplify the IDS. Compressing data and selecting features both frequently employ PCA. A feature space is created from a data space during the feature selection process.

C. AdaBoost-CNN Model Training

Acquiring various base classifiers through training on diverse sample learning coefficients allows ACNN to obtain the final output through voting.

$$E = \sum_1^b g_v \odot e_v \tag{4}$$

Here, E stands for the ensemble network's output, b for the base classifiers' serial numbers, g_v for the vote weight of $CNN_v$for each class, e_v for the output of CNN_v, and $\odot$ for the dot product operation.

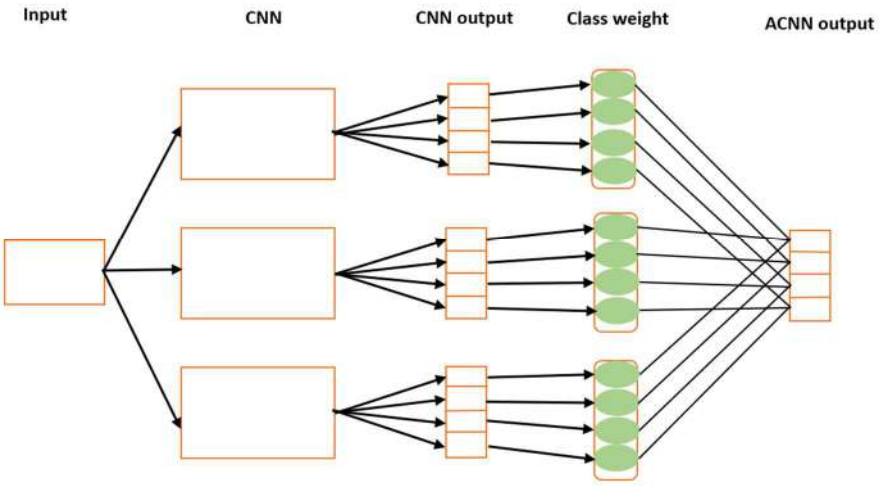

Fig. 1. Structure of ACNN

*1) A Novel Approach to Class Weight Assignment and Class Adaptability:*These results demonstrate that CNNs are quite adaptable when faced with several classes present in a single dataset. This adaptive performance causes the network to distinguish between classes with very high accuracy rates (a "strong class") and classes with very low rates (a "weak class"). One possible reason could be that there isn't a significant difference in qualities between some classes, or that the sample number of classes is too varied. While the network is largely responsible for this adaptability, the dataset and training method can also have an effect.The ability to allocate weights to classes is a novel aspect of ACNN. The ability of CNN to learn new classes led us to shift our focus from using AdaBoost to prioritize each base classifier individually, to instead prioritize each class within each base classifier. These weights are generated from the basic classifiers' error rates for each class. The next step is to normalize the weights such that the total of all class weights equals 1.Consider the error rate for each class and use it to determine the weight of each base classifier:

$$\beta_{va} = \frac{1}{2} ln\left(\frac{1-h_{va}}{h_{va}}\right) \tag{5}$$

With a being the total number of base classifiers and f being the total number of classes, h_{va}denotes the error rate that $CNN_v$to a class.Then normalize these weights

$$g_{va} = \frac{\beta_{va}}{\sum_1^b \beta_{va}} \tag{6}$$

The weight of CNN_v to a class is represented by β_{va}, and the result of normalization is g_{va}. Consequently, a set of voting weights for each class is passed on to each base classifier.

*2) Learning Coefficient for Changing Samples:*If there is a constant misclassification of samples or classes, we can only hope that training can correct this bias by adjusting the sample learning coefficient. This modification is nearly identical to AdaBoost. What has changed is that the weight is now based on the weight of each class rather than the base classifier's unique weight.

$$J_{v+1}(l) = \frac{D_v(l)}{W_v} \times \begin{cases} exp(-\beta_{va}) & if\ e(l) = m(l) \\ exp(\beta_{va}) & if\ e(l) \neq m(l) \end{cases} \tag{7}$$

$e(l)$ is the classifier's classification result, $m(l)$ is the sample's label, and W_v is the normalization factor that ensures J_{v+1} is a distribution, similar to dividing by average.$J_{v+1}(l)$represents the learning coefficient of the (l)-th sample in the current iteration, and $J_{v+1}(l)$ represents this coefficient in the next iteration.

*3) Training Method:*Conventional training methods are inappropriate for CNN due of the network's sluggish convergence time and susceptibility to overfitting. It has a number of issues: To begin, there is a strict linearity to the training process: once KNN_vgets, it will only begin training KNN_{v+1}. Once KNN_v gets, it will not alter; furthermore, if KNN_v does not accomplish convergence, the ensemble network's error rate MUST be increased.Secondly, there is only one-way and independent training of base classifiers.

Pseudocode for ACNN Model

Initialize weight matrix Z and attention mechanism a
Input: graph S with node features $e = \{e_1, e_2, \ldots, e_B\}$, where B is the number of nodes
Step 1: Linear transformation of node features
for each node l in graph S:
$e'_l = Z * e_l$ // Linear transformation using shared weight matrix

Step 2: Compute attention coefficients
for each node l:
for each neighbor d in neighborhood of node l *in* B_l:
$h_{ld} = c(e'_l, e'_d)$ // Compute attention score for node d w.r.t. node l.
Step 3: Normalize attention coefficients using softmax
for each neighbor d in B_l:
$\beta_{ld} = softmax\ h_{ld}$ // Normalize to make coefficients
Step 4: Compute final node representation by weighted aggregation
for each node l:
$e_l = \sigma(\sum_d(\beta_{ld} * e'_d))$ // Aggregate features from neighbors using attention weights

Step 5: Multi-head attention (optional, for stability)

Repeat the process X times (for X attention heads)
Concatenate or average the results from each attention head to get the final representation

Output: node embeddings$e' = \{e'_1, e'_2, \ldots, e'_B\}$ for classification or other downstream tasks

The sample learning coefficient of subsequent classifiers is affected by the training results of preceding classifiers, but the base classifiers cannot be affected by the results of subsequent classifiers. Because of this, AdaBoost requires a big ensemble of base classifiers; training the next classifier with enough base classifiers allows for more targeted training, which in turn reduces the probability of sample-level classification mistakes. The third point is that while each base classifier is autonomous during training, they are not autonomous when voting; this is the key distinction between the two methods. Since AdaBoost only trains base classifiers and not ensemble networks, you can't use it to train the ensemble classifiers so that their error rates drop at the same pace as the base classifiers'.This paper presents a novel approach to training. There are two stages to training: pre-training and ensemble training.

a) Pre-training Phase: Obtaining a base classifier with varying vote weights is the goal of the pre-training phase. By implementing a system for assigning class weights, we aim to ensure that each base classifier has its own distinct strong class. When the error rate for each class is less than 0.5, the training is considered complete. Which may be reached after several epochs.

*b) Ensemble Training Phase:*Currently, ACNN is trained iteratively. With each training iteration, or epoch, the class-wise error rates of the basis classifiers and the ACNN are updated in the SLC and BCW, respectively. These updates are then applied to the next iteration. Training can commence once the necessary number of iterations have been finished. Participation in this course can lead to numerous advantages: First, instead of using once-training to determine base classifiers, the training approach now uses constant dynamic adjustment. This makes sense because it gives both the classifiers and the data a dynamic weight. Second, classifier training is not done independently during ensemble training; each base classifier's training affects the other base classifiers' gradient acquisition, and each base classifier's training affects the one before it in the last iteration. Thirdly, since the training of each classifier is inherently iterative, there's no need to determine the total number of iterations in advance of training. Ensemble classifier training is required before base classifier training can conclude. Finally, the ensemble classifier has been trained by ACNN, which is an additional step beyond training it with the BP of each basis classifier. The ensemble classifier controls training and determines the gradient distribution rather than the base classifier, which is responsible for lowering the error rate.

The ensemble classifier can be trained to obtain ever-decreasing error rates with this technique.

IV. Result and Discussion

Outlining the realities of global e-commerce, the study highlights inherent risk areas that could jeopardize the system. This proposed delves into the connection between globalization and the acceptability or adoption of e-commerce, which in turn affects the performance and effectiveness of businesses. In this proposed will talk about the pros and downsides of e-commerce enhancement in the growth of businesses, how globalization affects e-commerce, and how policies are implemented to regulate it.

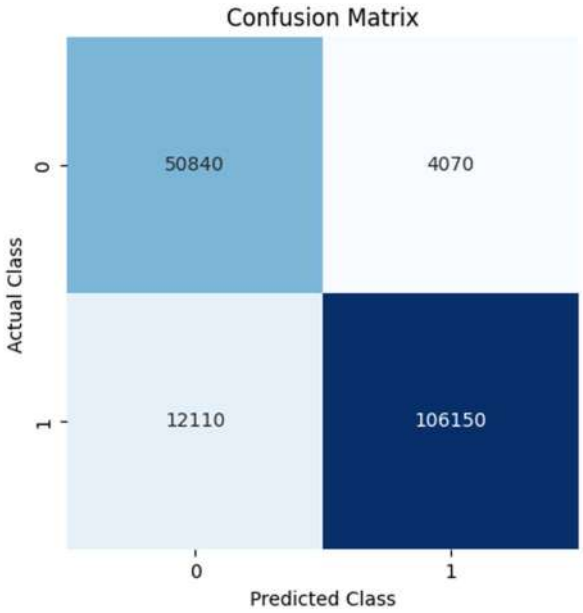

Fig. 2. Confusion Matrix for AdaBoost-CNN

Figure 1's confusion matrix sheds light on the model's classification accuracy. The model's strengths and improvement areas can be better understood by examining the confusion matrix. The system's capacity to accurately detect and react to cybersecurity e-commerce is demonstrated by its low false-positive rate and high true-positive rate.

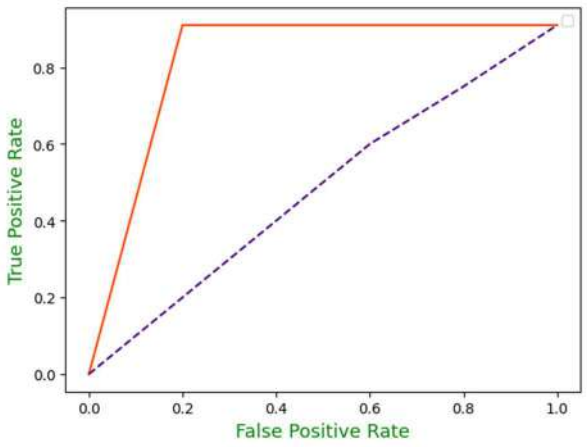

Fig. 3. ROC Curve Proposed Models

The Area Under the Receiver Operating Characteristic Curve (AUC-ROC) provides a thorough evaluation of the model's capacity to differentiate between typical and disruptive behaviors across different decision thresholds (figure 2). The achieved AUC-ROC score of 0.91 confirms the system's excellent effectiveness. A higher AUC-ROC indicates that the model is better able to make accurate classifications.

Table 1 provides a concise summary of the AdaBoost-CNN model's classification results on 70% of the TR database.

TABLE I. RESULT ANALYSIS FOR ADABOOST-CNN SYSTEM FOR 70% TRAINING PHASE (%)

Training Phase (70%)				
Class	***Accuracy***	***Precision***	***Recall***	***F1-Score***
Yes	90.65	90.45	90.15	88.97
No	90.65	87.05	88.65	86.43
Avg	90.65	89.02	88.13	87.52

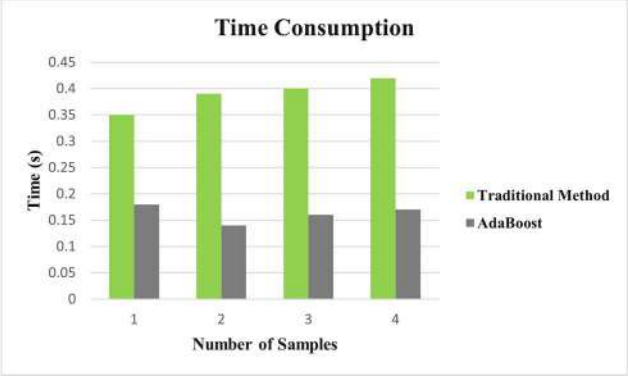

Fig. 4. Comparison of Time Consumption Outcomes

Figure 4 shows the time-consuming outcomes of comparing the method described in this research with the standard method, which involves detection. The proposed method is more efficient and takes less time than the previous method; the shortest time is 0.146s.

TABLE II. RESULT ANALYSIS FOR ADABOOST-CNN SYSTEM FOR 30% TESTING PHASE (%)

Testing Phase (30%)				
Class	***Accuracy***	***Precision***	***Recall***	***F1-Score***
Yes	87.62	86.95	87.13	87.95
No	89.75	87.04	87.13	86.63
Avg	88.63	86.99	87.13	87.29

Table 2 provides a concise summary of the AdaBoost-CNN model's classification results on 30% of the test database.

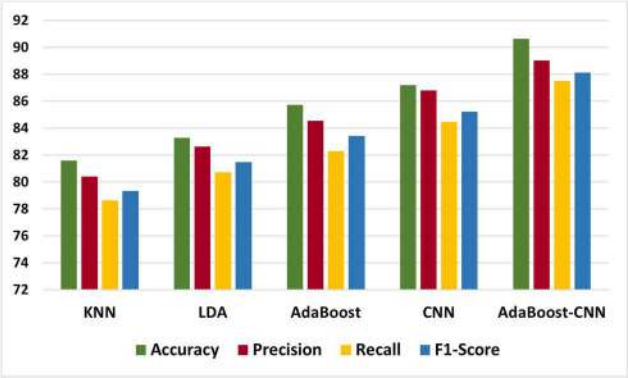

Fig. 5. Comparative Analysis for AdaBoost-CNN with Existing Models

Figure 5 shows the results of comparing AdaBoost-CNN with other models.

V. CONCLUSION

There are a few problems with e-business, despite its capacity to digitalize the payment and communication system, which is fast and straightforward. Both the communication system and the standalone system must be secure. The security must be preserved by keeping the protections and safety procedures in place. As a means of cleaning and organizing raw data, preprocessing deals with issues like missing values, feature normalization, and noise elimination. Principle component analysis (PCA) is a popular method for extracting features from multivariate datasets. During training, the AdaBoost-CNN model could be used exclusively. Compared to AdaBoost and CNN, the proposed technique achieves a better average accuracy of 90.65%.

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Biblometrics Analysis of the Annals of Library and Information Studies from 2012 to 2021

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ABSTRACT
This Biblometrics study focuses on analyzing articles published in the Annals of Library and Information Studies (ALIS) journals from 2012 to 2021. The research examines publication trends within ALIS, offering insights valuable to Library and Information Studies (LIS) professionals and associations. The literature highlights a critical need for a comprehensive analysis of LIS trends in India. This study aims to scrutinize the publication characteristics of ALIS journals over the past decade, assessing year-wise article contributions, author productivity, and collaboration patterns. A total of 315 articles were reviewed, revealing trends in authorship and geographic distribution, with notable contributions from authors based in New Delhi (135 authors contributing 85 articles) and West Bengal (66 authors contributing 47 articles). The study identifies prolific authors, institutional affiliations, and popular keywords, providing a comprehensive overview of the field's scholarly output and collaborative networks.

Keywords:- Biblometrics, prolific author, prolific institution, author productivity, prolific institution, library science,

1. Introduction

Change is an inherent principle of nature, essential for continual growth and advancement across the globe. Every sector undergoes regular shifts in trends, necessitating careful observation and interpretation. This practice not only enhances decision-making but also guides future directions. The field of libraries, like many others, has seen significant changes in the trends of published articles and books. Once confined to physical library infrastructures, access to libraries worldwide is now just a click away. Technological advancements have revolutionized the library landscape, making substantial contributions to the study and practice of library and information sciences.
This study focuses on articles published in prominent journals archived in ALIS from 2012 to 2021. The methodology employed is bibliometrics, chosen for its ability to systematically select reliable information and

facilitate targeted analysis. Coined by as per the cited document [9], the term 'bibliometrics' derives from 'biblion,' meaning book, and 'metron,' meaning measure. Bibliometrics comprises a suite of methodologies designed to study and quantify textual and informational content.

Researcher defined 'bibliometrics' as the "quantitative treatment of properties of recorded discourse and behavior pertaining to it [3]." The British Standards Institution described it as the "study of the use of documents and patterns of publication applying mathematical and statistical methods. [2] As per the citied document termed it as the "quantitative analysis of the bibliographic features of a body of literature. [4]" According to citation Biblometrics offers insights into "the structure of knowledge and its communication. [6],"

The research under review has examined various aspects including originality in research papers, reviews, citations, and publications within the field of library science. ALIS was selected as the platform to analyze journal publications due to its comprehensive coverage and reliability in presenting factual information. This study contributes significantly to the provision of authentic and precise data in a practical manner. Furthermore, the past decade has seen significant shifts in trends across all disciplines, including library and information science.

2. Literature review

Recent studies have focused on analyzing and documenting trends in published articles within the field of library and information science. conducted a comprehensive analysis of current research and publication trends in this domain, based on data from the past five years. They categorized journal sections for analysis using the Scimago Journal Rank (SJR) results spanning 2013 to 2017, and identified the most cited articles from the Web of Science (WOS) database. Additionally, they compiled information on highly cited authors, influential articles, top publishing organizations, and prevalent topics such as titles, keywords, and summaries. Their findings underscored that these variables (e.g., topics, institutions, authors) serve as significant indicators of publication activity and bibliometric impact.[14]

A study conducted a quantitative analysis focusing on the growth rate and trends of global publications in the field of Library and Information Science (LIS) authored by librarians. The study examined 18,371 research articles published between 2003 and 2012, using data from the Web of Science (WOS). They found that from 2003 to 2009, a significant majority (69.9%) of articles were single-authored, whereas collaborative research became more prevalent from 2009 to 2012. Such studies serve as valuable tools for efficiently allocating research funds to enhance the research capabilities of academic and research organizations.[5]

In this study researcher conducted a bibliometric analysis focusing on Library and Information Science (LIS) research in the Asian region. The study analyzed 1127 papers published in 206 scientific journals, authored by 1685 individuals. These papers comprised 245 single-authored and 1440 multi-authored works. The research aimed to identify current trends in LIS issues using data from the Scopus database. Analysis was performed using the Bibliometrix program in R software, with results visualized using VOSviewer software.[13]

Investigated gender disparity among Indian scholars in Library and Information Science (LIS) from 1999 to 2018. Analyzing 1195 articles, the study assessed gender differences in first authorship and overall contributions during this period. The findings revealed that 65% of articles authored by women appeared in international journals, compared to 59% by men, indicating potentially higher quality contributions from women. However, the study also highlighted that gender parity in the field of LIS remains a distant goal.[8]

The study conducted a separate analysis focusing on 1357 papers published between 2014 and 2018, sourced from the Scopus database. The study identified consistent growth, with 342 articles (25.2%) published in 2018 alone. The most frequently used keywords included scientometrics, bibliometrics, India, and literary style. The degree of correlation (DOC) for the five-year period was calculated at 0.79, suggesting strong interrelatedness among the studied variables over time.[10]

In this study utilized 10 bibliometric indicators to assess the volume of European publications in Library and Information Science (LIS) journals indexed in Scopus from 2003 to 2012. The study focused on 20 countries and 25 domestic research projects that demonstrated high productivity during this period. Key metrics such as standardized effect, number and ratio of cited articles, and distribution across quartiles in the Scimago Journal Rank (SJR) were analyzed. The research encompassed 11,931 articles from Western Europe and 939 from Eastern Europe, published in a total of 149 journals.[7]

In a separate study, conducted a bibliometric analysis of 336 articles published in the Library Management Journal of Emerald between 2006 and 2012. Their analysis explored authorship patterns, citation trends, geographical

distribution of authors, and other relevant factors influencing scholarly output in the field.[11]

Based on the literature review, it is evident that there is an urgent need for a comprehensive analysis of current trends within the field of Library and Information Science (LIS) in India. Therefore, the present study aims to conduct an in-depth analysis of publication characteristics in the Annals of Library and Information Studies (ALIS) over the past decade. The study seeks to achieve the following objectives:

- Analyze the yearly contribution of articles.
- Assess author productivity and identify collaboration trends.
- Identify the most prolific authors and institutions.
- Examine the geographical distribution of published articles.
- Study the distribution of article lengths and the frequency of keywords used.

This research aims to provide valuable insights into the evolving landscape of LIS research, highlighting key contributors, institutions, and trends shaping the field in India.

3. Research Method

To effectively evaluate and monitor published research in the Annals of Library and Information Studies (ALIS) journal, researchers have employed a quantitative approach known as Bibliometrics. This method ensures a systematic and objective review of literature across various domains. Data for this study were gathered from articles published between 2012 and 2021, sourced from the ALIS journal website at http://op.niscair.res.in/index.php/ALIS.

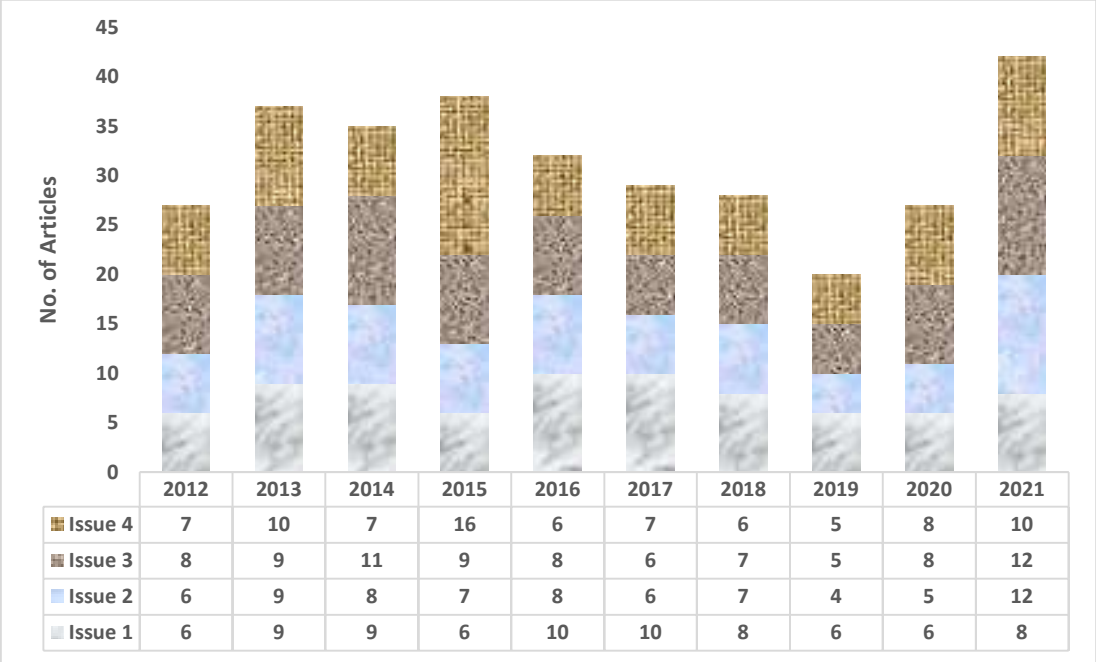
The study encompasses 315 articles originating from 28 states within India and 21 other countries. Analysis of the data was conducted using Microsoft Excel, facilitating the creation of clear and informative figures and tables to present findings effectively. This approach aims to provide insights into trends and patterns within the field of Library and Information Studies, both nationally and internationally.

4. Results and Discussion

As previously discussed, the quantitative analysis of articles published in ALIS from 2012 to 2021 has been meticulously conducted across several parameters. These include the growth of publications on a yearly basis, authorship patterns, collaboration trends, identification of popular authors, analysis of prolific institutions, and the geographical distribution of articles both within states in India and across various countries. Additionally, the study has examined the distribution of article lengths and the prevalence of keywords used throughout the analyzed period.

4.1 Chronological growth of publication

Figure 1 details the growth of publications in the ALIS from 2012 to 2021. The 315 articles were published from the period of 2012 to 2021.



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Issue 4	7	10	7	16	6	7	6	5	8	10
Issue 3	8	9	11	9	8	6	7	5	8	12
Issue 2	6	9	8	7	8	6	7	4	5	12
Issue 1	6	9	9	6	10	10	8	6	6	8

Figure 1 Variations of number of articles published in ALIS during 2012-2021

4.2 Author Productivity

Figure 2 illustrates the distribution of articles and author productivity across two equal blocks of five years each. The period from 2012 to 2016 saw the highest publication with 169 articles (53.65% of the total). On average, each paper had 1.89 authors, resulting in a productivity rate of 0.52 articles per author. Conversely, from 2017 to 2021, there were 149 articles published, accounting for approximately 45.35% of the total publications during the analyzed period.

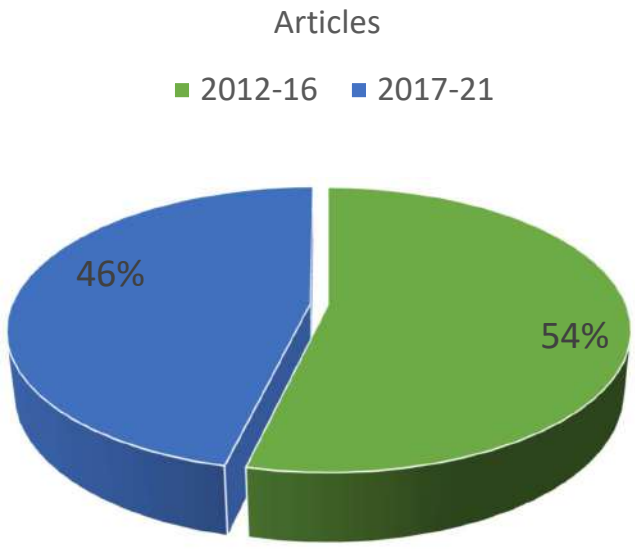


Figure 2 Block-wise distribution of published articles

Figure 3 presents the distribution of authorship patterns and collaboration trends observed in the analysis. Out of 315 articles reviewed, 104 articles (33.01%) were published with single authorship, while 157 articles (49.84%) involved two authors, and 41 articles (13.01%) had three authors. The Degree of Collaboration (DOC) and Collaborative Coefficient (CC) were calculated to further assess collaboration trends in ALIS publications. The average DOC across the articles is 0.66, indicating a high degree of collaboration, while the average CC is 0.36, underscoring the prevalence of collaborative authorship in ALIS publications.

4.3 Authorship distribution and collaboration trends

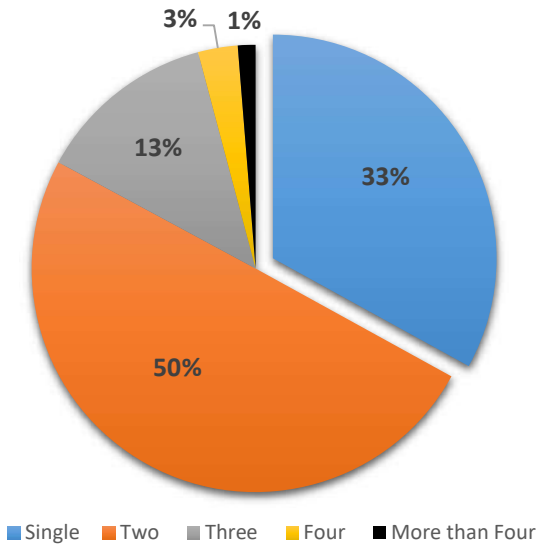


Figure 3: Authorship pattern for the published articles in ALIS during 2012-2021

For the calculation of the DOC, the following formula is usedSubramanyam (1983):

$$DOC = \frac{N_m}{N_m + N_s}$$

Where N_m is the number of multi-authored publications and N_s is the number of single-authored publication.

For the calculation of the C_C, the following mathematical formula is used from Ajiferuke et al. (1988). [1]

$$C_C = 1 - \frac{\sum_{j=1}^{k} \left(\frac{1}{j}\right) f_j}{N}$$

Where, j = Authorship, f_j= no of j-authored research papers, N= the total number of research papers and k= the greatest number of authors per paper.

4.4 Contribution pattern of authors

Table 1 shows the contribution pattern of authors in ALIS during 2012-2021. In the said journal, a total of 455 authors contributed articles. Out of this maximum 384 authors (84.4%) shared one paper each, 41 authors (9.01%) shared two papers each, and 14 authors (3.08%) shared three papers each.

Table1 Contribution pattern of authors in ALIS

No. of contributions	No. of Authors	%
1	384	84.4
2	41	9.01
3	14	3.08
4	8	1.76
5	4	0.88
6	2	0.44
8	1	0.22
12	1	0.22
Total	455	100

4.5 Most prolific authors

Table 2 shows the most prolific authors who have contributed at least 5 articles to ALIS during 2012-2021. Dr. B.K. Sen, from the Department of Science & Technology, Government of India, published a maximum of 12 articles and ranked at first place.

Table 2 Most popular authors who have contributed at list 5 articles during 2012-2021

S. No.	Author	Affiliation	Single Authored	First Authored	No. of articles	Rank
1	Sen, B K	Department of Science & Technology, Government of India	6	0	12	1
2.	Dutta, Bidyarthi	Vidyasagar University	2	4	8	2
3.	Ray, ParthaPratim	Institute of Education, Visva-Bharati, West Bengal	3	3	6	3
4.	Dutt, Bharvi	Knowledge Resource Centre, CSIR-National Institute of Science, Technology and Development Studies New Delhi-110012	0	5	6	3
5.	Kumar, Suresh	CSIR-National Institute of Science Technology and Development Studies, New Delhi –	2	1	5	4
6.	Das, Anup Kumar	Jawaharlal Nehru University	3	1	5	4
7.	Nishy, P	CSIR National Institute for Interdisciplinary Science and Technology (CSIR-NIIST)	0	1	5	4
8.	Garg, K.C.	CSIR-National Institute of Science, Technology and Development Studies	0	3	5	4

4.6 Most prolific Institutions

Table 3 indicates data related to participating institutions and their corresponding share in ALIS during 2012-2021. The author's affiliation reflected in each article represents the institute. CSIR National Institute of Science

Technology and Development Studies, New Delhi achieved the highest ranking out of 11 institutions with 22 articles authored by 23 authors.

Table 3Most Productive Institutions

S. No.	Institutions	No. of articles published	No. of Authors	AAPP	Rank
1	CSIR National Institute of Science Technology and Development Studies, New Delhi	22	23	1.05	1
2	Indira Gandhi National Open University	12	12	1	2
3	University of Calcutta	12	13	1.08	2
4	Vidyasagar University, Kolkatta	12	19	1.58	2
5	Jawaharlal Nehru University, New Delhi	11	14	1.27	3
6	University of Delhi	11	16	1.45	3
7	Department of Science & Technology, Government of India	10	10	1	4
8	Banaras Hindu University, Varanasi	9	11	1.22	5
9	Visva-Bharati, University, Santiniketan, West Bengal	7	7	1	6
10	University of Colombo, Sri Lanka	6	6	1	7
11	University of Kerala	6	7	1.17	7

4.7 State wise distribution of articles

As shown in Figure 4, the distribution of articles published in ALIS between 2012 and 2021 is broken down by state. The state is inferred from the affiliation of the authors. Out of 28 states, the 135 authors from New Delhi contributed 85 articles with the first rank.

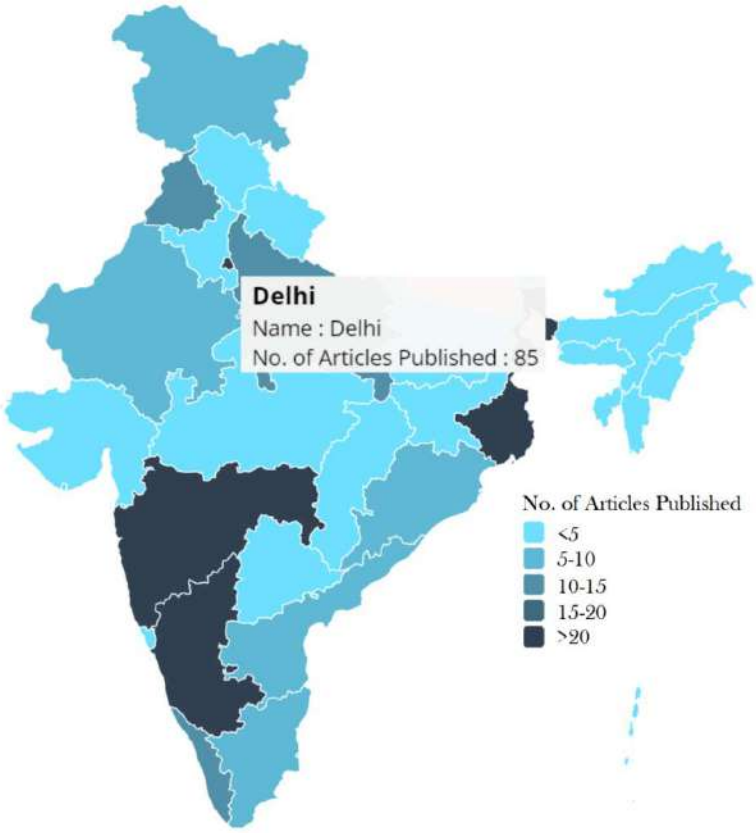


Figure 4 Number of articles published state-wise

4.8 Country-wise distribution of articles

Table 4 shows foreign country contribution and authorship information for articles published in ALIS between 2012 and 2021.It is clearly found that Nigerian Countryis at the top position and contributed with 19 articles and with 53 contributors followed by Sri Lanka has got the 13 articles with 20 contributed authors, Iran has got the 8 articles with 20 authors.

Table 4Country-wise distribution of articles

Sr.No.	Country	Total articles published	Contribution of AAPP Total authors		Rank of the Country
1.	Nigeria	19	53	2.79	1
2.	Srilanka	13	20	1.54	2
3.	Iran	8	20	2.5	3
4.	Bangaladesh	5	11	2.2	4
5.	South Africa	4	7	1.75	5
6.	Malaysia	3	3	1	6
7.	Poland	3	3	1	6
8.	Brazil	2	2	1	7
9.	Canada	2	4	2	7

10.	Chaina	2	4	2	7
11.	Indonesia	2	4	2	7
12.	Japan	2	2	1	7
13.	Portugal	2	3	1.5	7
14.	Tanzania	2	3	1.5	7
15.	USA	2	3	1.5	7
16.	Fiji	1	1	1	8
17.	Kazakistan	1	4	4	8
18.	Spain	1	3	3	8
19.	Sudan	1	1	1	8
20.	Turkey Istanbul	1	2	2	8
21.	Uganda	1	3	3	8

Keywords wise distribution of articles: Figure 5 shows the most frequently used keywords: "Scientometrics" is the most frequently used keyword, followed by "Bibliometrics", then India, Citation Analysis, E-resources, Information Literacy, Nigeria and open access are also frequently used keywords.

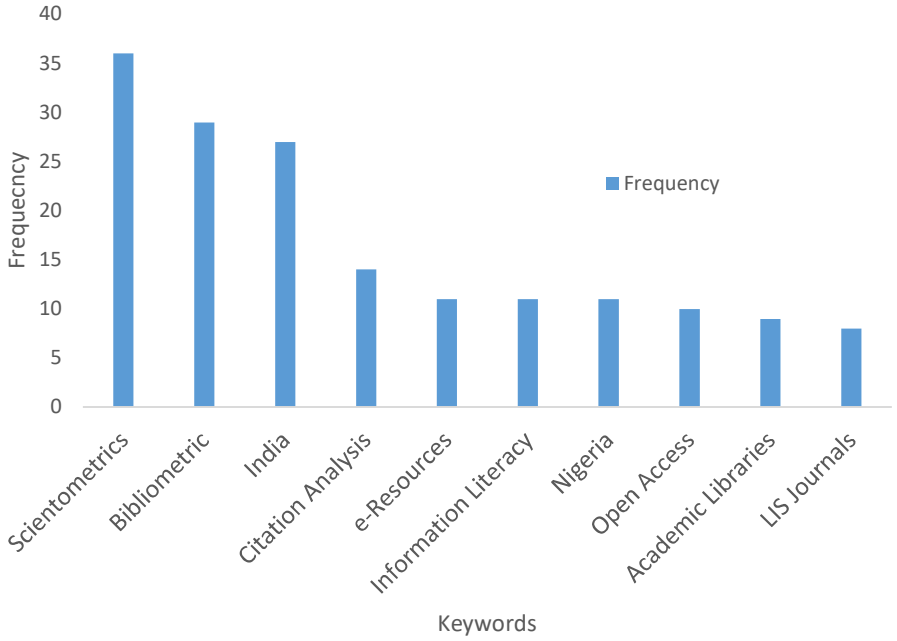


Figure 5 Frequently used keywords in ALIS

5. Conclusions

This study analyzes the publication trends of articles in ALIS from 2012 to 2021. Out of 315 articles selected from ALIS, the majority, 169 articles (53.65%), were published during the period 2012-2016. On average, each paper had 1.89 authors, resulting in a productivity rate of 0.52 articles per author. In terms of authorship patterns and collaboration trends, 104 articles (33.01%) were authored by a single author, while 157 articles (49.84%) involved two authors. The Degree of Collaboration (DOC) averaged 0.66, indicating a high level of collaboration among authors, with an average Collaborative Coefficient (CC) of 0.36, highlighting the prevalence of collaborative efforts in ALIS publications.

Geographically within India, New Delhi led with 85 articles published and contributions from 135 authors. Internationally, Nigeria held the top position with 19 articles published and 53 contributing authors, followed by Sri Lanka with 12 articles involving 20 authors. These findings underscore the diverse geographical contributions

and collaborative dynamics evident in ALIS publications over the past decade.

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including Pearson correlation and multiple regression analysis, were applied to identify associations between pharmacy preparedness and patient outcomes.

Results

Findings indicate substantial variation in community pharmacy preparedness levels. The Emergency Preparedness Index averaged 68.73, reflecting moderate readiness. Availability of emergency supplies was high (97.54%), while community awareness levels were recorded at 86.60%. However, pharmacy-specific preparedness remained suboptimal (79.93%), and timeliness of emergency response was delayed, averaging 57.80 hours. Statistical analysis showed a strong correlation between preparedness scores and patient safety indicators ($p < 0.01$). Machine learning models demonstrated an accuracy of 85% in predicting preparedness levels based on prior response performance.

Conclusions and Recommendations

The study highlights inconsistencies in pharmacy emergency preparedness, particularly in rapid response and pharmacy-specific measures. While supply availability and community awareness are relatively high, delays in response time and variable preparedness across pharmacies present challenges to patient safety. To enhance pharmacy disaster preparedness, it is recommended to implement comprehensive emergency training programs, deploy technology-driven communication systems for real-time coordination, and foster partnerships with local emergency services to minimize response times and optimize resource allocation. Future research should focus on assessing the impact of real-time pharmacy monitoring systems for emergency response, evaluating preparedness interventions across diverse geographical settings, and integrating predictive analytics to enhance pharmacy-based disaster management strategies.

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Table 1 (abstract OS66). See text for description

Evaluation Parameter	Emergency Preparedness Index	Availability of Emergency Supplies (%)	Community Awareness Level (%)	Pharmacy-Specific Preparedness (%)	Timeliness of Emergency Response (Hours)	Effectiveness of Communication Systems (%)
Score/Percentage	68.73	97.54	86.6	79.93	57.8	57.8

OS67

Exploring the Role of Artificial Intelligence in Optimizing Pharmacy Inventory and Reducing Medication Waste: A Pilot Study

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Introduction

Effective pharmacy inventory management is critical in ensuring medication availability while minimizing waste and financial losses. Traditional inventory control methods often fall short due to inefficiencies in demand forecasting, supply chain fluctuations, and expiration management [1–3]. The integration of Artificial Intelligence (AI) into pharmacy operations presents a promising avenue for optimizing inventory control and reducing medication waste. While digital interventions, including AI-based inventory management, show great promise, there is limited empirical evidence comparing the performance of different AI models in optimizing pharmacy stock levels and reducing medication waste. Reducing medication waste is crucial not only for minimizing financial losses in pharmacy operations but also for mitigating environmental hazards caused by pharmaceutical disposal and expired drug accumulation. This pilot study explores the application of machine learning (ML) models to predict medication demand, enhance stock management, and minimize waste in pharmacy settings.

Materials and Methods

The dataset used in this study consisted of pharmacy sales, prescription trends, and stock movement records collected over a two-year period, ensuring a robust evaluation of AI-driven inventory optimization strategies. Four machine learning models—Random Forest, XGBoost, LightGBM, and CatBoost—were deployed to analyze prescription patterns and predict optimal reorder points. Feature selection was performed using SHAP values to identify key contributors influencing inventory demand. Performance evaluation metrics included accuracy, precision, recall, F1-score, mean absolute error (MAE), and mean squared error (MSE). A comparative analysis was conducted to determine the most effective model for pharmacy inventory optimization.

Results

The study revealed that all models performed effectively in predicting medication demand, with XGBoost achieving the highest accuracy (94.51%) and CatBoost demonstrating superior recall (89.64%). LightGBM exhibited stable performance, though slightly lower in precision compared to XGBoost and CatBoost. Mean absolute error values ranged between 0.16 and 0.21, indicating minimal deviation in prediction accuracy. Additionally, feature importance analysis highlighted seasonal trends, prescription rates, and supplier reliability as key factors influencing inventory fluctuations as shown in figure- 1. The implementation of AI-driven inventory management strategies significantly reduced medication wastage by identifying optimal restocking thresholds.

Conclusions and Recommendations

The study demonstrates that AI-driven inventory optimization, particularly through models such as XGBoost and CatBoost, can markedly improve pharmacy operations by enhancing predictive accuracy and reducing medication waste. Integrating these technologies into pharmacy management systems could lead to significant cost savings and improved resource utilization. Future research should explore the incorporation of real-time data from IoT-based inventory tracking and assess the scalability of these models across diverse pharmacy settings. Policymakers and healthcare providers are encouraged to support the integration of AI solutions to promote sustainable and efficient medication management.

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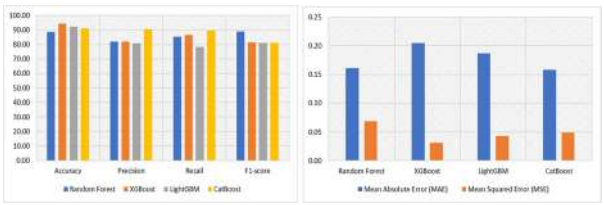

Fig. 3 (abstract OS67). For demand classification & exact quantity forecasting

OS68

Evaluating the Impact of Universal Health Coverage Policies on Medicine Accessibility: A Comparative Policy Analysis Across Regions

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Introduction

Universal Health Coverage (UHC) policies play a critical role in determining the accessibility and affordability of medicines across different healthcare systems. The effectiveness of these policies varies based on the structure of healthcare systems, financial risk protection mechanisms, and public-private partnerships[1,2]. While some nations have successfully expanded medicine accessibility through well-integrated, While UHC policies have been implemented in various countries, limited comparative evidence exists on how these policies influence medicine accessibility across different healthcare systems, particularly in terms of financial protection, affordability, and availability[3,4]. The comparison between the United States and India is relevant due to their contrasting healthcare models—where the U.S. relies on a predominantly private insurance-driven system with limited public healthcare, whereas India has a mixed healthcare system with significant reliance on out-of-pocket payments. Understanding these differences provides insights into how financial protection mechanisms impact medicine accessibility in different economic and policy contexts. This study undertakes a comparative analysis of UHC policies in the United States and India, examining their impact on medicine accessibility using key evaluation parameters, including financial protection, availability of essential medicines, out-of-pocket expenses, and health system structure.

Materials and Methods

This study adopts a comparative policy analysis approach, utilizing data from reputable sources such as the World Health Organization (WHO), Commonwealth Fund, and peer-reviewed journals. The study utilizes datasets from the World Health Organization (WHO) and Commonwealth Fund, covering healthcare accessibility trends and financial protection data from 2018 to 2023. Evaluation metrics include health system characteristics, levels of financial burden on patients, availability of essential medicines, and effectiveness of UHC policies in reducing inequities. Comparative synthesis was employed to evaluate healthcare system structures and policy impacts, while regression analysis was conducted to determine the correlation between UHC policy implementation and medicine affordability. Quantitative indicators, such as UHC service coverage indices and out-of-pocket expenditure proportions, are used to assess accessibility gaps. Data synthesis is conducted to highlight disparities and strengths in both healthcare systems.

Results

Findings indicate that while the United States offers a broad range of healthcare services, significant affordability challenges remain due to high drug costs and limited financial protection for uninsured individuals. In contrast, India's public health schemes have expanded medicine accessibility, yet high out-of-pocket expenses continue to hinder equitable distribution, particularly in rural areas.

The analysis shown in table- 1 reveals that while both countries exhibit progress in policy implementation, substantial gaps exist in ensuring equitable access to essential medicines. Financial risk protection remains inadequate in both settings, leading to persistent healthcare affordability concerns. Table 1 presents a comparative evaluation of key parameters.

Conclusions and Recommendations

The study underscores the need for targeted policy interventions to reduce financial barriers and improve medicine accessibility. In the USA, regulatory reforms to control drug pricing and expand public coverage are essential, while in India, increased investment in public pharmaceutical distribution and subsidy programs is recommended. Strengthening public-private partnerships and leveraging digital health solutions could further enhance access. Future research should employ longitudinal designs to assess the evolving impact of UHC policies on medicine accessibility across diverse healthcare settings.

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Content Delivery Models for Distributed and Cooperative Media Algorithms in Mobile Networks

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Abstract:
Content transport fashions for allotted and Cooperative Media Algorithms in cellular Networks (DC-MAMR) is a unique technique to providing multimedia content material in mobile networks, the use of disbursed and cooperative media algorithms. DC-MA-MR leverages an aggregate of content material request-based networking models, distributed and cooperative media algorithms to permit green dependable content material delivery. Particularly, DC-MA-MR takes benefit of the subscriber's ability to select preferred content for extraordinary services, while allowing for disbursed and cooperative media algorithms to be recognized prior to content request time. The ensuing model may be used to discover consumer-precise resources for content shipping, accordingly permitting them to receive content over more than one channels. Moreover, DC-MA-MR permits strategies for instant content material distribution, with an emphasis on robustness of the delivery mechanisms in the presence of various user requests and environmental conditions. Further, DC-MA-MR entails mechanisms for deciding on most effective media resources on the basis of know-how of user mobility, network situations, content recognition, and different issues. Eventually, DC-MA-MR is likewise designed for scalability and sustainability by way of leveraging more than one additives of current networks, along with coding, caching, clustering, and dispensed computing.

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I. Introduction

Content shipping fashions for disbursed and Cooperative Media Algorithms in Cellular Networks. Mobile networks are becoming increasingly crucial for b transport of multimedia content, including streaming videos and audio content material [1]. Content material delivery models for mobile networks are based on allotted and cooperative media algorithms that permit the efficient and speedy transmission of media documents. System model of vehicular ad hoc networks Content material transport models for allotted and cooperative media algorithms in cellular networks encompassed peer-to-peer (P2P) and disbursed network coding (DNC) [2]. P2P networks permit for an allotted device of computing, in which friends within the device can speak across a community and share facts, without counting on a centralized server. The critical benefit of a P2P architecture is its capacity to leverage the sources of many users imparting an allotted path for content shipping and decreasing prices for website hosting content material I [3]. Furthermore, since the distribution of content material is handled with the aid of peers within the community, P2P transport fashions also are surprisingly scalable and reliable. Disbursed network coding (DNC) is also used for powerful content material shipping in mobile networks [4]. DNC uses several users' assets to distribute and percentage records, increasing the velocity and throughput of the process [5]. It also reduces the number of facts transmitted on account that records are not dispatched back and forth among different friends; alternatively, it is coded in a streaming way. Moreover, DNC will increase the performance of content transport via the usage of fewer resources [6]. Content material transport fashions for allotted media algorithms in mobile networks have helped to enhance the performance and speed at which content material can tour [7]. Those fashions have enabled multimedia content material on cellular gadgets in an extra effective way, with progressed scalability and reliability. Moreover, leveraging the resources of more than one customer in the community reduced the price and complexity of hosting content [8]. Therefore, these content shipping models are essential for ensuring green and well-timed transport of multimedia content material over cellular networks. A key innovation in content shipping models for mobile networks' disbursed and cooperative media algorithms is using advances in

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Leveraging machine learning for real-time optimization in large-scale information systems

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Abstract

The quick development of information and the expanding complexity of large-scale data frameworks require progressed optimization methods to guarantee tall execution, versatility, and unwavering quality. Machine learning (ML) has developed as a effective apparatus for real-time optimization, advertising the capacity to memorize from tremendous sums of information and make data-driven choices with minimal human mediation. This term paper investigates the different applications of machine learning in optimizing large-scale data frameworks in genuine time, covering perspectives such as prescient analytics, peculiarity discovery, arrange activity administration, substance conveyance optimization, security, and personalized proposal frameworks. The paper points to supply a comprehensive outline of how machine learning can be utilized to upgrade the productivity, adaptability, and flexibility of these complex frameworks.

Subject Classification: *68Q10.*

Keywords: *Real-time optimization, Predictive analytics, Anomaly detection, Proximal policy resource allocation, System reliability, Policy gradient, Proactive adaptation.*

1. Introduction

Large-scale data frameworks have gotten to be fundamentally to different divisions, counting back, healthcare, e-commerce, and telecommunications, where they prepare tremendous sums of information in genuine time to supply administrations and bolster decision-making forms [1]. These systems are characterized by their scale, complexity, and require for tall availability and faithful quality [2]. Customary optimization strategies, though compelling in certain settings, habitually fight to handle

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the lively, non-linear, and high-dimensional nature of progressed information systems [3]. Machine learning (ML), with its capacity to memorize from data and alter to changing conditions, has risen as a transformative approach for optimizing these systems in honest to goodness time [4].

This term paper plunges into the applications of machine learning for real-time optimization in large-scale information systems, looking at its impact on prescient analytics, peculiarity area, organize action optimization, substance movement, security, and personalized proposal systems [5]. By utilizing these prescient models, information systems can capably allocate resources such as computing control, memory, and exchange speed based on real-time ask figures [6]. For occasion, in cloud computing circumstances, prescient models can anticipate workload spikes and normally scale resources up or down, minimizing operational costs while ensuring perfect execution [8], [9]. Also, in cash related trading systems, prescient analytics can offer help optimize trade taking care of by pre-allocating resources in the midst of peak trading hours. [7], [10]

2. Proposed Algorithim ARORL

To optimize large-scale information systems in real-time utilizing machine learning, it is fundamental to arrange an calculation that can handle colossal data streams, alter to changing conditions, and provide expedient decision-making capabilities [11], [12]. The proposed calculation,

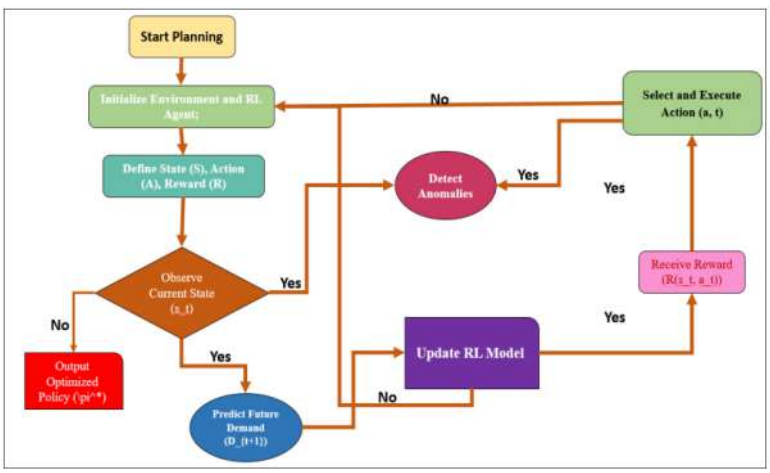

Figure 1

Design Schematic of Proposed ARORL Method

called Flexible Real-Time Optimization with Back Learning (ARORL), leverages back learning (RL) combined with coordinated learning for prescient analytics and abnormality area [13]. The ARORL calculation is sketched out to optimize system execution effectively by diligently learning and altering to present day data and changes inside the environment.

ARORL could be a half breed approach that combines a few components to optimize system execution inside a data environment as shown in figure 1. At its center could be a Fortification Learning (RL) Specialist, outlined to form ideal choices based on natural input. It's upheld by a Prescient Analytics Module that figures key measurements like request and asset utilization, and a Peculiarity Location Module that recognizes potential framework disappointments or security dangers.

3. Design of Proposed Algorithm

The ARORL calculation is built on the standards of fortification learning but amplifies its capabilities by joining directed learning for prescient analytics and unsupervised learning for peculiarity location.

Step 1: Environment Initialization

The calculation begins by characterizing the environment of the large-scale data framework, which incorporates all the framework components. Let the environment of a large-scale data framework be modeled as a Markov Choice Prepare (MDP), characterized by the tuple

$$(S, A, P, R, \gamma)st = [Lt, Ut, Rt, At, Dt]$$

Step 2: State Representation

Each state $s \in S$ is represented by a set of features.

$$P(st+1 \mid st, at)$$

Step 3: Action Space Definition

The action space A A consists of all possible actions that the RL agent can take to optimize the system,

$$A = \{a1, a2, \ldots, an\}$$

Step 4: Reward Function Design

The reward function (*s*,) guides the RL agent by assigning a reward value based on the outcome of an action *a* taken in state *s*.

$$R(st,at) = w1R\,latency\,(st,at) + w2R\,throughput\,(st,at)$$
$$+w3\,Rutilization\,(st,at) + w4R\,reliability\,(st,at)$$
$$-w5R\,anomaly\;(st,at)$$
$$V\pi(s) = E\pi[k = 0\Sigma\infty\gamma kR(st+k,at+k)s0 = s]$$
$$Q\pi(s,a) = E\pi[R(s,a) + \gamma s'\Sigma P(s'\mid s,a)V\pi(s')]$$

Step 5: Policy and Q-Value Function

The RL agent's policy $\pi(a \mid s;\theta)$ is a probability distribution over actions given the states, parameterized by θ.

$$Q(st,at) = E\pi[k = 0\Sigma\infty\gamma kR(st+k,at+k)st,at]$$

$$Dt+1 = fLSTM\,(Dt,Lt,Ut;\phi)$$

Step 6: Deep Q-Network (DQN) Update Rule

Using the Deep Q-Network (DQN) algorithm, the Q-value function is approximated using a neural network with parameters θ

$$L(\theta) = E[(yt - Q(st,at;\theta))2]$$

$$yt = R(st,at) + \gamma a'\,maxQ\,(st+1,a';\theta -)$$

Step 7: Policy Gradient Update (Proximal Policy Optimization - PPO)

$$LPPO(\theta) = Et\,[\min(rt(\theta)A\wedge t, clip(rt(\theta),1-\varepsilon,1+\varepsilon)A\wedge t)]$$

$$rt\,(\theta) = \pi(at\mid st;\;\theta\;old)\pi(at\mid st;\theta)$$

Step 8: Anomaly Detection Module

The anomaly detection Module employments unsupervised learning calculations to persistently screen the framework for unusual behavior. When an irregularity is identified, a caution is created, and the data is passed to the RL operator.

$$et = \|\,xt - x\wedge t\,\|\,2$$

$$\wedge t = g(f\,(xt;\,\theta e);\,\theta d):$$

$$Anomaly\,Detected = I(et > \delta)$$

Step 9: RL Agent Training

The RL agent is prepared employing a variant of Profound Q-Network (DQN) or Proximal Arrangement Optimization (PPO), which is appropriate for high-dimensional state spaces.

$$at* = arga \in AmaxQ(st, a; \theta)(\text{for}\, DQN)$$

At each time step *t*t, the RL agent selects an action *at* based on the current policy.

3. Result and Discussion

The viability of the Versatile Real-Time Optimization with Fortification Learning (ARORL) calculation is assessed through an arrangement of tests outlined to degree its execution in optimizing large-scale data frameworks.

Table 1

Comparison of Existing Algorithim Vs Proposed ARORL

Metric	Static Allocation	DQN Only	PPO Only	ARORL (Proposed)
Average System Latency (ms)	250	180	165	120
Data Throughput (Requests per Second)	2,500	3,200	3,400	4,200
Resource Utilization Efficiency (%)	65	75	78	90
Anomaly Detection Rate (%)	N/A	75	78	92
Cost Savings (%)	Baseline	15	18	35

The Execution Comparison Table 1, highlights the predominance of the ARORL calculation over other strategies like Inactive Allotment, DQN As it were, and PPO As it were over a few measurements.

ARORL significantly improves average system latency, reducing it to 120 ms compared to up to 250 ms with other methods. It also leads in data throughput at 4,200 requests per second and resource utilization efficiency at 90%. The performance comparison is depicted in figure 2 that shows the effectiveness of various optimization methods. Static Allocation, DQN Only, PPO Only, and ARORL (Proposed) across critical metrics like system latency, data throughput, and more.

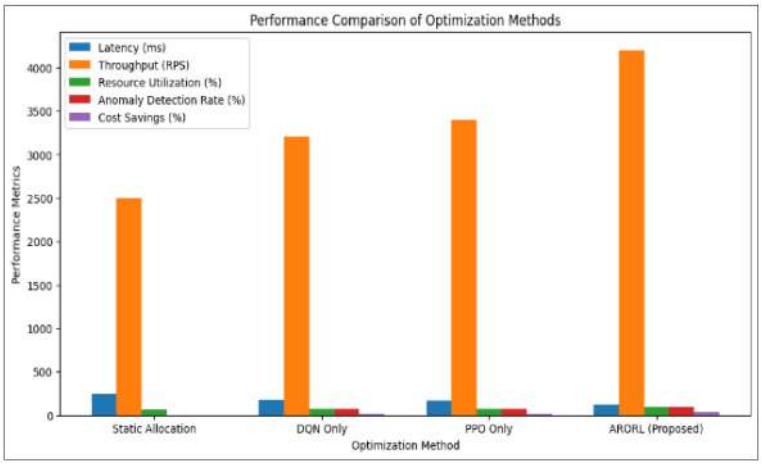

Figure 2

Graphical Representation of Comparison of Existing Algorithim Vs Proposed ARORL

Table 2

Sensitivity Analysis

Parameter	Low Setting	Medium Setting	High Setting
Discount Factor (γ\gamma)	0.85	0.90	0.95
Reward Weight w1w_1w1 (Latency)	0.1	0.3	0.5
Learning Rate (DQN/PPO)	0.0001	0.001	0.01
Batch Size (DQN/PPO)	32	64	128

The table 2, outlines how key parameters in optimization algorithms like DQN and PPO are adjusted across low, medium, and high settings. The Discount Factor increases from 0.85 to 0.95, enhancing the emphasis on future rewards. Reward Weight for Latency rises from 0.1 to 0.5, prioritizing latency reduction more at higher settings.

The sensitivity analysis is depicted in figure 3, demonstrates the impact of varying key parameters like the discount factor (γ) and weight for latency reduction on ARORL's performance metrics such as resource utilization efficiency and system latency.

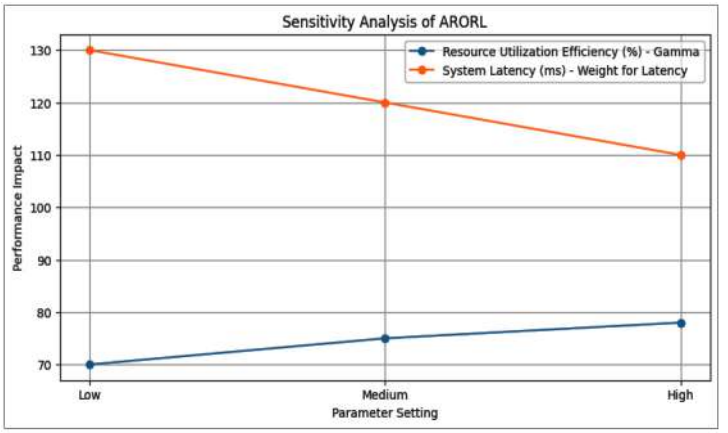

Figure 3

Representation of Sensitivity Analysis

Table 3

Anomaly Detection Performance Table

Method	True Positive Rate (TPR)	False Positive Rate (FPR)	Precision	Recall	F1-Score
DQN Only	70%	20%	0.78	0.70	0.74
PPO Only	72%	18%	0.80	0.72	0.76
ARORL (Proposed)	88%	10%	0.90	0.88	0.89

The table 3, compares the performance metrics of three different methods DQN Only, PPO Only, and the proposed ARORL across various statistical measures used to evaluate classification models. ARORL beats the other strategies altogether, accomplishing the most noteworthy Genuine Positive Rate (TPR) at 88%, the least Untrue Positive Rate (FPR) at 10%, and the finest scores in Exactness (0.90), Review (0.88), and F1-Score (0.89).

The inconsistency location execution outspread bar chart compares the accuracy, review, and F1-score of three strategies DQN As it were, PPO As it were, and ARORL (Proposed). The figure 4, highlights ARORL's prevalent execution in recognizing peculiarities, with higher accuracy, review, and F1-scores compared to the other strategies.

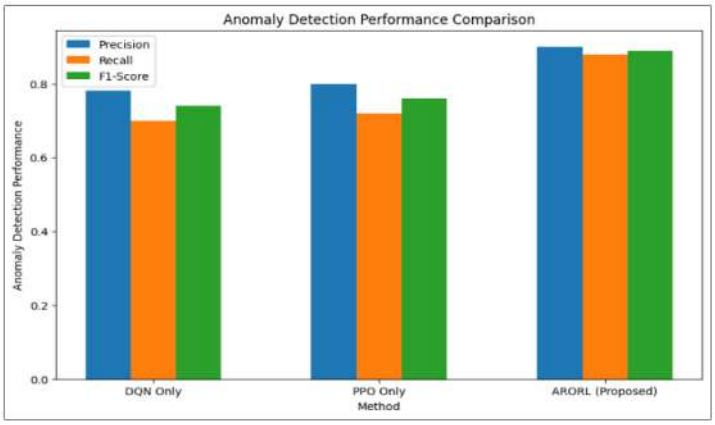

Figure 4

Graphical Representation of Anomaly Detection Performance

Table 4

Cost Efficiency Analysis

Optimization Method	Resource Allocation Cost (Units)	Downtime Cost (Units)	Total Operational Cost (Units)	Cost Savings (%)
Static Allocation	1,000	500	1,500	Baseline
DQN Only	850	300	1,150	15%
PPO Only	820	290	1,110	18%
ARORL (Proposed)	650	200	850	35%

The table 4, compares different optimization strategies, appearing that the proposed ARORL strategy altogether outflanks others in decreasing costs. Inactive Assignment serves as the standard with a add up to operational fetched of 1,500 units. The DQN strategy diminishes this taken a toll to 1,150 units, accomplishing a 15% reserve funds, whereas PPO as it were assist diminishes it to 1,110 units, or 18% investment funds. ARORL, in any case, diminishes the entire cost significantly to 850 units, coming about within the most noteworthy investment funds of 35%, illustrating its prevalent productivity in fetched administration.

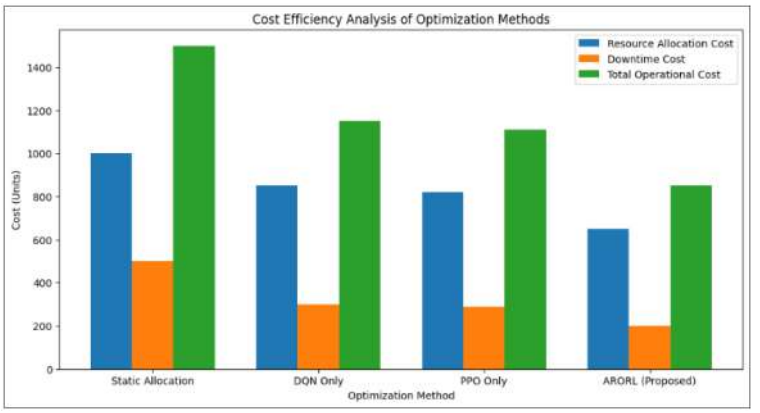

Figure 5

Graphical Representation of Cost Efficiency Analysis

The taken a toll effectiveness examination spiral bar chart shows asset assignment, downtime, and add up to operational costs for strategies like Inactive Allotment, DQN As it were, PPO As it were, and ARORL (Proposed). The figure 5 uncovers ARORL's prevalent cost efficiency, accomplishing the least add up to operational costs through proficient asset administration and minimized downtime, highlighting its critical cost-saving potential for large-scale data frameworks.

Table 5

Comparison with State-of-the-Art Methods

Metric	DDPG	A3C	SAC	ARORL (Proposed)
Average System Latency (ms)	155	148	142	120
Data Throughput (Requests per Second)	3,600	3,700	3,800	4,200
Resource Utilization Efficiency (%)	82	84	85	90
Anomaly Detection Rate (%)	80	82	85	92
Cost Savings (%)	22	25	28	35

The table 5, compares the execution of four optimization algorithms DDPG, A3C, SAC, and the proposed ARORL across five measurements. ARORL reliably outflanks the other strategies, accomplishing the least normal framework inactivity at 120 ms and the most noteworthy

information throughput at 4,200 demands per moment. It moreover leads in asset utilization effectiveness at 90% and peculiarity discovery rate at 92%. ARORL gives the most prominent taken a toll reserve funds, with a 35% lessening, compared to 22-28% investment funds with the other calculations. These comes about highlight ARORL's prevalent capability in optimizing framework execution over different basic perspectives.

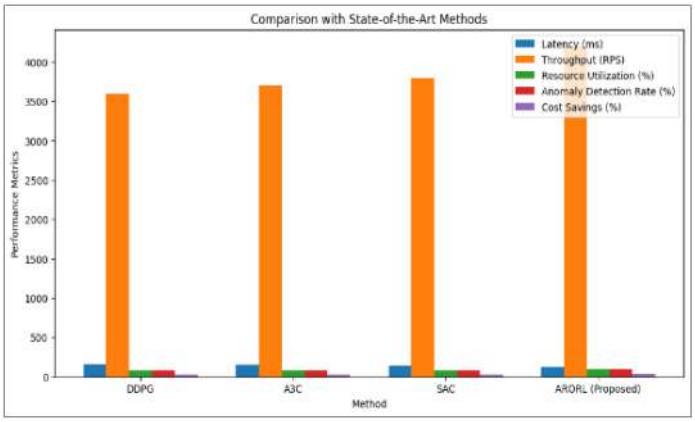

Figure 6

Graphical Representation of Comparison with State-of-the-Art Methods Table

The figure 6 outwardly underscores ARORL's predominance in diminishing inactivity, upgrading throughput, optimizing asset utilize, and moving forward inconsistency location, highlighting its adequacy as a comprehensive optimization arrangement for complex situations.

5. Conclusion

In combining Machine learning has developed as a transformative device for real-time optimization in large-scale data frameworks, tending to the challenges of energetic situations, high-dimensional information, and advancing client requests. From prescient analytics for asset administration and irregularity location for framework observing to arrange activity optimization, substance conveyance, and security upgrade, machine learning offers a comprehensive suite of arrangements for upgrading the proficiency, adaptability, and unwavering quality of these complex frameworks. As innovation proceeds to advance and the volume of information develops exponentially, the part of machine learning in real-time optimization is balanced to gotten to be indeed more

basic, driving advancement and proficiency over different divisions that depend on large-scale data frameworks.

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12	Dr. Ganraj S. Mane	Enhancing Employee Performance through Job Satisfaction: A Case Study of Indian Restaurants in Riyadh, Saudi Arabia	Indian Journal of Psychology	Dec, 2024	0019-5553	15
13	Prof. S. N. Gambhire	Adapting to Change: The Role of Work-Life Balance Initiatives in Enhancing Employee Productivity in the IT Sector"- A Systematic Review	Indian Society for Technical Education	Jan, 2025	0971-3034	48(1)
14	Prof. D.D. Mhetre	Green Marketing in the 21st Century: Trends, Strategies, And Consumer Behaviour	Rabindra Bharati University Journal of Economics	Dec, 2024	0975-802X	17(2)
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IMPORTANCE OF CARE FOR THE CUSTOMERS PARTICULARLY IN THE SERVICE SECTOR

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Abstract

This paper aims to study the Importance of Customer Care Management (CRM) in the Service Sector. The study is conducted through a literature review, data collection from industry experts and customers and also data publicly accessible on related authentic websites including GOI websites. The paper covers the inputs on the current state of CRM in the Service Industry, the challenges, and the benefits of effective CRM. The results of the study indicate that while the industry has recognized the importance of CRM, there are still significant challenges in implementation, particularly in terms of technology adoption and employee participation. Care for the customer and effective implementation of CRM can lead to increased customer satisfaction, loyalty, and profitability to the Service Industry. In essence, this scholarly endeavor not only scrutinizes the current state of CRM in the Service Sector but also unveils a roadmap for overcoming impediments. By accentuating the symbiotic relationship between customer care and CRM proficiency, it endeavors to illuminate a path towards a future where the Service Industry can not only surmount challenges but thrive through a harmonious integration of customer-centric principles and strategic CRM implementations.

Keywords: CRM, Indian Customer Satisfaction, CSI, Brand Loyalty, Profitability.

INTRODUCTION

We find that normally all families have their fixed shops for groceries, shoes, sweets, garments, medicines and doctors. There may be many options available to them in the locality but generally they do not prefer to explore until and unless some issues of dissatisfaction erupt in the transactions. The Importance of care for the Customers particularly in the Service Sector is obvious because of its high desirability in public and immediate impact on reputation, customer confidence and revenues. The Service Industry generally includes Hospitality Sector, Health Care, Taxi and Logistics, Food and Beverages Supply, Couriers and Parcel Services, Household Packers and Movers, Cable TV providers Internet Service Providers, Porters, Security Service Providers, Event Managers, Caterers, Tours & Travel Services and Household Maintenance and Repair Service providers etc. These are the services that immediately affect our life and comfort, underscoring the importance of prioritizing customer satisfaction.

CUSTOMER NEEDS

Customers do have apprehensions; it is natural. They feel the need of an umbrella of trust. They need to be guaranteed about the quality of the product, value for their money and the reassurance of availability of services, whenever required in future. Brand image, word of mouth, past experience and delivering what was promised, are the key factors in closing a sale or retaining customer loyalty. Promptness of service, genuine concern for customer inconvenience and positive attitude of the service staff play a major role in creating a good perception about the product and the company. A company that intends to improve its Customer Base, Customer Satisfaction Index, Brand Image, Turnover and profitability has to strategically work hard to relentlessly sustain and enhance Customer Delight. This is achieved through monitoring the inputs gathered through CRM (Customer Relationship Management) Tools and proactively acting upon them. In the realm of customer dynamics, it is intrinsic to recognize the innate reservations that customers naturally harbor. These reservations necessitate the establishment of a reliable trust infrastructure, where customers seek assurances not only in the product's quality but also in the substantial value they derive from their investment. The enduring promise of accessible services in the future adds another layer to this tapestry of trust. The decision-making process for customers is a nuanced amalgamation of diverse factors, with brand image holding a pivotal role. It intertwines with the echoes of positive word-of-mouth, reflections from past experiences, and the critical element of delivering on promised commitments. These factors collectively act as architects, either culminating in a successful sale or weaving the intricate threads of customer

loyalty. In the choreography of customer interactions, the spotlight falls on the timeliness of service, coupled with a genuine dedication to alleviating any customer inconvenience. The demeanor exhibited by the service staff transcends the bounds of professionalism, becoming a transformative force that sculpts the perceptual landscape surrounding both the product and the company at large.For any company aspiring to ascend the echelons of customer-centric success, strategic commitment is not an option but a necessity. The pursuit of broadening the Customer Base, elevating the Customer Satisfaction Index, fortifying Brand Image, and amplifying Turnover and profitability demands an unwavering dedication to sustaining and enhancing Customer Delight. This isn't a passive pursuit but an active, ongoing endeavor, driven by the discerning use of Customer Relationship Management (CRM) tools. It involves not just the passive monitoring of customer inputs but a proactive engagement that responds adeptly to the rich insights gleaned through these tools. This approach weaves a sophisticated tapestry of customer satisfaction and loyalty, where each touchpoint becomes a pivotal note in the harmonious symphony of sustained success and enduring customer delight.

KNOW YOUR CUSTOMER PREFERENCES TO ENHANCE BRAND IMAGE AND IMPROVE SALES

We share here below some data[S1]. Study and action on this input can help us grow our business:

Feedback sharing by customers:
- 50% customers share their experiences on social media, 72% talk about them in person.

Media Reviews:
- 87% customers read online reviews
- 94% customers will recommend a company whose service they rate as "very good."
- 67% of customers report a terrible customer experience as the reason for switching businesses.
- 13% of customers tell 15 or more people if they have a negative experience.

Handling Customer irritation and anger
- 21% of patients went to other pharmacist because they had to wait too long.
- 70% of customers reported high irritation when their call is transferred from one department to another.
- 33% got frustrated for having to wait on hold
- 33% got frustrated having to repeat themselves to multiple support reps.
- 70% complainants were willing to shop with a business again after their complaints were resolved.
- 78% customers gave up on a transaction because of a negative customer experience.
- 67% customers end a call in frustration when they cannot reach a customer service representative.
- 60% of consumers deserted a brand and switched to another because of poor customer service.

Phone Support:
- 75% consumers prefer phone calls to reach customer support.
- Very few use text messaging.
- Rest use mobile apps for communicating with the company.

What the customer wants:
- 75% consumers choose to interact with a real person.
- 33% consumers consider having their problem solved in one single interaction as best service.
- 95% consumers say that customer service is essential for brand loyalty.

UNETHICAL BUSINESS PRACTICES AND ITS DISADVANTAGES

We often observe certain business malpractices as trends. Some cooking gas agencies insist upon a new consumer to buy the stove and accessories also from their dealership. Such activities ultimately result in creating a negative image, that of an unethical practitioner.

In life whether personal or public, the importance of value system, morality and ethics can never be disregarded for short term benefits; else we pay the price. A business house, tempted to make an easy buck, if not backed up with a value system, can buckle under slightest enticement. Today we see this happening, not only with individual persons but renowned business houses. Examples of unethical business practices are: harm to environment, kickbacks, fraudulent accounting, unfair competition, tax evasion, hidden clauses in user agreements, false product claims, fine-prints in T&C etc, all of which ultimately resulting in loss of prestige, loss of credibility, legal battles, losing customer base and financial losses.

Misguiding, misrepresenting, fleecing, and overcharging has become so common that the government of India has come up with a Notification in September 2023 as 'Guidelines for prevention and regulation of Dark Pattern 2023.' This step has been taken by the government to educate the consumers and penalize the offenders. Such practices have been termed at 'Dark Patterns' in business dealings especially in 'On-line' transactions. These are being summarized below:

Specified Dark Patterns: *[N1]

I. ***False Urgency:*** Creating a false scarcity (deceptive messages like "only two seats left" etc.) to mislead and pressurize the consumer into immediate purchase.

II. ***Basket Sneaking:*** Inclusion of additional costs like Insurance, Convenience, Charity etc. at the time of checkout from e commerce platform.

III. ***Confirm Shaming:*** By forcing user to press buttons having captions like "I don't care for the poor" if the user does not want to pay for induced charity.

IV. ***Forced action:*** Website force a user to buy any additional goods, subscriptions or services in order to buy the wanted product.

V. ***Subscription trap:*** They make cancellation process of a paid subscription either impossible or complex or they

hide the cancellation option button.

VI. Interface interference: They highlight certain specific information and change the color of the 'No' button so that it is not easily visible.

VII. Bait and Switch: They advertise a low cost but at the time of payment a higher cost is demanded. Frivolous reasons are then shown e.g. "The discount period is already over".

VIII. Drip pricing: The elements of prices are not revealed upfront. Post confirmation of purchase, higher amount is shown at the time of checkout. E.g. After buying an air ticket, they demand extra payment for seat selection even if the customer does not want any choice.

VIII. Disguised advertisement: Misleading, masked advertisements e.g. pure juice even though the product is synthetic.

VIII. Nagging: Seller insists upon getting credit card details, phone no, email id and then bombarding them with unwanted messages and calls.

CONCLUSION AND RECOMMENDATIONS

After having known our Customer preferences, we need to start working on enhancing Brand Image and improve sales. Apart from providing quality service to the customer in a prompt manner, market studies show that following points are essentials for providing excellent services:

1. A Toll free customer contact number
2. A Help Desk – providing polite and prompt response.
3. Live Interactive website
4. FAQs listed on the portal
5. Display status of customer order
6. Providing easy and multiple choice modes of payments to the customer
7. Customer contact details like email id, phone number
8. CRM Tool to capture and manage customer data.
9. Generate ticket number to customer for registered complaint and its current status
10. Provide 'Personalized Services' where expected and is possible to provide.
11. Rather than having a multichannel Customer Contact Service, have an integrated Customer Contact Service so that complaint once registered shall not be repeated and same response shall be rendered from all the channels.

We hope that with such efforts business is bound to grow and customers shall be delighted with the care provided to them. The business house shall get more and more General Referrals, better Customer Retention, Competitive Advantage over rivals, enhanced Brand Image and larger revenues.

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EFFECTIVE STRATEGIES FOR MANAGING A MULTIGENERATIONAL WORKFORCE

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Abstract
In today's dynamic workplace, organizations must effectively manage a multigenerational workforce, which includes Baby Boomers, Generation X, Millennials, and Generation Z. Each generation brings unique values, work styles, and communication preferences that can impact team collaboration and productivity. This Research Paper explores key strategies for managing a diverse workforce, including fostering an inclusive culture, leveraging generational strengths, implementing flexible work policies, and enhancing communication. By understanding generational differences and promoting intergenerational collaboration, organizations can create a more cohesive and productive work environment. These strategies help maximize employee engagement, improve retention, and drive organizational success.

Keywords: Multigenerational Workforce, Baby Boomers, Generation X, Millennials, Generation Z, Generation Alpha, Workplace Diversity

1.0 Introduction

In today's globalized and fast-evolving workplace, organizations are increasingly facing the challenge of managing a multigenerational workforce. With employees from Baby Boomers to Generation Z—and the emerging Generation Alpha—organizations must adapt to varying work styles, communication preferences, and expectations to foster collaboration, engagement, and productivity. The convergence of these diverse age groups within a single workplace presents both opportunities for innovation and challenges in leadership, teamwork, and organizational policies.

A multigenerational workforce refers to the coexistence of multiple age groups within the workplace, each shaped by distinct historical, economic, and technological influences. **Baby Boomers (1946-1964)**, for instance, value job security, hierarchical leadership, and face-to-face communication. **Generation X (1965-1980)** prefers autonomy, work-life balance, and efficiency-driven leadership. **Millennials (1981-1996)** are digital natives who thrive in collaborative, purpose-driven environments, while **Generation Z (1997-2012)** seeks flexibility, technological integration, and an inclusive work culture. Additionally, **Generation Alpha (born after 2013)** is expected to bring an entirely new level of digital fluency and AI-driven workplace dynamics when they enter the job market in the coming years.

1.1 The Changing Workplace Landscape

Workplace trends have significantly shifted due to rapid technological advancements, globalization, and unforeseen global events, such as the COVID-19 pandemic. These changes have accelerated the adoption of hybrid work models, increased reliance on artificial intelligence (AI), and heightened awareness of mental health and work-life integration. As a result, organizations must rethink traditional workplace structures and create adaptable, inclusive, and technology-driven strategies to meet the diverse needs of a multigenerational workforce.

Technological transformation has also redefined how employees interact, collaborate, and perform tasks. Older generations, who initially relied on in-person meetings and paper-based documentation, have had to adapt to video conferencing, cloud-based collaboration tools, and real-time project management systems. Meanwhile, younger employees who grew up with social media and instant messaging expect seamless digital communication, flexible work arrangements, and data-driven decision-making.

2.0 Literature Review

The study of multigenerational workforce management has gained prominence in recent years, with scholars and business leaders exploring the impact of generational diversity on organizational effectiveness, communication, and leadership. Several researchers have proposed theories to explain generational differences and their impact on workplace dynamics. Lancaster and Stillman (2002) introduced the concept of generational personalities, arguing that societal and technological changes shape each generation's expectations and behaviors. Zemke, Raines, and Filipczak (2000) emphasized the importance of adaptability in leadership, proposing that organizations must tailor management approaches to meet the needs of different generations.

Herzberg's Motivation-Hygiene Theory (1959) and Maslow's Hierarchy of Needs (1943) have also been applied to multigenerational workforce studies, with research suggesting that each generation places varying emphasis on job security, career progression, flexibility, and personal development. Baby Boomers, for instance, are driven by extrinsic rewards, while Millennials and Gen Z employees prioritize intrinsic motivators such as meaningful work and personal growth opportunitiesAccording to a study by Twenge et al. (2010), Millennials and Gen Z employees are more likely to value work-life balance and seek continuous feedback compared to older generations. Similarly, research by Costanza et al. (2012) found that generational differences in workplace values, while present, may be less pronounced than commonly assumed, with individual personality traits playing a more significant role in workplace behaviors.

A 2019 study by the Society for Human Resource Management (SHRM) highlighted the impact of digital transformation on workforce expectations. The study found that younger generations prefer remote and flexible work arrangements, whereas older generations value traditional office settings and in-person interactions.

2.3 Research Gap

Despite extensive research on multigenerational workforce management, several gaps remain. Existing studies have primarily focused on Baby Boomers, Gen X, Millennials, and Gen Z, with limited research on the anticipated impact of Generation Alpha. Future research should explore how AI, automation, and digital transformation will shape the work expectations of younger generations entering the workforce.

3.0 Objectives of the Study

The primary objective of this study is to explore effective strategies for managing a multigenerational workforce and to provide insights into fostering collaboration and engagement among different age groups in the workplace. The specific objectives of this study are:

- **To examine generational characteristics and workplace**
- **To analyze** challenges and opportunities that arise from the interaction of multiple generations in a professional setting.
- **To evaluate** strategies such as mentorship programs, flexible work arrangements, and tailored leadership approaches that foster an inclusive work environment.
- **To investigate the role of digital transformation in bridging generational gaps**

4.0 Significance of the Study

Managing a multigenerational workforce effectively is crucial for organizations aiming to achieve sustainable growth and innovation. The significance of this study lies in its ability to provide organizations, HR professionals, and business leaders with actionable insights and strategies to foster a cohesive and high-performing workforce. The study contributes to the existing body of knowledge in the following ways:

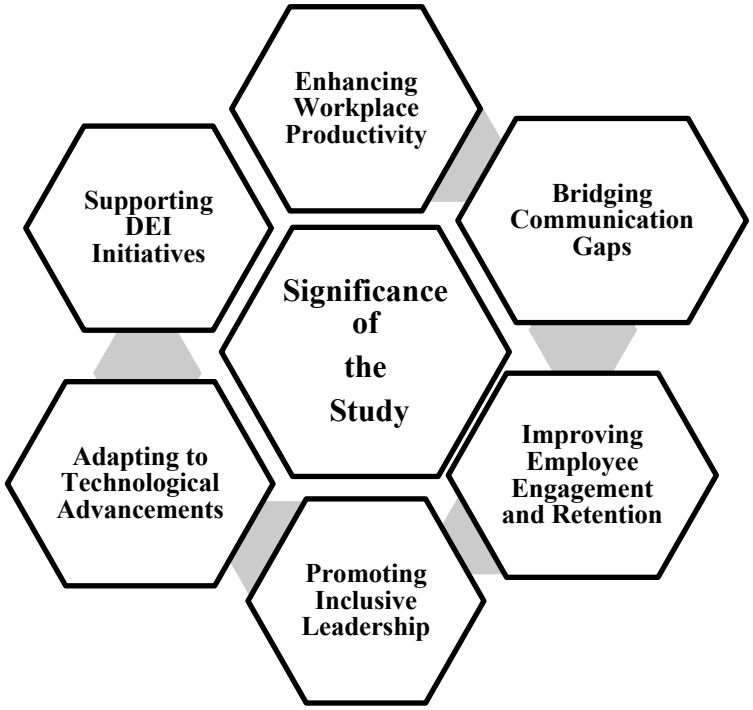


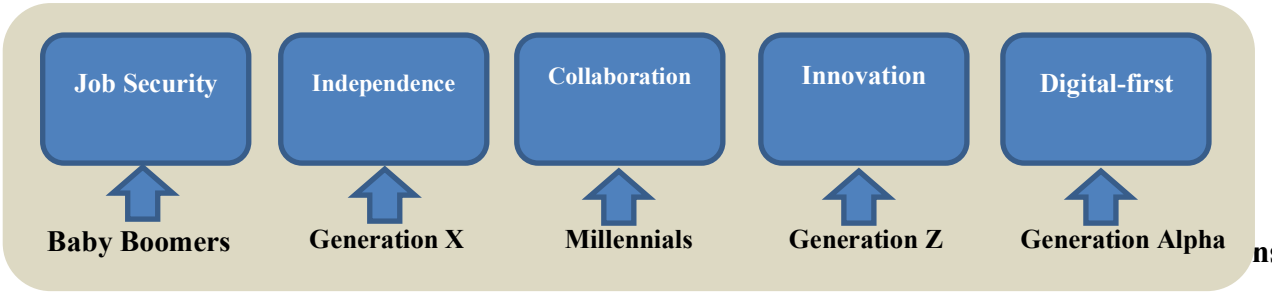
Diagram No. 4.0 Significance of the Study

5.0 Changing Generational Characteristics and Workplace Expectations

Over time, generational values have evolved due to significant economic, technological, and social changes. Each generation brings its own set of priorities and expectations to the workplace, shaping how organizations develop policies and manage employees. The following table and diagram illustrate the shifts in generational values:

Generation	Core Work Values	Preferred Communication	Career Expectations	Work-Life Balance Perspective
Baby Boomers (1946-1964)	Job security, loyalty, hierarchy	Face-to-face, formal emails	Long-term commitment, structured career progression	Sacrifices for career success

Generation X (1965-1980)	Independence, pragmatism, efficiency	Direct emails, phone calls	Self-directed career growth, work flexibility	Strives for balance but values career growth
Millennials (1981-1996)	Purpose-driven work, collaboration	Instant messaging, video calls	Fast career progression, continuous learning	High priority on work-life integration
Generation Z (1997-2012)	Innovation, diversity, inclusivity	Social media, short-form communication	Entrepreneurial mindset, adaptability	Non-negotiable work-life harmony
Generation Alpha (2013+)	Digital-first, sustainability, automation	AI-driven communication, virtual reality	AI-powered career opportunities	Seamless integration of work and personal life



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6.0 Challenges in Managing a Multigenerational Workforce

While generational diversity can be a strength, it also presents unique challenges in leadership, communication, and workplace policies. Some of the common difficulties organizations face include:

1. **Communication Gaps** – Each generation has distinct preferences for communication. While Baby Boomers may prefer phone calls and formal emails, Millennials and Gen Z favor instant messaging and collaborative platforms. This difference can lead to misunderstandings and inefficiencies if not managed effectively.
2. **Workplace Expectations and Job Loyalty** – Baby Boomers often equate professional success with long-term commitment and hierarchical advancement, while younger generations prioritize career mobility, flexibility, and personal development opportunities. This divergence can cause friction between different groups and requires organizations to create policies that balance stability with innovation.
3. **Adapting to Hybrid and Remote Work Models** – The shift towards remote and hybrid work has further highlighted generational disparities. While Gen X and Millennials may embrace remote work for its flexibility, older employees may struggle with digital adaptation and prefer traditional office environments. Bridging this gap requires organizations to invest in digital training programs and inclusive remote work policies.
4. **Leadership and Management Styles** – Traditional leadership structures emphasize authority and experience, often aligning with Baby Boomer expectations. However, Millennials and Gen Z favor participative and collaborative leadership, where mentorship, feedback, and inclusivity are prioritized. Leaders must develop adaptive strategies that cater to both traditional and contemporary management styles.

5. **Diversity, Equity, and Inclusion (DEI)** – The modern workforce demands more than just generational inclusivity—it requires organizations to address broader issues of diversity, equity, and inclusion. Different generations have varying perspectives on social responsibility, gender equality, and corporate ethics. Companies must implement DEI initiatives that align with evolving societal values while maintaining intergenerational cohesion.

7.0 Key Strategies for Managing a Multigenerational Workforce

1. **Fostering an Inclusive and Collaborative Culture**
   - Promote mentorship and reverse mentoring programs to encourage knowledge sharing across generations.
   - Encourage intergenerational team projects to leverage diverse perspectives and skills.
   - Recognize and accommodate different communication preferences, from face-to-face meetings to instant messaging and video calls.
2. **Adapting to Remote and Hybrid Work Models**
   - Provide technology training for older generations while embracing digital fluency among younger employees.
   - Ensure hybrid work policies cater to different needs, such as work-life balance for Gen X and flexibility for Millennials and Gen Z.
   - Establish clear communication norms to bridge the gap between in-office and remote employees.
3. **Integrating AI and Digital Transformation**
   - Upskill employees across all generations to use AI-driven tools and automation effectively.
   - Implement digital literacy programs to help bridge the technology gap for less tech-savvy employees.
   - Encourage a culture of continuous learning to help all generations adapt to workplace advancements.
4. **Prioritizing Diversity, Equity, and Inclusion (DEI)**
   - Develop unbiased recruitment strategies that attract diverse talent across all age groups.
   - Implement policies that support inclusivity, such as diverse leadership and equal growth opportunities.
   - Promote mental health and well-being programs that cater to varying generational stressors and expectations.
5. **Sustainability and Corporate Social Responsibility (CSR)**
   - Align company values with environmental and social initiatives to engage younger generations.
   - Encourage employee involvement in sustainability efforts, fostering a shared sense of purpose.
   - Highlight ethical business practices and social impact to appeal to Millennials and Gen Z.

8.0 Role of Digital Transformation in Bridging Generational Gaps

Digital transformation plays a pivotal role in fostering collaboration and inclusivity among different generations in the workplace. With rapid advancements in technology, organizations are leveraging digital tools to create a seamless, adaptive, and efficient work environment that caters to the diverse needs of a multigenerational workforce. Below are key ways in which digital transformation helps bridge generational gaps:

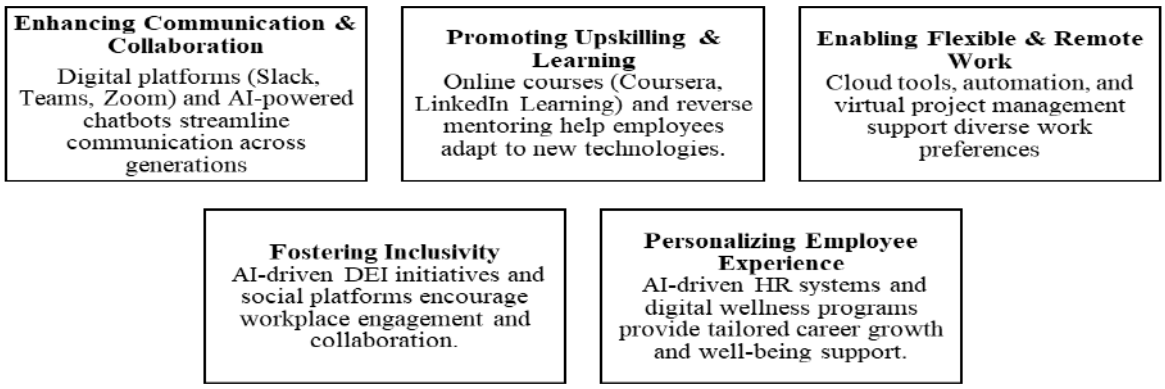

Diagram No. 8.0 Role of Digital Transformation in Bridging Generational Gaps

By integrating digital tools, organizations create a seamless and adaptive work environment for all generations.

9.0 Conclusion

As workplaces continue to evolve, successful organizations will be those that understand and embrace the strengths of a multigenerational workforce. By leveraging technology, fostering inclusivity, prioritizing work-life balance, and adapting to emerging workplace trends, companies can create a thriving, collaborative, and future-ready workforce. The key to success lies in recognizing generational differences while uniting employees through shared goals and a culture of mutual respect and adaptability.

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Humanities and Social Sciences

मध्य भारती
मानविकी एवं समाजविज्ञान की द्विभाषी शोध-पत्रिका

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"EXPLORING EFFECTIVE STRATEGIES AND TRENDS IN SOCIAL MEDIA MARKETING FOR ENHANCED BRAND COMMUNICATION AND AWARENESS"

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ABSTRACT:

Social Media is the current big buzzword in the world of Internet Marketing, and with good reason. It is already such a big part of the Internet culture. It is here to stay and should be ignored by marketers, or indeed anybody, at their peril. It is important to understand why customers use these websites, as there is a broad demographic on these sites. Some organizations use them for business purposes, to network and find new deals. Then there are others who use social networking sites for purely personal reasons and are totally oblivious to the fact that there is a business presence in the social networking environment at all. It is fascinating to see that there are so many different things going on in one place, and even more incredible that they seem to all work in harmony.

To know the opinion of customers for social networking sites, how do they use it, what are the sites they use and how these sites help them in socializing? Formulate and implement marketing strategies for branding, promoting and communicating the information to the customers. What are the attractive form of advertisements and improve the quality of advertisement? Are we reaching the right audience, and if so, are we reaching themeffectively?

Key Words: *Social Media, Internet Marketing, Internet culture, Social networking*

INTRODUCTION: SOCIAL MEDIA MARKETING:

Social media marketing is a powerful way for businesses of all sizes to reach prospects and customers. Your customers are already interacting with brands through social media, and if you're not speaking directly to your customers through social platforms like Facebook, Twitter and

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Instagram, organizations missing out. Great marketing on social media can bring remarkable success to Institutions, creating devoted brand advocates and even driving leads.

What is Social Media Marketing?

Social media marketing, (SMM), is a form of internet marketing that involves creating and sharing content on social media networks in order to achieve your marketing and branding goals. Social media marketing includes activities like posting text and image updates, videos, and other content that drives audience engagement, as well as paid social media advertising to improve your business's social presence.

With these tips, organizations can begin developing your own social media marketing expert plan.

OBJECTIVES OF THE RESEARCH PAPER:

1. To find most effective strategy of social media marketing.
2. To find out the awareness of social media marketing.
3. To find effective brand communication for social media promotion.
4. To study key trends in social media marketing

Social Media and Marketing: Before you begin creating social media marketing campaigns, consider your business's goals. Starting a social media marketing campaign without a social strategy in mind is like wandering around a forest without a map you might have fun, but you'll probably get lost.

Here are some questions to ask when defining your social media marketing goals:

- What are you hoping to achieve through social media marketing?
- Who is your target audience?
- Where would your target audience hang out and how would they use social media?
- What message do you want to send to your audience with social media marketing?

Your business type should inform and drive your social media marketing strategy.

Example of a drone company doing social media marketing on Instagram for example, an e-commerce or travel business, being highly visual, can get a lot of value from a strong presence on

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Instagram. A business-to- business or marketing company might find more leverage in Twitter or LinkedIn.

Social media marketing can help with a number of goals, such as:

- Increasing organization website traffic
- Building conversions
- Raising organization brand awareness
- Creating a brand identity and positive brand association
- Improving communication and interaction with key audiences

The bigger and more engaged your audience is on social media networks, the easier it will be for you to achieve every other marketing goal on your list!

BEST SOCIAL MEDIA MARKETING TIPS:

Social Media Content Planning — As discussed previously, building asocial media marketing plan is essential. Consider keyword research andcompetitive research to help brainstorm content ideas that will interest your target audience. What are other businesses in your industry doing to drive engagement on social media?

Great Social Content — Consistent with other areas of online marketing, content reigns supreme when it comes to social media marketing. Make sure you post regularly and offer truly valuable information that your ideal customers will find helpful and interesting. The content that you share on your social networks can include social media images, videos, info graphics, how-to guides and more. Other social media marketing insight. If your competitors are using a certain social media marketing channel or technique that seems to be working for them, considering doing the same thing, but do it better!

A great Facebook ad should be consistent with your whole brand image

- A Consistent Brand Image — Using social media for marketing enables your business to project your brand image across a variety of different social media platforms. While each platform has its own unique environment and voice, your business's core identity, whether it's friendly, fun, or trustworthy, should stay consistent.
- Social Media for Content Promotion — Social media marketing is a perfect channel for

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sharing your best site and blog content with readers. Once you build a loyal following on social media, you'll be able to post all your new content and make sure your readers can find new stuff right away. Plus, great blog content will help you build more followers. It's a surprising way that content marketing and social media marketing benefit each other.

- Sharing Curated Links — While using social media for marketing is a great way to leverage your own unique, original content to gain followers, fans, and devotees, it's also an opportunity to link to outside articles as well. If other sources provide great, valuable information you think your target audience will enjoy, don't be shy about linking to them. Curating and linking to outside sources improves trust and reliability, and you may even get some links in return.

- Tracking Competitors — It's always important to keep an eye on competitors they can provide valuable data for keyword research and Measuring social media performance through Twitter Analytics

- Measuring Success with Analytics — You can't determine the success of your social media marketing strategies without tracking data. Google Analytics can be used as a great social media marketing tool that will help you measure your most triumphant social media marketing techniques, as well as determine which strategies are better off abandoned. Attach tracking tags to your social media marketing campaigns so that you can properly monitor them. And be sure to use the analytics within each social platform for even more insight into which of your social content is performing best with your audience.

Social Media Crisis Management — Things don't always go swimmingly for brands on social media. It's best to have a playbook in place so your employees know how to handle a snafu. Check out our guide to social media crisis management to see examples of the worst social media disasters, plus tips on how they should have been handled.

How to Choose the Best Social Media Platforms for Marketing?

Here's a brief overview about how to use social media for marketing according to each platform's unique user base and environment. Different social media marketing sites require different approaches, so develop a unique strategy tailored for each platform.

EMERGING TECHNOLOGIES USED FOR SOCIAL MEDIA MARKETING:

The future of marketing may hinge on new and emerging technologies in the digital world. In this lesson, we'll explore some of these new communication tools and their impact on digital marketing.

Virtual Home Improvement- Exploring a home improvement store can be fun, but it can also be difficult to envision how new paint colors, light fixtures, and window treatments will look in your

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remodeling project Virtual reality platforms are creating new opportunities for marketing. Lowe's has created a solution to that problem using a relatively new and unusual tool: virtual reality. The company's Holoroom initiative gives customers a sneak peek of their planned project using virtual reality technology. The program also lets customers pick products to add to their designs so they can better-visualize the final product. Today's digital marketing borders on science fiction with its virtual reality capabilities and wearable technology. At one time, Digital technologies and trends in marketing have come a long way in a short period of time. Today, we can search for a nearby store using by speaking our search, order supplies with the push of a button or use our daily exercise class to earn points at the drugstore. Let's take a look at a few of the more prevalent technologies make themselves known and what it could mean for digital marketing.

VOICE SEARCH: Amazon sold millions of its Echo Dot devices during Christmas shopping in 2017. Consumers are using them to set their alarms, find cooking tips, and figure out what to wear in the morning. And, it all boils down to one concept: voice search.

NEW VOICE SEARCH TECHNOLOGIES MAY REQUIRE MARKETERS TO ADAPT THEIR STRATEGIES.

Voice search is the ability to speak commands rather than type them. Speech these options seemed far-fetched, only to be talked about in movies and speculative fiction. Now, marketers are using these emerging technologies and disrupting marketing along the way.

Emerging Digital Technologies: Recognition technology has now made it possible for consumers tosearch for any topic using regular speech patterns. The increasing presence of these devices clearly presents new opportunities for marketers. For example, instead of a consumer searching for 'Best pizza in New York City', they might say, 'Where can I find good pizza in NYC?' For marketers, voice search means developing a better understanding of the **keywords** your customers are using when looking for answers. Creating a more conversational tone in your content will help devices find answers and deliver it to them. More relevant content will boost yoursearch engine optimization (SEO), your traffic, and your brand awareness.

Augmented Reality: There's no better place for augmented reality to find a marketing foot hold than in the movie industry. AMC Cinemas has taken advantage of it by creating movie posters that allow movie-goers to access movie information and trailers simply by aiming their phone at them. The app even integrates ticket-purchasing as well.

Merriam: Webster defines augmented reality as 'enhanced version of reality created by the use of technology to overlay digital information on an image of something being viewed through a device.' Marketers could use AR to provide content in print ads or retail window displays. Because customers use their smartphones, even while shopping in-store, AR marketing What does this

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mean for marketers? It means making a deeper understanding of consumers' wants and needs a priority for the company. AR presents an opportunity for businesses to present solutions to customers during the consideration stage of the buying cycle.

Virtual Reality: To go back to our opening example, virtual reality uses computer generation to mimic a user's true reality, creating a realistic and interactive atmosphere that can give consumers an immersive experience with a branding has the capabilities of providing exactly the right information at the right time Virgin Atlantic uses it by letting consumers experience its luxury travel options. Features like VIP check-in and the clubhouse experience are being used to sell Virgin's travel experience. Excedrin has also used virtual reality to create a migraine simulator to help educate families about the migraine experience Marketers can harness the power of virtual reality since it seeks to disrupt traditional marketing by giving consumers more hands-on access and turning a sales pitch into a complete experience. It could be used to create a virtual shopping experience for busy consumers. It also has the ability to allow marketers to collect more data from customers, leading to better personalize and customization.

Wearables: Wearables such as smartwatches and fitness trackers are creating new avenues for digital marketers. Walgreen's has used it as part of its marketing, partnering with Fitbit to tie to its loyalty program. Customers who sync their Fitbit to Walgreens' Balance Rewards program can get discounts, creating a stronger relationship and increased brand loyalty between a business and its consumers.

Using Facebook for Social Media Marketing: Facebook’s casual, friendly environment requires an active social media marketing strategy. Start by creating a Facebook Business Fan Page. You will want to pay careful attention to layout, as the visual component is a key aspect of the Facebook experience. Facebook is a place people go to relax and chat with friends, so keep your tone light and friendly. And remember, organic reach on Facebook can be extremely limited, so consider a cost-effective Facebook ad strategy, which can have a big impact on your organic Facebook presence as well.

Using Google+ for Social Media Marketing: Google+ entered the scene as a Facebook competitor, but it now serves a more niche audience. It won't work for everybody, but some communities are very active on Google+. On Google+ you can upload and share photos, videos, links, and view all your+1s. Also take advantage of Google+ circles, which allow you to segment your followers into smaller groups, enabling you to share information with some followers while barring others. For example, you might try creating a super- fan‖ circle, and share special discounts and exclusive offers only with that group. Note that Google has announced plans to retire Google+, so plan accordingly!

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Using Pinterest for Social Media Marketing: Pinterest is one of the fastest growing social media marketing trends. Pinterest's image-centered platform is ideal for retail, but anyone can benefit from using Pinterest for social media purposes or sales-driving ads. Pinterest allows businesses to showcase their product offerings while also developing brand personality with eye-catching, unique pin boards. When developing your Pinterest strategy, remember that the social network's primary audience is female. If that's your demographic, you need a presence on Pinterest!

Using Twitter for Social Media Marketing: Twitter is the social media marketing tool that lets you broadcast your updates across the web. Follow tweeters in your industry or related fields, and you should gain a steady stream of followers in return. Mix up your official tweets about specials, discounts, and news with fun, brand-building tweets. Be sure to retweet when a customer has something nice to say about you, and don't forget to answer people's questions when possible. Using Twitter as a social media marketing tool revolves around dialog and communication, so be sure to interact as much as possible to nurture and build your following.

Using LinkedIn for Social Media Marketing: LinkedIn is one of the more professional social media marketing sites. LinkedIn Groups is a great venue for entering into a professional dialog with people in similar industries and provides a place to share content with like- minded individuals. It's also great for posting jobs and general employee networking. Encourage customers or clients to give your business a recommendation on your LinkedIn profile. Recommendations makes your business appear more credible and reliable for new customers. Also browse the Questions section of LinkedIn; providing answers helps you get established as a thought leader and earns trust.

Using YouTube for Social Media Marketing: YouTube is the number one place for creating and sharing video content, and it can also be an incredibly powerful social media marketing tool. Many businesses try to create video content with the aim of having their video go viral, but in reality those chances are pretty slim. Instead, focus on creating useful, instructive how-to videos. These how-to videos also have the added benefit of ranking on the video search results of Google, so don't under- estimate the power of video content!

Location-Based Social Media Tools: Social media platforms like Yelp and Foursquare are great for brick and mortar businesses looking to implement marketing on social media. Register on these sites to claim your location spot, and then consider extra incentives such as check-in rewards or special discounts. Remember, these visitors will have their phones in hand, so they will be able to write and post reviews. A lot of good reviews can significantly help sway prospective visitors to come in and build your business!

Using Reddit for Social Media Marketing: Reddit, or similar social media platforms such as Stumble Upon or Digg, are ideal for sharing compelling content. With over 2 billion page views a

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month, Reddit has incredible social media marketing potential, but marketers should be warned that only truly unique, interesting content will be welcomed. Posting on Reddit is playing with fire ubmit spam my or overtly sales-focused content and your business could get berated by this extremely tech-savvy community. If you have content you believe the Reddit community (majority is young, geeky, liberal, and internet-obsessed) would enjoy, you could reap tremendous benefits and earn valuable traffic. Using social media in marketing does more than improve site traffic and help businesses reach more customers; it provides a valuable venue for better understanding and learning from your target audiences.

Paid Social Media Marketing Tips: We love paid social advertising because it's a highly cost-effective way to expand your reach. If you play your cards right, you can get your content and offers in front of a huge audience at a very low cost. Most social media platforms offer incredibly granular targeting capabilities, allowing you to focus your budget on exactly the types of people that are most likely to be interested in your business. Below are some tips and resources for getting started with paid social media marketing:

Social Media Advertising for Small Businesses: Learn the ins and outs of social media advertising on four major networks: Facebook, Twitter, LinkedIn, and Google+.

Creating Effective Facebook Ads: If you know how to use it properly, Facebook can be one of the most powerful advertising platforms for driving your business forward. And it's not just for raising brand awareness. In this guide, you'll learn how to create effective Facebook ads that generate real leads. If you're already advertising on Facebook and are looking to save time AND money, check out Word Stream Social Ads, our new offering that makes Facebook advertising easier and more effective.

CONCLUSION: Communication about the product or service provides a major contribution to brand competition in the market. It not only provides information about a product or service but also promotes creative innovation. Besides advertising, it also facilitates consumer satisfaction. The hidden fact is that no brand can progress without effective communication strategy to attract their customers or users. Big and small variety of brands now a days laid their base on social network communication to get recognized in the target market. Communication should be more preferred than advertising. So, if the brand is communicated well and remembered by the audience, then it is a greatest success to the organization for their promotion through social media. Promotional way of advertising is best: the usual banner ads and video ads attract them. So advertising must be interactive, promotional and in innovative form to hold the audience.

The most effective strategy of social media marketing:

1. Marketing Automation Tools,

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2. Content Marketing

3. Trend, Big data,

4. Mobile Marketing Trend,

5. Conversion rate optimization(CRO).

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A STUDY OF IMPACT ON EMPLOYEE PRODUCTIVITY WITH REFERENCE TO TRAINING PROVIDED WITH REFERENCE TO MAHINDRA AUTOMOBILE DEALERSHIP SECTOR IN PUNE CITY.

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Sambhaji Sawant Dr Sambhaji B. Sawant . Research Guide Director-Abhijit Kadam Institute of Management and Social Sciences

Abstract:_ In the Automobile Dealership sector training provided to employees is one of the most important activities conducted for the development of knowledge and skills required by the employees. Automobile dealerships had adopted various methods for providing necessary training to their employees considering the objective to improve the productivity of the employees. The data for the research was collected with the help of a structured questionnaire form 60 employees working in Automobile Dealership in Pune City. Data collected was analysed by using one way Anova. Several studies have been conducted related to employees training in the Automobile Industry but less work is carried regarding training for Automobile Dealership. The impact of training on employee's productivity is the primary objective of the current study.The Researcher had made an attempt to provide comprehensive knowledge on training provided to employees in Automobile Dealership.

Keywords: Employee, productivity, Automobile, industry, dealership.

Introduction: Human resource plays an important role in each and every organization in achieving the goals and objectives of the organisation. In Automobile dealership employees are the key resource which are responsible for performing various functions and enhance the profitability, it is only possible because of proper timely training provided to the employees which improves the productivity and profit for the Dealership. Employees performing job plays an important role for improving the quality of work and develop new knowledge and skills required for accomplishing the functions. The training provided to employee has variation in respect of quality and quantity of training methods adopted and provided by different Dealership. Now a day's there is tremendous increase in the competition between Dealership for having large customers and increase in the sales. The demand of the customers is changing regarding the various products and this need to keep the employees in Dealership updated according to new technology adopted so that more satisfied customers can be created. Employees need to adapt themselves with the new technology based on the changes in the technology which will result for providing high productivity and enhancing performance. The Researcher had made an attempt for providing comprehensive knowledge on training provided to employees in Automobile Dealership

Objectives of the study:

Primary objective of the study To study the impact of training on the employees working in Automobile Dealership in Pune City is the primary objective of the study , in which the importance of training for employees will be identified as well as what is the perception regarding training on employees will be identified.

Secondary objective of the study:

1. To find the impact on employees productivity after the completion of training.
2. To check the feedback of employees regarding the training received in concern with satisfaction with the training programme.

REVIEW OF LITERATURE

Sinaga, Marida, and Setyo Riyanto. " Training and Development to improve employee performance " ECOBISMA (JUHuman resources (HR) is an important aspect for sustainability of business activities in the organization. A organization can increase work productivity if there is good cooperation and a reciprocal relationship between the company's management and its employees

Palo, S,Padhi, N (2003) " Measuring Effectiveness of Total Quality Management Training" Stated that Training is an important aspect in Human resource Practices which helps for developing the skills and qualities of the employees which in turn helps in improving the performance of the employees.

ldwin and Ford (1988) In this study it specifies different divisions of training input and training output also conditions of transfer in which several issue of working environment which had change in behaviour of the employees considered as one of the measure of transfer.

Gupta ,S,Bostrom, R.P(2006)[12] The study specifies the usage of different methods of training gives the importance in understanding that what knowledge we possess and what knowledge we need to possess will definitely help in providing more qualitative techniques for making improvement in the performance of the employees with the help of effective training methods.

RESEARCH METHODOLOGY: Primary data was collected with the help of structured questionnaires from the employees who are working in Mahindra Dealership. Secondary data was also collected from the human resource development department. In this study a simple random method is considered in this the respondents are the employees of Mahindra Dealership Sahyadri and Unnati dealership in Pune City. The respondents are provided with the questionnaire for collecting sample from 120 respondents.

Questionnaire Design: The questionnaire is designed into three sections

First section: It consisted of questions related to the personal information, qualification, designation and experience of the respondents. Second Section: it consists of questions which are related to the training of the employees. Third Section: it consists of questions related to productivity of the employees. 5 point likert scale was used for the data analysis after receiving the response from the respondents.

STATISTICAL TOOLS USED: ANOVA ANALYSIS: ONE WAY ANOVA TEST

HYPOTHESIS:

H0: There is no difference between training and Productivity of employees in the Dealership.

H1: There is a difference between training and Productivity of employees in the Dealership.

Table 1 showing Anova for training and development and quality of work performance

	Sum of Squares	df	Mean Square	F	Sig
Within Groups	53.90	70	.77		
Between Groups	9.21	2	4.60	5.98	.004
Total	63.11	72			

INFERENCE: From the above study it is inferred that H1 hypothesis i.e. Alternative Hypothesis is accepted and H0 Null Hypothesis is rejected in the study as p value is 0.004 which is less than 0.05 , which shows there exist significant relationship between training and productivity of the employees in the Dealership , so we can state that there is positive impact on the employees performance if they are provided with effective training in the Automobile Dealership.

Suggestion:

1. As training conducted for employees has a positive impact, Automobile Dealership must look forward for conducting Training programmes which are relevant to the functions performed by the employees.
2. Training provided by a certified trainer helps in improving the skills and knowledge which result in positive impact on productivity
3. It is necessary to get transparent feedback regarding training from the employees to identify the areas for improvement.
4. It was found that the employee's productivity is enhanced because of training provided to them which helps in the growth of the Dealership, so it becomes necessary to impart training programmes to the employees of Automobile Dealership.

Conclusion: The research specifies that training provided to employees in the Automobile dealership has a positive impact on increasing the productivity of the employees. As in today's market there is cut throat competition between the Dealership in Pune City for having more number of customers it had become the need to timely keep the IT is necessary that an analysis of the need of training must be done and the area where it requires continuous improvement must be considered for providing training to the employees. The study specifies that Training provided to employees shows a positive impact on the productivity of the employees in the Automobile Dealership which result in motivating the employees positively. Training in Automobile Dealership helps in providing necessary techniques for operating Automobile vehicles as well as problem solving skills related with Automobile vehicle sales.

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GREEN MARKETING IN THE 21ST CENTURY: TRENDS, STRATEGIES, AND CONSUMER BEHAVIOR

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ABSTRACT

As people become more aware of environmental issues like climate change, pollution, and the depletion of natural resources, the way they view products and services has changed. Because of this, **green marketing—**which involves promoting products or services for their environmental benefits—has become an important strategy for businesses that want to connect with eco-conscious consumers and meet the growing demand for sustainable products. This paper looks at green marketing in the 21st century, focusing on the latest trends, business strategies, and changes in consumer behavior towards eco-friendly products. By reviewing industry examples and research, the paper explores what is driving the rise of green marketing, how it affects business performance, and the challenges companies face in dealing with sustainability issues.

1) INTRODUCTION

In the 21st century, businesses are under more pressure to adopt sustainable practices and respond to growing concerns about environmental issues. As problems like climate change, pollution, and resource depletion become more urgent, consumers are paying more attention to the environmental impact of their products. This shift in what consumers care about has led to the growth of green marketing, which focuses on promoting eco-friendly products and sustainable business practices. Green marketing reflects these changing values and allows businesses to innovate, stand out in the market, and build customer loyalty over time.

This paper examines the current state of green marketing by examining trends, strategies, and consumer behavior that are driving the growth of sustainable marketing practices. By analyzing business strategies and consumer attitudes, the paper provides insights into how well green marketing works and the challenges companies face when adopting and communicating sustainable practices.

Objectives

1. To study the current status of green marketing.
2. To identify barriers to the adoption of green marketing.
3. To discuss the future growth of green marketing.
4. To provide insights for businesses on aligning with sustainability.

2) THE RISE OF GREEN MARKETING

Green marketing has changed a lot over the past few decades. The term became more popular in the 1980s as environmental issues started to get more attention worldwide. In the beginning, green marketing mainly focused on product innovations, like using biodegradable

packaging, creating energy-efficient appliances, and using recycled materials. As environmental concerns became more important, green marketing expanded to include things like **corporate social responsibility (CSR)**, being transparent about the supply chain, and adopting sustainable business practices.

2.1 Evolution of Green Marketing

In the late 20th century, important works like Jacquelyn Ottman's *The Green Consumer Guide* (1990) helped shape early green marketing strategies. The **Brundtland Report** (1987), which introduced the idea of **sustainable development**, also gave businesses a guide for adding environmental concerns into their plans. This shift toward sustainability grew stronger as consumers started demanding more environmentally responsible products, especially in industries like energy, transportation, and everyday consumer goods.

By the 21st century, the focus of green marketing shifted from just offering eco-friendly products to a broader approach. Now, companies are working to include sustainability in all areas of their business, from how they manage their supply chains to the design of their products and the way they communicate their values to customers.

2.2 Green Marketing in the Digital Age

With the growth of digital media and online shopping, green marketing has adapted to new platforms. Social media has become a key tool for businesses to share their sustainability efforts directly with consumers. On platforms like Instagram, Twitter, and Facebook, companies can quickly update people about their eco-friendly actions and create communities of consumers who share similar values. Also, the internet makes it easier for consumers to compare the environmental impact of different products, which has increased the demand for honest and transparent green marketing messages.

3) TRENDS IN GREEN MARKETING

Green marketing in the 21st century has been influenced by several important trends that show how much sustainability matters in many industries. These trends show how businesses are including environmental concerns in their marketing to attract consumers who care about the planet.

3.1 Increased Focus on Sustainability Across Industries

In recent years, sustainability has gone beyond just industries like renewable energy and organic farming to impact nearly every sector. From cars to clothing and technology, more businesses are making sustainability a key part of their products and marketing. For example:

- **Automotive Industry**: Companies like **Tesla** and **BMW** have been at the forefront of promoting electric vehicles (EVs) as a cleaner alternative to traditional gasoline-powered cars. They market EVs not just for their advanced technology, but also for their positive environmental benefits, such as reducing carbon emissions and increasing energy efficiency.
- **Fashion Industry**: The fashion industry has often been criticized for its negative environmental impact. However, brands like **Patagonia** and **Everlane** are changing this by using recycled materials and supporting fair labor practices. Their green marketing focuses on being transparent about their operations and sourcing ethically, appealing to consumers who care about both environmental and social issues.

3.2 Rise of Eco-Labels and Certifications

A key trend in green marketing is the growing use of eco-labels and certifications. More and more, consumers want proof from trusted third parties that a product is truly environmentally friendly. Certifications like Energy Star, Fair Trade, and Forest Stewardship Council (FSC) help businesses build trust with eco-conscious shoppers.

For example, The Body Shop uses the Fair Trade certification to show its dedication to ethical sourcing and sustainability. Similarly, Nestlé has added eco-labels to some of its products, highlighting their efforts to reduce environmental impact through better sourcing and packaging.

3.3 Emphasis on Circular Economy and Waste Reduction

Another big trend in green marketing is the focus on the circular economy. This is a system where businesses aim to reduce waste, reuse materials, and recycle products once they are no longer in use. Companies are creating products that are built to last, can be repaired, and can be recycled, which appeals to environmentally conscious consumers.

For example, IKEA follows circular economy principles by offering take-back programs for old products and using recycled materials in their items. By promoting these efforts, businesses help reduce waste and attract customers who care about the environmental impact of what they buy

3.4 Integration of Corporate Social Responsibility (CSR) in Marketing

Corporate Social Responsibility (CSR) is now a key part of green marketing. Companies that take part in CSR activities—like supporting the environment, ensuring fair labor practices, and cutting down on their carbon emissions—often highlight these efforts in their marketing to show they are serious about sustainability.

For example, Unilever has made CSR a big part of its brand. Through its Sustainable Living Plan, Unilever focuses on sustainable sourcing, reducing waste, and improving health and well-being. These efforts are central to how the company promotes itself as an environmentally and socially responsible brand.

4) GREEN MARKETING STRATEGIES

To successfully market eco-friendly products, businesses need to use strategies that connect with consumers and clearly show their dedication to sustainability. Here are some key strategies used in green marketing:

4.1 Product Innovation and Eco-Friendly Packaging

A key strategy in green marketing is creating eco-friendly products that meet consumer demand for sustainability. This includes energy-saving appliances, organic foods, and environmentally friendly clothing.

Along with new product ideas, companies are also focusing on using sustainable packaging. Brands like Lush Cosmetics and Coca-Cola are leading the way by using recyclable or biodegradable materials to cut down on waste. For example, Coca-Cola's PlantBottle is made from plant-based materials, showing how companies can innovate packaging to meet consumer expectations for sustainability.

4.2 Green Advertising and Communication

Green advertising is about promoting eco-friendly products by highlighting their sustainability features in marketing campaigns. To be effective, green advertising needs to be

clear, honest, and transparent to avoid greenwashing—making false claims about a product's environmental benefits.

For example, Apple promotes its products by focusing on their environmental sustainability, like using recycled aluminum and renewable energy in production. Apple's ads highlight its efforts to reduce its carbon footprint and use more sustainable materials

4.3 Building Brand Loyalty Through Sustainability

One of the long-term benefits of green marketing is that it helps build brand loyalty. Consumers who care about sustainability are more likely to stick with brands that share their values. For example, Patagonia has built a loyal following by showing its commitment to environmental and social responsibility. Through initiatives like Worn Wear, which promotes reusing and repairing clothes, and its efforts to protect public lands, Patagonia connects with customers who value sustainability.

4.4 Transparency and Third-Party Verification

Transparency is key for businesses in green marketing. Companies that give clear and trustworthy information about the environmental impact of their products are more likely to gain consumer trust. Third-party certifications and eco-labels are helpful because they verify a company's claims and assure customers that the company's green efforts are genuine.

5) CONSUMER BEHAVIOR AND GREEN MARKETING

Understanding consumer behavior is essential for businesses that want to use green marketing effectively. As environmental concerns grow, many consumers are willing to pay more for products that are sustainably sourced, energy-efficient, or made from recycled materials. Recognizing this shift can help businesses create products and marketing strategies that appeal to eco-conscious shoppers.

5.1 Factors Driving Green Consumerism

Several factors are driving the growing demand for green products:

- **Environmental Awareness**: As more people become aware of global environmental issues, they are paying closer attention to the ecological impact of their purchases.
- **Health Concerns**: Many consumers believe that green products, such as organic food and non-toxic personal care items, are healthier and safer for both themselves and the environment.
- **Social Influence**: Social media, celebrity endorsements, and the influence of peers have all played a big role in encouraging consumers to choose eco-friendly products.

5.2 Barriers to Green Consumption

Despite the increasing demand for green products, there are still some barriers:

- **Price**: Green products often cost more, which can discourage price-sensitive consumers from buying them.
- **Lack of Information**: Many consumers find it hard to tell which products are truly sustainable due to misleading labels or not enough clear information.
- **Convenience**: Some eco-friendly products may be harder to find or less convenient to use, making it harder for them to gain widespread popularity.

6) FUTURE GROWTH OF GREEN MARKETING:

Green marketing will grow as more people want eco-friendly products and businesses face stricter environmental rules. Consumers, especially younger ones, care about sustainability and expect companies to be honest about their efforts. As new green technologies and ways to reuse and recycle products emerge, businesses will focus more on these in their marketing. Companies embracing sustainability will stand out, while those that fake it will face backlash. In the future, being eco-friendly will be a key part of a business's identity and offer long-term growth.

CONCLUSION

Green marketing has evolved from a niche idea to a mainstream business strategy in the 21st century, driven by rising consumer demand for sustainable products and corporate responsibility. As trends like sustainability, the circular economy, and Corporate Social Responsibility (CSR) continue to grow, businesses need to adopt transparent and innovative marketing strategies to connect with eco-conscious consumers.

While challenges like higher prices, consumer education, and the risk of greenwashing remain, the future of green marketing looks bright. Companies that genuinely commit to sustainability will likely gain a competitive edge. By responding to the increasing demand for environmentally responsible products and practices, businesses can enhance their brand value and play a role in building a more sustainable global economy.

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USING AI tools in Libraries

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Abstract-
Artificial Intelligence (AI) is transforming library services, providing unparalleled prospects for enhancing efficiency, accessibility, and user experience. This research paper offers a thorough examination of the implementation of artificial intelligence (AI) technologies in libraries. It explores the many uses, advantages, difficulties, and potential future developments of using AI in libraries. AI integration in libraries involves a range of functions, such as cataloging, categorization, information retrieval, and user engagement. AI utilizes modern technologies like natural language processing and machine learning algorithms to automate the indexing and precise classification of library items. It also allows the creation of customized recommendation systems, which greatly improves the discoverability and accessibility of resources for library customers.
The adoption of AI in libraries brings forth numerous advantages. It optimizes operational efficiency by automating routine tasks, minimizes human errors, and facilitates round-the-clock access to information resources. Additionally, AI-driven analytics offer valuable insights into user behavior and preferences, enabling libraries to tailor their services to meet evolving needs effectively. However, the implementation of AI in libraries presents certain challenges. These include the need for specialized technical expertise among library staff, financial constraints in acquiring and maintaining AI systems, and concerns regarding data privacy and ethical considerations. Looking ahead, the future of libraries is envisioned to be deeply intertwined with AI technologies. Libraries may utilize robots for shelf organization and inventory management, and AI-powered chatbots and virtual assistants for tailored support. Although there may be concerns, AI has the ability to transform libraries into critical centers of information distribution and community participation in the digital era.
Key words- Artificial Intelligence, Libraries, Library Services, Automation, Information Retrieval, Machine Learning, Natural Language Processing, User Experience, Efficiency, Challenges & Future Prospects etc.

Introduction –

The concept of intelligence, both in humans and machines, lies at the core of Artificial Intelligence (AI). Intelligence encompasses the ability to perceive, learn, reason, and apply knowledge effectively. While humans naturally possess intelligence that develops over time, the aspiration to create computers or machines that exhibit similar cognitive abilities has intrigued many. Artificial Intelligence aims to imbue machines with the capacity to perceive, reason, and behave like humans, ultimately enabling them to accomplish tasks autonomously.
In human intelligence, the Intelligence Quotient (IQ) serves as a measure, typically obtained through aptitude tests assessing various aspects of intellectual functioning. Similarly, in AI, intelligence is characterized by the machine's capability to perform tasks amidst variability and adapt its actions based on environmental cues. This

ability to learn and improve without explicit programming distinguishes intelligent machines from conventional ones. AI has already become pervasive in daily computing activities, with features like speech recognition, natural language processing, and machine learning integrated into many computer systems and mobile devices. These technologies operate on perceptual recognition, enabling computers to efficiently recognize patterns at a scale and speed surpassing human capabilities.

Libraries, as essential providers of information access, are also embracing AI to meet the evolving demands of users in the digital age. Intelligent library systems leverage AI to enhance cataloging, indexing, reference services, and information retrieval processes. These systems use NLP and knowledge-based services to go beyond conventional approaches.

The integration of AI tools in libraries represents a paradigm shift in information and service delivery, driven by the rapid advancement of technology. Failure to adopt these innovations may lead to libraries becoming obsolete in today's information-driven society. With researchers and experts actively developing intelligent systems akin to "library robots," the realization of smart libraries powered by AI is not merely speculative but imminent.

Benefits of Implementing AI in Libraries

The justification for using artificial intelligence (AI) in libraries stems from its capacity to fundamentally transform the operations and delivery of services in libraries. AI technology have several advantages that may optimize library operations and increase user experiences. AI systems have the capability to automate repetitive jobs like cataloging, indexing, and data management. This enables librarians to dedicate their time and skills to more intricate activities. This automation enhances efficiency and productivity, allowing libraries to efficiently handle and arrange enormous quantities of information.

Furthermore, AI has the potential to enhance the accessibility and retrieval of information for those using library services. Natural language processing (NLP) and machine learning techniques empower AI systems to comprehend and analyze user queries, hence delivering more precise and relevant search results. This improves the user experience by facilitating the efficient and effortless retrieval of the desired information.

Furthermore, AI-driven recommendation systems have the capability to customize the browsing experience for consumers by proposing relevant resources according to their interests and preferences. This not only simplifies the process of finding things, but also promotes the act of exploring and stumbling across new stuff by chance.

In addition, artificial intelligence (AI) technology such as chatbots and virtual assistants may provide continuous help to users by responding to inquiries, offering aid, and directing consumers to relevant information and services. This improves the accessibility and convenience for library customers, particularly for those who may need help outside of the normal operation hours.

In general, the application of artificial intelligence (AI) in libraries provides many benefits, such as greater effectiveness, expanded access to information, customized services, and improved user experiences. Libraries can stay relevant and important resources for their communities by using AI technology to meet the changing requirements and expectations of their users in the digital era.

The fundamental principles and ideas of Artificial Intelligence (AI)

Artificial intelligence (AI) includes a wide range of theories and concepts designed to empower computers or robots to do tasks that often necessitate human intelligence. Artificial intelligence (AI) aims to mimic human cognitive functions like learning, logical reasoning, problem-solving, perception, and language comprehension. Machine learning is a major aspect of artificial intelligence that involves developing techniques enabling computers to improve their performance by learning from data, without requiring explicit programming. This facet of artificial intelligence is crucial for tasks like character identification, image analysis, three-dimensional understanding, and voice recognition. Natural language processing (NLP) is a crucial element of artificial intelligence (AI) that allows computers to comprehend, interpret, and produce human language. NLP approaches are crucial for tasks like speech recognition, language translation, and sentiment analysis. AI also includes expert systems that aim to imitate the decision-making skills of human professionals in specific fields.

The three main focuses of AI are perception, reasoning, and action. Perception involves the ability of computers to interpret and understand sensory inputs from the environment, such as images or speech. Reasoning is fundamental for intelligent decision-making and problem-solving, involving internal processes or algorithms that enable computers to determine the best course of action. Action pertains to the capacity of computers to carry out tasks by using their senses and thinking abilities. AI encompasses a range of meanings, including the development of computers capable of thinking and the exploration of mental abilities using computational models. AI is primarily focused on developing intelligent computers that can do tasks in a way that imitates human intellect. Whether strong or weak, AI systems aim to mimic aspects of human cognition to solve complex problems and adapt to new situations effectively.

Artificial Intelligence trends

The advancement in the field of AI has led to the development and implementation of various applications across different domains. One notable area of advancement is in autonomous vehicles or self-driving cars. These vehicles utilize AI algorithms to navigate roads, interpret traffic signs and signals, and make driving decisions without human intervention. Similarly, navigation systems in smartphones and GPS devices employ AI technology to provide real-time route guidance and traffic updates.

In the realm of gaming, AI has enabled computers to compete against humans in complex games such as chess, Go, and poker. AI-powered game-playing agents use advanced algorithms and strategies to analyze game states and make optimal moves, challenging even the most skilled human players. AI is also used in fraud detection, where machine learning algorithms evaluate trends in financial transactions to identify possibly fraudulent behavior. Through the process of analyzing historical data, these artificial intelligence systems are able to consistently enhance their ability to identify fraudulent activities and adapt to emerging forms of deceptive conduct.

Another area where AI has advanced is robotics. Using AI algorithms, robots can execute basic assembly line chores to sophisticated surgeries with accuracy and efficiency. Robots learn from their surroundings and improve over time thanks to machine learning. AI has found applications in education, with systems like IBM's Teacher Advisor providing personalized lesson plans and resources for educators. Additionally, AI-powered platforms like Semantic Scholar assist researchers in efficiently searching and accessing academic literature by leveraging machine learning algorithms to analyze and categorize vast amounts of research data. Artificial intelligence systems are broadly classified based on their degree of intelligence and nature of functionality. From reflex agents capable of responding to stimuli to collaborative systems that can autonomously perform tasks, AI technologies continue to evolve and expand their capabilities, driving innovation and transformation across various industries and sectors.

Applications of AI in Libraries

- **AI applications in library services and operations:**

Libraries are transforming how they engage with users and manage resources by incorporating artificial intelligence (AI) more and more into their services and operations. Enhanced user experience, increased productivity, and more capabilities are just a few advantages that AI provides. The following are some important uses of AI in libraries:

1. Information retrieval and recommendation systems: Users can receive more relevant and accurate search results from AI-powered search engines based on their search history, preferences, and usage patterns.
2. Virtual assistants and chatbots: AI-driven virtual assistants can handle routine inquiries, assist users in navigating library resources, and provide real-time support via chat or voice interfaces.
3. Collection management and resource allocation: AI algorithms can analyze usage data and user feedback to optimize collection development decisions, identify gaps in collections, and allocate resources effectively.
4. Metadata management and classification: Artificial intelligence (AI) technologies, including machine learning and natural language processing (NLP), can automate the categorization and classification of library content, increasing user accessibility and discoverability.
5. Patron analytics and user profiling: AI tools can analyze user behavior, preferences, and demographics to generate insights that help libraries tailor services, personalize recommendations, and target outreach efforts more effectively.

- **Examples of AI tools and technologies used in libraries:** Libraries are leveraging a variety of AI tools and technologies to enhance their services and operations. Some examples include:

1. Smart recommendation systems: Libraries employ AI-driven recommendation algorithms to provide users with relevant book, article, and resource recommendations based on their reading preferences and areas of interest.

2. Chatbots and virtual assistants: Libraries deploy AI-driven chatbots to provide instant assistance to patrons, answer common questions, and guide users in finding information or accessing services.
3. Automated cataloging and indexing tools: AI algorithms automate the process of cataloging and indexing library materials, reducing the time and effort required by library staff and improving metadata quality.
4. Predictive analytics software: Libraries use predictive analytics tools to forecast demand for specific resources, anticipate user needs, and optimize collection development strategies.

- **Case studies and success stories of AI implementation in libraries:** Several libraries have successfully implemented AI solutions to improve services, engage patrons, and streamline operations. Case studies and success stories highlight the impact of AI in libraries, including:

1. The Singapore National Library implemented a robot called AuRoSS (Autonomous Robotic Shelf Scanning) to automate the inventory management process, resulting in significant time savings and improved accuracy.
2. The University of Oklahoma Libraries deployed a chatbot named AskAL to provide 24/7 assistance to students and faculty, reducing the workload on library staff and improving user satisfaction.
3. The Los Angeles Public Library used machine learning algorithms to analyze circulation data and optimize branch locations, resulting in better resource allocation and improved access to library services for underserved communities.

Principles of Artificial Intelligence

Artificial intelligence relies on representation, search, reasoning, and learning, according to "The McGraw-Hill Encyclopedia of Science and Technology (2007)".

1. **Representations**: In artificial intelligence, representations refer to the internal structures or models used by intelligent systems to describe problems or knowledge domains. These representations enable the system to identify and manipulate relevant information effectively. For example, an expert system designed for medical diagnosis would represent symptoms and disease information, while a robotic system might use symbolic 3D descriptions of its environment.
2. **Search**: Search algorithms are fundamental to problem-solving in artificial intelligence systems. These algorithms explore possible solutions within the problem space, often employing heuristic techniques to efficiently navigate large search spaces. A search algorithm could scan a database of previous issues and solutions to identify the most similar match to the current challenge.
3. **Reasoning**: Reasoning mechanisms enable intelligent systems to derive solutions from available knowledge or data. Deductive and inductive reasoning methods are commonly used, allowing systems to infer conclusions or hypotheses from existing information. Expert systems, for example, employ rule-based reasoning to generate solutions based on predefined sets of rules and knowledge.

4. **Learning:** Learning is a crucial aspect of artificial intelligence systems, enabling them to adapt and improve performance over time. Machine learning methods like statistical learning, neural networks, and reinforcement learning enable systems to gain knowledge from data and experience. These methods allow systems to adjust their representations, improve search strategies, update knowledge, and strengthen reasoning abilities using feedback and observable results.

Digital Libraries and Artificial Intelligence

Digital libraries, which store, manage, and provide access to digital collections of resources, have greatly benefited from the integration of artificial intelligence (AI) technologies. Digital libraries benefit from AI in a number of ways, including resource management, content analysis, user interaction, and information retrieval. AI is having the following effects on digital libraries:

1. **Improved search and discovery:** Artificial intelligence (AI)-driven search algorithms improve digital library resource retrieval by comprehending context, evaluating user queries, and producing pertinent search results. Semantic search is made possible by natural language processing (NLP) tools, which let users locate resources based more on meaning than keywords.
2. **Personalized recommendations:** To provide tailored recommendations, AI systems examine user preferences, browsing history, and interactions with digital library resources. Artificial Intelligence improves user satisfaction and engagement by making appropriate resource recommendations based on user behavior and interests.
3. **Metadata enrichment and classification**: AI technologies, such as machine learning and computer vision, automate the process of metadata generation, tagging, and classification for digital library resources. This improves the organization, discoverability, and accessibility of digital collections.
4. **Content analysis and annotation:** AI tools can analyze the content of digital resources, extract key information, and generate descriptive metadata, summaries, or annotations. Natural language processing techniques enable text mining, sentiment analysis, and topic modeling, facilitating deeper insights into digital library content.
5. **User interaction and assistance**: AI-powered virtual assistants and chatbots provide personalized assistance to users, answering questions, guiding navigation, and offering recommendations. These virtual agents enhance user engagement, streamline interactions, and provide round-the-clock support.
6. **Preservation and curation:** AI technologies contribute to the preservation and curation of digital library collections by automating tasks such as quality assessment, digitization, metadata validation, and content migration. Machine learning algorithms can detect and mitigate risks to digital preservation, ensuring the long-term accessibility of digital resources.

Benefits of AI in Libraries

Artificial Intelligence (AI) offers numerous benefits to libraries, revolutionizing traditional library operations and enhancing user experiences. Some of the key benefits include:

1. Improved Efficiency: Repetitive jobs like cataloging, categorization, and information retrieval are automated by AI, freeing up library employees' time for more intricate and valuable work. Faster service delivery and higher production are the results of this.
2. Enhanced User Experience: Recommendation engines driven by AI assist users in finding pertinent content based on their search history, preferences, and usage patterns. User engagement and satisfaction with library collections are enhanced by personalized recommendations.
3. Accessibility: AI technologies enable libraries to provide accessible services to diverse user groups, including those with disabilities. For example, AI-driven text-to-speech and speech recognition systems assist visually impaired users in accessing digital resources.
4. Resource Optimization: AI algorithms analyze usage patterns and demand trends to optimize collection development and management. Libraries can allocate resources more efficiently by identifying popular materials, weeding outdated items, and predicting future needs.
5. Decision Support: AI technologies enable library administrators to make data-driven decisions by producing insightful information from massive amounts of data. Predictive models and analytics dashboards make it easier to spot new trends, evaluate the value of services, and manage resource allocation.
6. Content Curation: AI-powered content curation platforms sift through vast amounts of digital content to identify high-quality resources relevant to the library's collection. This streamlines the acquisition process and ensures that the library offers up-to-date and authoritative materials to users.
7. Preservation and Digitization: AI-driven technologies facilitate the preservation and digitization of fragile or deteriorating materials, such as historical documents and rare manuscripts. Automated scanning and image enhancement tools ensure the long-term accessibility and integrity of cultural heritage collections.
8. Innovative Services: AI opens up possibilities for introducing innovative library services, such as virtual assistants, chatbots, and interactive kiosks. These services provide users with instant support, guidance, and information retrieval, enhancing overall user satisfaction.
9. Cost Savings: AI lowers operating costs and improves resource allocation for libraries by automating repetitive processes and optimizing procedures. Long-term cost reductions can result from the use of AI technologies by boosting productivity and efficiency.

Challenges and Limitations of AI in Libraries

Although artificial intelligence (AI) has many benefits for libraries, there are a number of issues and restrictions that must be resolved. These include:

1. Technical Constraints: Robust technical infrastructure, comprising high-performance computing resources, storage capacity, and network connectivity, is necessary for the implementation of AI systems. The acquisition and upkeep of the required IT know-how, software, and hardware may provide difficulties for libraries.
2. Data Quality and Availability: Large amounts of high-quality data are necessary for AI systems to produce precise forecasts and suggestions. The effectiveness and dependability of AI models, however, may be impacted by inadequate, inconsistent, or out-of-date data that libraries come upon.
3. Ethical Considerations: AI technology bring up moral questions about security, prejudice, privacy, and transparency of data. Libraries need to make sure AI systems abide by moral standards and legal requirements, safeguard user privacy, and lessen the possibility of algorithmic prejudice or discrimination.
4. Integration Complexity: It can be difficult and time-consuming to integrate AI technologies with current workflows and library systems. When deploying AI applications across many platforms and contexts, libraries may face obstacles related to compatibility, data silos, and interoperability.
5. Staff Training and Expertise: For the purpose of creating, implementing, and maintaining AI systems, library employees need certain training and knowledge. Personnel with the requisite expertise in data science, machine learning, and artificial intelligence technologies may be hard to find and keep in libraries.
6. Cost Considerations: Implementing AI solutions often involves significant upfront investment in technology infrastructure, software licenses, and staff training. Libraries with limited budgets may struggle to justify the cost of adopting AI or competing for funding with other priorities.
7. User Acceptance and Trust: Users may be apprehensive about AI technologies due to concerns about privacy, surveillance, and loss of human interaction. Libraries must communicate transparently about the purpose, capabilities, and limitations of AI systems to build user trust and acceptance.
8. Maintenance and Sustainability: AI systems require ongoing maintenance, updates, and fine-tuning to remain effective and relevant over time. Libraries must allocate resources for regular system monitoring, performance optimization, and adaptation to changing user needs and technological advancements.

Conclusion

In conclusion, Artificial Intelligence (AI) has the potential to completely transform library operations and services. Libraries can increase productivity, optimize resource allocation, and improve user experience by utilizing AI tools and technology. But there are drawbacks to implementing AI in libraries as well, such as issues

with user acceptability, ethical concerns, and technological limitations. Notwithstanding these difficulties, AI in libraries offers more advantages than disadvantages, opening the door for creative methods of user interaction, cataloging, reference services, and information retrieval. Libraries must adopt AI responsibly going ahead, addressing ethical issues, protecting user privacy, and fostering user trust. Libraries may continue to develop and prosper in the digital age by overcoming these obstacles and seizing the opportunities presented by AI, acting as essential information and knowledge centers for communities all over the world.

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Deepseek AI in Libraries

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Abstract

The integration of DeepSeek AI into libraries is revolutionizing how information is accessed, organized, and utilized, enhancing library services, operations, and user experiences. DeepSeek AI leverages advanced natural language processing (NLP) and machine learning algorithms to provide intelligent search capabilities, automate cataloging, and offer personalized recommendations, making information retrieval more efficient and accurate. AI-powered chatbots and virtual assistants assist users by answering queries, guiding them through resources, and enhancing user engagement. Additionally, DeepSeek AI utilizes predictive analytics to optimize resource management, anticipate demand, and improve inventory management. The AI's ability to detect plagiarism and support academic integrity makes it particularly valuable in educational and research-focused libraries. DeepSeek AI also supports multilingual capabilities, making libraries more inclusive and accessible to diverse user groups. Its use, however, begs questions about data privacy, algorithmic bias, employment displacement, and the necessity of responsibility and openness. Libraries must address these challenges through responsible AI deployment, ensuring compliance with privacy regulations, mitigating biases, and ensuring the continued role of human expertise. Despite these concerns, DeepSeek AI's transformative impact on libraries—enhancing accessibility, improving resource management, and fostering a more personalized and efficient user experience—position it as a key player in the future of library services. The AI's ability to bridge the gap between traditional knowledge management and modern digital needs will continue to shape libraries' evolution as dynamic hubs for information and learning.

Keywords: DeepSeek AI, Machine Learning, Automate Cataloging, Resources, Transparency, Job Displacement, and Accountability etc.

Introduction

The integration of Deepseek AI in libraries is transforming how information is accessed, organized, and utilized. Libraries, traditionally seen as repositories of physical and digital knowledge, are increasingly

adopting AI-driven solutions to enhance user experience, streamline operations, and improve research efficiency. Deepseek AI, an advanced artificial intelligence system, plays a pivotal role in this transformation by automating cataloging, enabling intelligent search capabilities, and offering personalized recommendations based on user preferences. Unlike traditional keyword-based searches, Deepseek AI employs natural language processing (NLP) and machine learning algorithms to understand context, making information retrieval more accurate and efficient. Additionally, AI-powered chatbots and virtual assistants integrated within library systems assist users in finding relevant resources, answering queries, and providing research guidance. The implementation of Deepseek AI also extends to predictive analytics, which helps libraries manage inventory, anticipate demand, and optimize resource allocation. Furthermore, AI-driven plagiarism detection and automated content summarization enhance academic integrity and facilitate knowledge dissemination. Despite these benefits, the adoption of AI in libraries raises concerns regarding data privacy, algorithmic bias, and the need for digital literacy among users and librarians. Addressing these challenges requires ethical AI deployment, continuous monitoring, and training programs to ensure that AI tools complement human expertise rather than replace it. As libraries evolve into dynamic learning hubs, Deepseek AI's role in enhancing accessibility, efficiency, and engagement becomes increasingly crucial. By harnessing AI's potential, libraries can bridge the gap between traditional knowledge management and the digital age, ultimately fostering a more inclusive and knowledge-driven society. The future of libraries with AI integration promises greater innovation, ensuring that they remain indispensable in the rapidly advancing information landscape.

Research Objectives

- To explore the impact of DeepSeek AI on improving search efficiency and accuracy in library systems.
- To analyze the effectiveness of DeepSeek AI in automating cataloging and resource management in libraries.
- To evaluate the ethical and privacy challenges associated with the implementation of DeepSeek AI in libraries.

DeepSeek: A Rising Force in the AI Industry

DeepSeek (Chinese: 深度求索; pinyin: Shēndù Qiúsuǒ) is a Chinese artificial intelligence software company based in Hangzhou, Zhejiang, and owned by the hedge fund High-Flyer. Founded in 2023 by Liang Wenfeng, DeepSeek quickly emerged as a major AI player, launching its first open-source large language model (LLM) with capabilities comparable to OpenAI's GPT-4o and Meta's LLaMA 3.1 but at a fraction of the cost—reportedly $6 million compared to OpenAI's $100 million for GPT-4. DeepSeek traces its origins to High-Flyer, a hedge fund co-founded by Liang in 2016, which transitioned to AI-driven trading by 2021, leveraging Nvidia GPUs and its Fire-Flyer computing clusters. The company's

strategic stockpiling of Nvidia A100 GPUs before U.S. sanctions enabled continued AI development despite restrictions on advanced chip exports. DeepSeek's rapid rise has been marked by a series of model releases, including DeepSeek Coder (November 2023), DeepSeek-LLM, DeepSeek-MoE, DeepSeek-Math, and DeepSeek-V2 (May 2024), which ignited a price war among Chinese AI firms, earning it the nickname "Pinduoduo of AI." Further advancements led to DeepSeek-Coder V2 (June 2024), DeepSeek-V2.5 (September 2024), and DeepSeek-R1-Lite-Preview (November 2024), culminating in the DeepSeek-V3 series (December 2024) and the launch of its first free chatbot app in January 2025. Within a week, DeepSeek's chatbot surpassed ChatGPT as the most downloaded free app on the U.S. iOS App Store, contributing to an 18% drop in Nvidia's stock price. Despite its disruptive impact, DeepSeek has faced scrutiny over compliance with Chinese government censorship policies and data collection practices, leading to regulatory actions such as Australia's ban on its technology in government devices in February 2024. While remaining open-source, DeepSeek enforces content restrictions aligned with local regulations, limiting discussions on politically sensitive topics. The company continues to expand its AI capabilities by recruiting researchers from top Chinese universities and beyond, positioning itself as a formidable challenger to established AI giants while navigating geopolitical and economic constraints.

The DeepSeek login page shortly after a cyberattack that occurred following its January 20 launch

Applications of DeepSeek AI in Libraries

DeepSeek AI is revolutionizing libraries by integrating advanced artificial intelligence to enhance various aspects of library operations, services, and user experiences. Here are some key applications of DeepSeek AI in libraries:

1. **Intelligent Search and Discovery:** DeepSeek AI enhances the search process by going beyond traditional keyword matching. Its advanced natural language processing (NLP) capabilities enable the system to understand the context and intent behind search queries. This allows for more accurate and relevant search results, offering users personalized recommendations, related

resources, and multimedia content. Users can interact with the system more naturally, making the search process faster and more efficient.

2. **Personalized Recommendations:** DeepSeek AI uses machine learning algorithms to analyze users' search histories, reading patterns, and preferences to recommend books, articles, and other resources that align with their interests. This personalized approach helps users discover materials they might otherwise overlook, improving engagement and satisfaction with library resources.
3. **Automated Cataloging and Classification:** Traditional cataloging systems often rely on manual tagging and classification, which can be time-consuming and error-prone. DeepSeek AI automates this process by using machine learning to categorize new content based on its content, context, and metadata. This reduces the workload for library staff and ensures that materials are consistently organized, up-to-date, and easy to find.
4. **Chatbots and Virtual Assistants:** AI-powered chatbots and virtual assistants can interact with library users to answer questions, provide research assistance, and help with library navigation. These tools can handle simple queries about library hours or help locate specific materials, allowing library staff to focus on more complex tasks. They can also guide users through the process of finding and using resources, making libraries more user-friendly.
5. **Predictive Analytics for Resource Management:**DeepSeek AI can be used to predict the demand for certain materials and identify trends in library usage. By analyzing historical data and user behavior, it can help libraries optimize their collection management, ensuring that high-demand resources are readily available. Additionally, AI can assist in inventory management, anticipating when materials need to be reordered or replaced.
6. **Plagiarism Detection and Academic Integrity:** For academic libraries, DeepSeek AI can be utilized to detect plagiarism in student submissions and research papers. Its algorithms analyze documents for similarities with other works, helping to uphold academic integrity and ensure the quality of scholarly resources within the library.
7. **Language Translation and Multilingual Support:** DeepSeek AI's multilingual capabilities make libraries more inclusive by providing language translation for materials, making them accessible to a broader audience. This application is especially beneficial in multicultural environments, where library users speak different languages and require content in their preferred language.

Case Studies and Implementation Examples of DeepSeek AI in Libraries

Several libraries and institutions worldwide are already implementing DeepSeek AI to enhance their services, streamline operations, and improve user experiences. Here are some notable examples:

1. **Academic Libraries in China:** Several university libraries in China have adopted DeepSeek AI for improving research and cataloging. For instance, ***Zhejiang University Library*** integrated DeepSeek's intelligent search and recommendation systems to help students and faculty discover relevant academic resources more efficiently. By using DeepSeek's advanced natural language processing (NLP) capabilities, the library's digital catalog was transformed into a more interactive and user-friendly platform, allowing for context-aware searches and personalized reading suggestions based on individual academic profiles.
2. **Public Libraries in Urban Areas:** ***Shanghai Public Library*** integrated DeepSeek AI to offer real-time assistance throug h AI-powered chatbots. These chatbots help patrons with various services, from book availability inquiries to event notifications and resource recommendations. The system also uses AI to predict the demand for certain types of books and educational resources, allowing the library to optimize acquisitions and ensure popular materials are always in stock.
3. **National Libraries in Europe:** The ***National Library of France*** leveraged DeepSeek AI's automated cataloging system to manage their vast archives of historical documents. DeepSeek AI's ability to analyze metadata and categorize new materials significantly reduced the time required to digitize and index books and manuscripts. Additionally, DeepSeek's AI-powered content summarization tools enabled researchers to quickly access key information from historical texts, streamlining research processes and improving productivity.
4. **Corporate Libraries in Tech Firms:** A leading ***technology corporation's internal library*** utilized DeepSeek AI to improve resource management and facilitate knowledge sharing among employees. DeepSeek AI was integrated into the company's intranet, allowing employees to ask questions, access relevant technical papers, and receive AI-driven research suggestions, significantly enhancing internal knowledge discovery.

These examples illustrate how DeepSeek AI is enhancing library operations, driving digital transformation, and improving user experiences across various library settings, from academic institutions to public and corporate libraries.

Challenges and Ethical Considerations in Using DeepSeek AI in Libraries

While DeepSeek AI offers numerous benefits to libraries, its integration also raises several challenges and ethical concerns that need careful consideration.

1. **Data Privacy and Security:** Libraries deal with sensitive user data, such as personal information, borrowing histories, and search queries. The implementation of AI systems like DeepSeek questions the methods used in data collecting, storage, and protection. Data breaches or abuse run

the danger of violating people's rights. Libraries must ensure that DeepSeek AI complies with data protection regulations, such as GDPR, and implement strong security measures.

2. **Algorithmic Bias and Fairness:** DeepSeek AI, like any AI system, may inherit biases from its training data. These biases could influence search results, recommendations, or categorization, leading to unequal access to information. Libraries must ensure that the AI models are continually tested and refined to reduce bias, promoting fairness and equity in the services they provide.
3. **Impact on Employment:** The automation of cataloging, customer service, and other library functions raises concerns about the potential loss of jobs for library staff. While AI can enhance efficiency, libraries need to balance automation with the need for human expertise, ensuring that staff roles evolve rather than diminish.
4. **Transparency and Accountability:** DeepSeek AI's decision-making process must be transparent to ensure that users trust the system. Libraries must be accountable for the AI's actions, particularly in sensitive areas like content filtering and recommendation systems, where errors can have significant consequences.

Conclusion

In conclusion, DeepSeek AI integration in libraries brings a radical change in information management practices, accessed, and utilized. By leveraging advanced AI technologies, libraries can significantly enhance user experiences through intelligent search, personalized recommendations, automated cataloging, and efficient resource management. DeepSeek AI's capabilities also extend to maintaining academic integrity through plagiarism detection and providing multilingual support, making libraries more inclusive and accessible. However, the implementation of AI in libraries comes with challenges related to data privacy, algorithmic bias, employment impacts, and the need for transparency. To fully harness the potential of DeepSeek AI while mitigating these risks, libraries must ensure ethical deployment, ongoing monitoring, and continuous training for staff and users. With careful consideration and responsible management, DeepSeek AI has the potential to redefine the role of libraries in the digital age, making them more innovative, efficient, and responsive to the evolving needs of users. The future of libraries is undoubtedly intertwined with AI-driven advancements.

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EFFECTIVE STRATEGIES FOR MANAGING A MULTIGENERATIONAL WORKFORCE

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Abstract
In today's dynamic workplace, organizations must effectively manage a multigenerational workforce, which includes Baby Boomers, Generation X, Millennials, and Generation Z. Each generation brings unique values, work styles, and communication preferences that can impact team collaboration and productivity. This Research Paper explores key strategies for managing a diverse workforce, including fostering an inclusive culture, leveraging generational strengths, implementing flexible work policies, and enhancing communication. By understanding generational differences and promoting intergenerational collaboration, organizations can create a more cohesive and productive work environment. These strategies help maximize employee engagement, improve retention, and drive organizational success.

Keywords: Multigenerational Workforce, Baby Boomers, Generation X, Millennials, Generation Z, Generation Alpha, Workplace Diversity

1.0 Introduction

In today's globalized and fast-evolving workplace, organizations are increasingly facing the challenge of managing a multigenerational workforce. With employees from Baby Boomers to Generation Z—and the emerging Generation Alpha—organizations must adapt to varying work styles, communication preferences, and expectations to foster collaboration, engagement, and productivity. The convergence of these diverse age groups within a single workplace presents both opportunities for innovation and challenges in leadership, teamwork, and organizational policies.

A multigenerational workforce refers to the coexistence of multiple age groups within the workplace, each shaped by distinct historical, economic, and technological influences. **Baby Boomers (1946-1964)**, for instance, value job security, hierarchical leadership, and face-to-face communication. **Generation X (1965-1980)** prefers autonomy, work-life balance, and efficiency-driven leadership. **Millennials (1981-1996)** are digital natives who thrive in collaborative, purpose-driven environments, while **Generation Z (1997-2012)** seeks flexibility, technological integration, and an inclusive work culture. Additionally, **Generation Alpha (born after 2013)** is expected to bring an entirely new level of digital fluency and AI-driven workplace dynamics when they enter the job market in the coming years.

1.1 The Changing Workplace Landscape

Workplace trends have significantly shifted due to rapid technological advancements, globalization, and unforeseen global events, such as the COVID-19 pandemic. These changes have accelerated the adoption of hybrid work models, increased reliance on artificial intelligence (AI), and heightened awareness of mental health and work-life integration. As a result, organizations must rethink traditional workplace structures and create adaptable, inclusive, and technology-driven strategies to meet the diverse needs of a multigenerational workforce.

Technological transformation has also redefined how employees interact, collaborate, and perform tasks. Older generations, who initially relied on in-person meetings and paper-based documentation, have had to adapt to video conferencing, cloud-based collaboration tools, and real-time project management systems. Meanwhile, younger employees who grew up with social media and instant messaging expect seamless digital communication, flexible work arrangements, and data-driven decision-making.

2.0 Literature Review

The study of multigenerational workforce management has gained prominence in recent years, with scholars and business leaders exploring the impact of generational diversity on organizational effectiveness, communication, and leadership. Several researchers have proposed theories to explain generational differences and their impact on workplace dynamics. Lancaster and Stillman (2002) introduced the concept of generational personalities, arguing that societal and technological changes shape each generation's expectations and behaviors. Zemke, Raines, and Filipczak (2000) emphasized the importance of adaptability in leadership, proposing that organizations must tailor management approaches to meet the needs of different generations.

Herzberg's Motivation-Hygiene Theory (1959) and Maslow's Hierarchy of Needs (1943) have also been applied to multigenerational workforce studies, with research suggesting that each generation places varying emphasis on job security, career progression, flexibility, and personal development. Baby Boomers, for instance, are driven by extrinsic rewards, while Millennials and Gen Z employees prioritize intrinsic motivators such as meaningful work and personal growth opportunitiesAccording to a study by Twenge et al. (2010), Millennials and Gen Z employees are more likely to value work-life balance and seek continuous feedback compared to older generations. Similarly, research by Costanza et al. (2012) found that generational differences in workplace values, while present, may be less pronounced than commonly assumed, with individual personality traits playing a more significant role in workplace behaviors.

A 2019 study by the Society for Human Resource Management (SHRM) highlighted the impact of digital transformation on workforce expectations. The study found that younger generations prefer remote and flexible work arrangements, whereas older generations value traditional office settings and in-person interactions.

2.3 Research Gap

Despite extensive research on multigenerational workforce management, several gaps remain. Existing studies have primarily focused on Baby Boomers, Gen X, Millennials, and Gen Z, with limited research on the anticipated impact of Generation Alpha. Future research should explore how AI, automation, and digital transformation will shape the work expectations of younger generations entering the workforce.

3.0 Objectives of the Study

The primary objective of this study is to explore effective strategies for managing a multigenerational workforce and to provide insights into fostering collaboration and engagement among different age groups in the workplace. The specific objectives of this study are:

- **To examine generational characteristics and workplace**
- **To analyze** challenges and opportunities that arise from the interaction of multiple generations in a professional setting.
- **To evaluate** strategies such as mentorship programs, flexible work arrangements, and tailored leadership approaches that foster an inclusive work environment.
- **To investigate the role of digital transformation in bridging generational gaps**

4.0 Significance of the Study

Managing a multigenerational workforce effectively is crucial for organizations aiming to achieve sustainable growth and innovation. The significance of this study lies in its ability to provide organizations, HR professionals, and business leaders with actionable insights and strategies to foster a cohesive and high-performing workforce. The study contributes to the existing body of knowledge in the following ways:

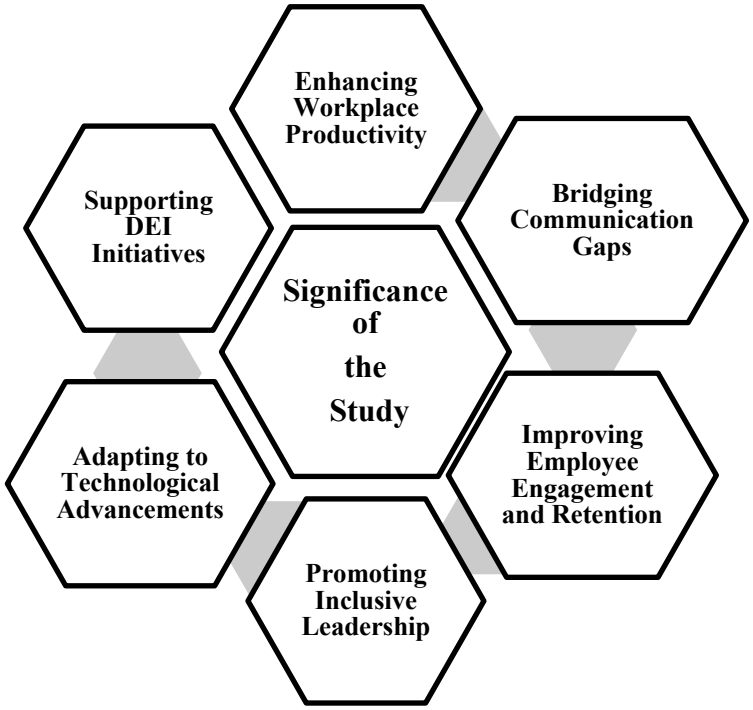


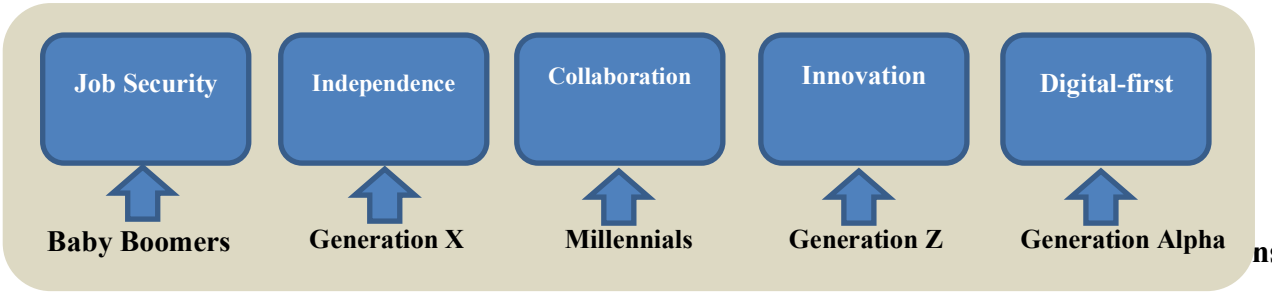
Diagram No. 4.0 Significance of the Study

5.0 Changing Generational Characteristics and Workplace Expectations

Over time, generational values have evolved due to significant economic, technological, and social changes. Each generation brings its own set of priorities and expectations to the workplace, shaping how organizations develop policies and manage employees. The following table and diagram illustrate the shifts in generational values:

Generation	Core Work Values	Preferred Communication	Career Expectations	Work-Life Balance Perspective
Baby Boomers (1946-1964)	Job security, loyalty, hierarchy	Face-to-face, formal emails	Long-term commitment, structured career progression	Sacrifices for career success

Generation X (1965-1980)	Independence, pragmatism, efficiency	Direct emails, phone calls	Self-directed career growth, work flexibility	Strives for balance but values career growth
Millennials (1981-1996)	Purpose-driven work, collaboration	Instant messaging, video calls	Fast career progression, continuous learning	High priority on work-life integration
Generation Z (1997-2012)	Innovation, diversity, inclusivity	Social media, short-form communication	Entrepreneurial mindset, adaptability	Non-negotiable work-life harmony
Generation Alpha (2013+)	Digital-first, sustainability, automation	AI-driven communication, virtual reality	AI-powered career opportunities	Seamless integration of work and personal life



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6.0 Challenges in Managing a Multigenerational Workforce

While generational diversity can be a strength, it also presents unique challenges in leadership, communication, and workplace policies. Some of the common difficulties organizations face include:

1. **Communication Gaps** – Each generation has distinct preferences for communication. While Baby Boomers may prefer phone calls and formal emails, Millennials and Gen Z favor instant messaging and collaborative platforms. This difference can lead to misunderstandings and inefficiencies if not managed effectively.
2. **Workplace Expectations and Job Loyalty** – Baby Boomers often equate professional success with long-term commitment and hierarchical advancement, while younger generations prioritize career mobility, flexibility, and personal development opportunities. This divergence can cause friction between different groups and requires organizations to create policies that balance stability with innovation.
3. **Adapting to Hybrid and Remote Work Models** – The shift towards remote and hybrid work has further highlighted generational disparities. While Gen X and Millennials may embrace remote work for its flexibility, older employees may struggle with digital adaptation and prefer traditional office environments. Bridging this gap requires organizations to invest in digital training programs and inclusive remote work policies.
4. **Leadership and Management Styles** – Traditional leadership structures emphasize authority and experience, often aligning with Baby Boomer expectations. However, Millennials and Gen Z favor participative and collaborative leadership, where mentorship, feedback, and inclusivity are prioritized. Leaders must develop adaptive strategies that cater to both traditional and contemporary management styles.

5. **Diversity, Equity, and Inclusion (DEI)** – The modern workforce demands more than just generational inclusivity—it requires organizations to address broader issues of diversity, equity, and inclusion. Different generations have varying perspectives on social responsibility, gender equality, and corporate ethics. Companies must implement DEI initiatives that align with evolving societal values while maintaining intergenerational cohesion.

7.0 Key Strategies for Managing a Multigenerational Workforce

1. **Fostering an Inclusive and Collaborative Culture**
   - Promote mentorship and reverse mentoring programs to encourage knowledge sharing across generations.
   - Encourage intergenerational team projects to leverage diverse perspectives and skills.
   - Recognize and accommodate different communication preferences, from face-to-face meetings to instant messaging and video calls.
2. **Adapting to Remote and Hybrid Work Models**
   - Provide technology training for older generations while embracing digital fluency among younger employees.
   - Ensure hybrid work policies cater to different needs, such as work-life balance for Gen X and flexibility for Millennials and Gen Z.
   - Establish clear communication norms to bridge the gap between in-office and remote employees.
3. **Integrating AI and Digital Transformation**
   - Upskill employees across all generations to use AI-driven tools and automation effectively.
   - Implement digital literacy programs to help bridge the technology gap for less tech-savvy employees.
   - Encourage a culture of continuous learning to help all generations adapt to workplace advancements.
4. **Prioritizing Diversity, Equity, and Inclusion (DEI)**
   - Develop unbiased recruitment strategies that attract diverse talent across all age groups.
   - Implement policies that support inclusivity, such as diverse leadership and equal growth opportunities.
   - Promote mental health and well-being programs that cater to varying generational stressors and expectations.
5. **Sustainability and Corporate Social Responsibility (CSR)**
   - Align company values with environmental and social initiatives to engage younger generations.
   - Encourage employee involvement in sustainability efforts, fostering a shared sense of purpose.
   - Highlight ethical business practices and social impact to appeal to Millennials and Gen Z.

8.0 Role of Digital Transformation in Bridging Generational Gaps

Digital transformation plays a pivotal role in fostering collaboration and inclusivity among different generations in the workplace. With rapid advancements in technology, organizations are leveraging digital tools to create a seamless, adaptive, and efficient work environment that caters to the diverse needs of a multigenerational workforce. Below are key ways in which digital transformation helps bridge generational gaps:

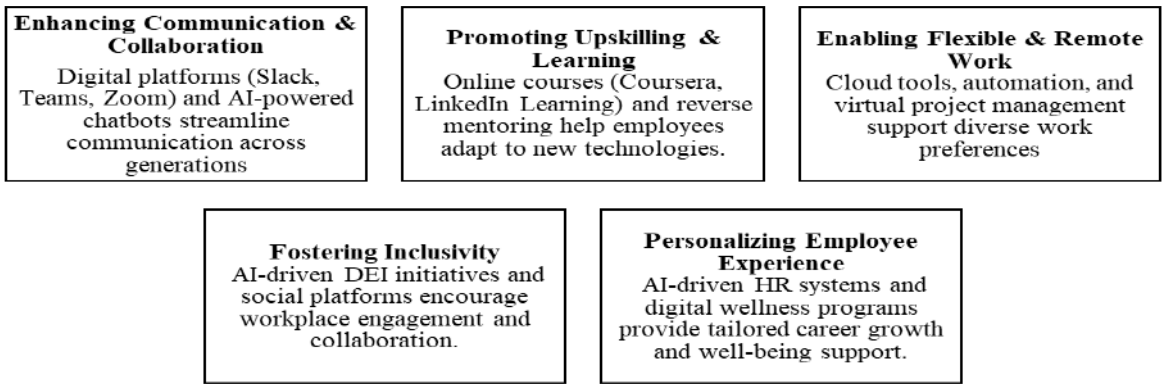

Diagram No. 8.0 Role of Digital Transformation in Bridging Generational Gaps

By integrating digital tools, organizations create a seamless and adaptive work environment for all generations.

9.0 Conclusion

As workplaces continue to evolve, successful organizations will be those that understand and embrace the strengths of a multigenerational workforce. By leveraging technology, fostering inclusivity, prioritizing work-life balance, and adapting to emerging workplace trends, companies can create a thriving, collaborative, and future-ready workforce. The key to success lies in recognizing generational differences while uniting employees through shared goals and a culture of mutual respect and adaptability.

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THE POWER OF VISUAL STORYTELLING: EXPLORING VIDEO MARKETING STRATEGIES, CHALLENGES, AND OPPORTUNITIES IN THE TOURISM INDUSTRY

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ABSTRACT
Storytelling is one of the most popular method to influence the customers. This study explores the complex world of tourism video marketing in Maharashtra, India, focusing on trends, language, presentation style, content analysis, and view time of Maharashtra-specific travel videos. The research aims to understand the main obstacles and opportunities related to video marketing in the travel and tourist industry, as well as the opinions of marketing experts. A mixed-method research strategy was used to investigate a broad sample population of 180 Maharashtra residents involved in video marketing related to tourism. The results provide background information on respondents' professional and demographic traits and highlight the relevance of digital channels in tourism promotion. Regression analysis reveals the strong influence of platforms like YouTube and Instagram on the outcome variable. However, further investigation into predictor contributions and other elements is necessary to better understand the dynamics of video marketing. This study contributes valuable perspectives on efficient promotional tactics and opportunities to improve tourism promotion in Maharashtra and India.

Keywords: *Travel, video marketing, trends, language, style of presentation, content analysis, viewing duration, marketing experts, and mixed-methods research*

1. INTRODUCTION
India is the land of opportunity. It is the country with unity in diversity. The tourism industry is a significant contributor to the growth of the Indian economy, ranking 44th in the World Economic Forum's travel and tourism Competitive Index (TTCI) in 2019 (Happ, 2018). It offers numerous opportunities for hotels, transport infrastructure, and employment (Rainoldi, 2018). The government provides free loans to MSME's, including the tourism sector, to help them cope with the Covid-19 crisis. Air Bubble Agreements are made with 27 countries, including Sri Lanka and Thailand (Chamboko-Mpotaringa, 2021). Government campaigns, such as "Swadesh Darshan," aim to boost the tourism industry's potential. India's cultural richness and diverse culture attract tourists. Digital tools are being used to analyze budgets, explore places, and book accommodations, boosting the industry's growth (Amin, 2019). Travel agencies and international hotel chains are emerging, offering staycations to alleviate stress.

The transition from traditional to modern marketing has led to the use of electronic media, such as web, email, and wireless media, along with digital data, including customer behavior, to manage and execute marketing activities (Hausmann, 2018). Advanced electronic devices and platforms have enabled the targeting of potential customers with pre-designed messages that cater to their needs and problems (Jaas, 2022). Digital marketing integrates communication, data, and messaging on multiple platforms, making it the best form of integrated marketing (Akdu, 2020).

1.1.OPPORTUNITIES
Traveling is something that most people are naturally inclined to do, whether it's for work, a new opportunity, or just for fun. In today's tech-savvy world, arranging a trip is a breeze, thanks to all the

convenient online resources. To increase the number of travellers using their platforms, online travel businesses use technology to simplify the process of booking a trip. Governments often launch programs to encourage online tourism because of the substantial contribution the sector makes to a country's gross domestic product (GDP). A wide range of services, including domestic and international travel plans, are offered by online travel firms. Online travel agents attract customers with their diverse selection of services, making them the go-to platforms for all their travel needs. Technological developments that make travel easier and more accessible are a major factor in the tourism industry's meteoric rise.

1.2. CHALLENGES

Travel and tourism industry has been facing a series of challenges in a new context. Foreign visitors to India are hurt by the country's subpar infrastructure. Funding and Technology: Despite having new ideas, many small travel companies have challenges when it comes to funding and technology resources, which might hamper their recognition and growth. The necessity to improve the public's view of India as a tourist destination by strategic advertising is a big obstacle for the country's tourism industry. India's tourist business isn't as competitive as it could be because of the country's hefty taxes, which make luxury travel pricey. The ever-increasing level of competition is a major obstacle for tourism-related businesses, who must come up with creative solutions to stay ahead of the curve. It's hard to keep service standards consistent when you offer so many different kinds of services; any dip in quality reflects poorly on your brand. It is tough to collect and manage data from many platforms, necessitating the installation of advanced systems for optimum utilization. Customers Value Deals More Than Brand Loyalty, Making It Difficult to Establish Loyal Customers Due to Rising Levels of Competition and Similar Products.

1.3.STATEMENT OF THE PROBLEM

One of the most important strategic tools for promoting tourist destinations around the world, including Maharashtra, India, is video marketing (Chen, 2023). Even if video marketing is becoming more important in the tourism business, there are still many aspects that need to be understood and addressed (Labanauskaitė, 2020). So, the purpose of this research is to look into the patterns, topics, languages, presenting styles, and duration of Maharashtra-related tourist films (Beck, 2018). Furthermore, it aspires to investigate how marketing experts view video marketing within this framework. In addition, the study is focused on determining the main obstacles and potential benefits linked to video marketing in the tourism industry (Steinhoff, 2021). The goal is to help improve video marketing tactics for promoting tourism in Maharashtra and India as a whole by offering thoughts and suggestions in this regard.

1.4. OBJECTIVES OF THE STUDY

- To examine the various trends of video marketing of tourism in Maharashtra
- To analyze the content, language, presentation style, watch time of videos for tourism in Maharashtra
- To understand the perceptions of marketing professionals towards video marketing of tourism in Maharashtra
- To identify the major challenges and prospects of video marketing
- To suggest the better ways of video marketing for tourism in India

1.5.HYPOTHESIS OF THE STUDY

H1: Promotional content for Maharashtra's tourist attractions is more likely to be successful when shared on social media sites like YouTube and Instagram.

H2: Marketing videos for Maharashtra's tourist attractions can reach more people if they use cutting-edge software.

2. LITERATURE REVIEW

Kumar (2023) studied the utilization of advanced showcasing apparatuses in the travel industry, zeroing

in on their viability and suggestions for business development. It features the job of online entertainment showcasing, Website optimization, content advertising, and powerhouse organizations in upgrading brand perceivability, client commitment, and driving traveler traffic. The survey likewise talks about arising patterns in the travel industry computerized showcasing, like computer generated experience, expanded reality, and man-made reasoning, and their expected effect on future advertising techniques. The survey fills in as an important asset for scholastics, specialists, and policymakers trying to remain refreshed on the most recent improvements in the travel industry computerized showcasing.

Tiago (2019) conducted content analysis of YouTube recordings in objective promoting, featuring their visual allure, narrating abilities, and wide-contacting crowd. It examines methodologies utilized by advertisers to use YouTube successfully, for example, making drawing in satisfied, teaming up with powerhouses, and advancing procedures for perceivability and commitment. The survey additionally features the developing scene of objective advertising in the computerized age, accentuating the requirement for advertisers to adjust to changing purchaser ways of behaving and mechanical headways. By blending bits of knowledge from insightful writing and industry rehearses, the survey adds to a more profound comprehension of YouTube recordings' true capacity as an important device for objective promoting and offers direction for experts and scientists in the field.

Ardito (2019) reviewed the role of big data in smart tourism, highlighting its potential to revolutionize destination management, marketing, and customer experience. It addresses challenges such as data privacy concerns, integration issues, and the need for advanced analytics tools. The review also addresses issues related to data quality, accuracy, relevance, and ethical implications of data-driven decision-making. Despite these challenges, the review identifies numerous opportunities for the tourism industry, such as personalized marketing strategies, real-time insights into traveler behavior, and enhanced destination planning. By synthesizing existing literature and industry practices, the review contributes to a deeper understanding of the future of smart tourism and offers valuable guidance for researchers, practitioners, and policymakers in effectively leveraging big data in the tourism sector.

According to **Ketter (2021),** COVID-19 pandemic has led to a shift in digital marketing strategies for tourism destinations. These destinations have used social media, websites, and other digital channels to convey messages of solidarity, safety, and resilience. They emphasize the importance of staying home in the short term to enable future travel opportunities. The authors analyze case studies and empirical evidence to explore the effectiveness of digital marketing campaigns, highlighting the role of storytelling, virtual experiences, and user-generated content in keeping travelers inspired and connected. They also address the challenges and limitations faced by destinations in executing digital marketing strategies amidst uncertain circumstances. The authors provide valuable insights into the evolving landscape of destination marketing during crisis, offering practical implications for tourism practitioners and policymakers.

3. RESEARCH METHODOLOGY

3.1.RESEARCH DESIGN

The researchers have opted for the hybrid method (qualitative and quantitative both). The social media platforms such as YouTube and Instagram were considered for Video Content of Tourism domain.

3.2.SAMPLE POPULATION

Maharashtra residents make up the study's sample population. Members of this group include those who work in marketing for travel and tourism via video, such as executives, managers, content developers, digital marketers, and marketers.

3.3.SAMPLE OF THE STUDY

A total of 180 respondents residing in Maharashtra were included in the study's sample. A variety of

positions and levels of expertise in tourism-related video marketing were considered while selecting the sample using a purposive sampling technique:

3.4.SAMPLING TECHNIQUE

This study employed purposive sampling. Judgmental or selective sampling, also known as purposeful sampling, includes picking individuals or groups with relevant qualities for our investigation. We specifically chose video marketing experts from Maharashtra tourist organizations Agora Voyages, Yolo India Tours, and K K Holidays N Vacations. The purpose was to identify marketing experts and employees involved in video marketing activities or who may shed light on e-commerce video marketing trends, attitudes, obstacles, and potential.

3.5.VARIABLE

3.5.1. Independent Variable

- YouTube, Instagram

3.5.2. Dependent Variable

- Content Creation
- Software
- Maximum Reach
- Multiple Platforms
- Reports Generation
- Customization
- Affordable

3.6.DATA COLLECTION

In my descriptive research, I relied on self-structured questionnaires to assemble my data. An extensive literature review on CPD was undertaken by the researchers prior to the construction of the study tool. Total 180 respondents could participated in the survey.

3.6.1. Primary study

Staff members gathered primary data, which was the sole source used in the study. Survey: Marketers at the Maharashtra-based tourist business were the subjects of a standardized questionnaire. The poll aimed to gather information about how people feel about video marketing and the difficulties that come with using it. Findings: In order to gain a better understanding of the trends and patterns, we watched and assessed tourist marketing videos for language, substance, presentation style, and total viewing duration.

3.6.2. Secondary data

It is critical to have access to secondary data. It is based on a variety of sources, including academic journals, workshops, conferences, case studies, reference books, periodicals, and annual reports of clothing organizations.

3.7.TECHNIQUES USED FOR DATA ANALYSIS

With the use of tools, we may conduct a wide range of statistical studies, such as correlation, hypothesis testing, descriptive statistics, and regression analysis.

4. DATA ANALYSIS

The data reveals the study participants' demographic and professional traits. Men made up 55% of the sample, while women made up 45%. The 30-35 age group had the biggest percentage of respondents (57.7%), followed by 20-25 (30.5%) and 25-30 (11.6%). More than half of respondents (52.7%), followed by post-graduates (25.5%) and graduates (21.6%) had non-graduate degrees.

Table 1: Demographic Respondent

	Sub groups	Frequency	Percentage
Gender	Male	99	55
	Female	81	45
Age	20-25	55	30.5
	25-30	21	11.6
	30-35	104	57.7
Education	Graduate	39	21.6
	Post Graduate	46	25.5
	Other	95	52.7
Experience	Less than 1 year	60	33.3
	1 year - 2 year	41	22.7
	More than 2 years	79	43.8

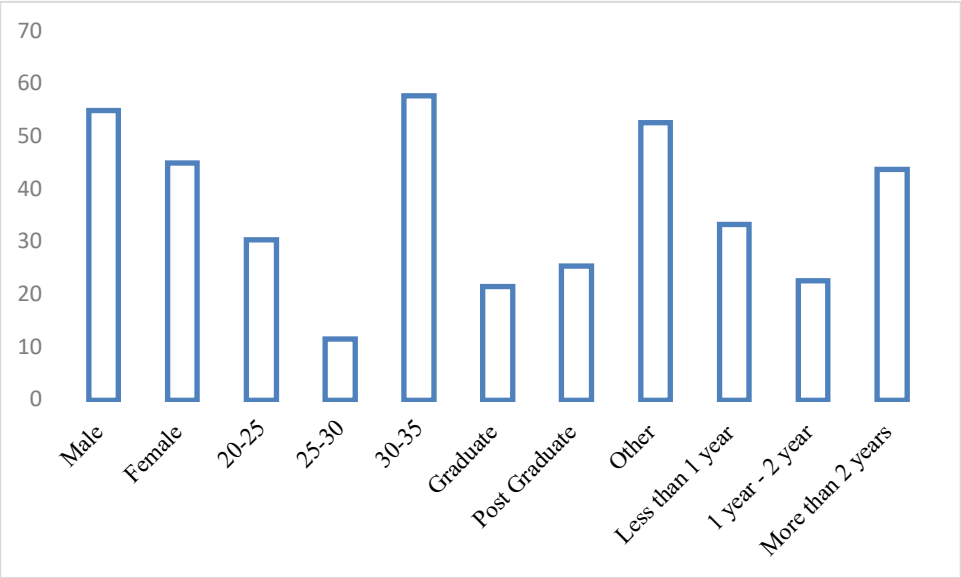

Figure 1: Graphical Representation on the percentage of Demographic Respondent

Professional experience data shows a balanced distribution across three categories. About 43.8% of respondents had more than 2 years of experience, 33.3% had less than 1 year, and 22.7% had 1 to 2 years. These data reveal the respondent pool's demographic and professional variety, which can inform the study's analysis and interpretation.

Table 2: Model outline of factor

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.750[a]	.585	.560	.88080
a. Predictors: (Constant) YouTube, Instagram				

The relapse examination uncovers that YouTube and Instagram have a moderate degree of prescient exactness, making sense of roughly 58.5% of the fluctuation in the result variable. In the wake of adapting to the quantity of indicators, the model actually makes sense of around 56% of the changeability. The standard mistake of the gauge is.88080, addressing the typical distinction among noticed and anticipated values. The model shows a solid match, proposing that YouTube and Instagram might impact the result variable. In any case, further examination and thought of different variables might be important to comprehend and decipher these discoveries completely.

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	230.045	1	57.420	69.143	.001[b]
	Residual	147.215	178	.800		
	Total	379.130	179			
a. Dependent Variable: Content Creation, Software; Maximum Reach, Multiple Platforms, Reports Generation, Customization, Affordable						
b. Predictors: (Constant) YouTube, Instagram						

The ANOVA table shows a measurably critical relapse investigation on the connection among YouTube and Instagram and the reliant variable, Content Creation, Programming; Most extreme Come to, Various Stages, Reports Age, Customization, Reasonable. The model is genuinely huge, with a F-measurement of 69.143 and a p-esteem of.001, demonstrating that something like one of the indicators (YouTube or Instagram) essentially affects the result variable. The Relapse Amount of Squares (230.045) and Remaining Amount of Squares (147.215) address the fluctuation made sense of by the indicators, while the Complete Amount of Squares (379.130) addresses the all out changeability in the reliant variable. These outcomes build up the previous discoveries that YouTube and Instagram on the whole fundamentally affect the reliant variable.

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	-.714	.309	-.630	-6.501	.094
	Accessibility	-.059	.09	-.055	-2.776	.304
	Cost-Effectiveness	.361	.151	.271	5.449	.071
	User Interface	.145	.003	.112	3.520	.170
	Data Retrieval	.0.249	0.149	0.230	0.221	0.309
	Integration with other platforms	0.301	0.012	0.209	.240	0.165
	User friendliness	0.200	0.30	0.	0.280	0.108
a. Dependent Variable: Content Creation, Software; Maximum Reach, Multiple Platforms, Reports Generation, Customization, Affordable						

The coefficients table presents the assessed relapse coefficients for every indicator in the model, alongside their standard blunders, normalized coefficients (Beta), t-esteems, and comparing p-values. These coefficients assist with grasping the strength and bearing of the connection between every indicator and the reliant variable (Content Creation, Programming; Greatest Come to, Numerous Stages, Reports Age, Customization, Reasonable). The steady term addresses the normal worth of the reliant variable

when all indicators are zero, with a massive distinction from zero at the 0.05 level. The singular indicators 'Openness' and 'Cost-Adequacy's show fluctuating levels of relationship with the reliant variable, yet none give off an impression of being genuinely critical at the traditional 0.05 level. Further examination and bigger example sizes might be important to affirm the importance and viable pertinence of these discoveries with regards to the reliant variable.

Table 5: A Correlation Matrix between dependent variables

Correlation								
		Content Creation	**Software**	**Maximum Reach**	**Multiple Platforms**	**Reports Generation**	**Customization**	**Affordable**
Content Creation	Pearson Correlation	1	.781**	.753**	789**	750**	751**	755**
	Sig. (2-tailed)		0.02	0				
	N	180	180	180	180	180	180	180
Software	Pearson Correlation	.781**	1	.799**	789**	715**	782**	750**
	Sig. (2-tailed)	0	0	0	0	0	0	0
	N	180	180	180	180	180	180	180
Maximum Reach	Pearson Correlation	.753**	.800**	1	745**	710**	755**	700**
	Sig. (2-tailed)	0.01	0	0	0	0	0	0
	N	180	180	180	180	180	180	180
Multiple Platforms	Pearson Correlation	789**	789**	745**	1	743**	748**	720**
	Sig. (2-tailed)	0	0	0	0	0	0	0
	N	180	180	180	180	180	180	180
Reports Generation	Pearson Correlation	750**	715**	710**	743**	1	750**	725**
	Sig. (2-tailed)	0	0	0	0	0	0	0
	N	180	180	180	180	180	180	180
Customization	Pearson Correlation	751**	782**	755**	748**	750**	1	720**

	Sig. (2-tailed)							
	N	180	180	180	180	180	180	180
Affordable	Pearson Correlation	755**	750**	700**	720**	725**	720**	1
	Sig. (2-tailed)	0	0	0	0	0	0	0
	N	180	180	180	180	180	180	180

A number of features of tourist video marketing show robust positive correlations in the correlation matrix, suggesting the existence of substantial links between the various variables. At the $p < 0.05$ level, there are statistically significant correlations between 'Content Creation' and 'Software' (r =.781), 'Maximum Reach' (r =.753), 'Multiple Platforms' (r =.789), 'Reports Generation' (r =.750), 'Customization' (r =.751), and 'Affordable' (r =.755). Also, 'Software' is positively correlated with 'Maximum Reach' (r =.799), 'Multiple Platforms' (r =.789), 'Reports Generation' (r =.715), 'Customization' (r =.782), and 'Affordable' (r =.750), suggesting that these factors are interdependent in shaping the results of tourism video marketing. Also, the interconnected nature of these variables in determining the effectiveness of marketing strategies is suggested by the strong positive correlations that 'Maximum Reach' has with 'Multiple Platforms' (r =.745), 'Reports Generation' (r =.710), 'Customization' (r =.755), and 'Affordable' (r =.700). The significance of taking into account various aspects at once in creating effective tourism video marketing campaigns is underscored by these findings. To maximize the impact and success of tourist advertising, it is necessary to optimize numerous components, such as content generation and pricing, and the constantly high correlation coefficients across many dimensions highlight this necessity for a holistic strategy.

5. RESULTS

The study's data analysis reveals a gender distribution with a slight predominance of men (55%), followed by women (45%). The majority of respondents are aged 30-35, with 57.7% being in this age group. This suggests that individuals in this age range are more likely to be engaged in tourism video marketing activities. The majority of respondents have non-graduate degrees, indicating a diverse educational background. Professional experience is balanced across different categories, with 43.8% having more than 2 years of experience, indicating a substantial level of expertise in the field. However, 33.3% have less than 1 year of experience, suggesting a relatively new industry. This comprehensive overview of demographic and professional characteristics provides valuable context for understanding the perspectives and insights shared by respondents in relation to tourism video marketing in Maharashtra, India. These insights can inform the subsequent analysis and interpretation of the research findings, enriching the overall understanding of the dynamics and trends within the tourism industry in the region.

6. CONCLUSIONS

The study reveals a diverse demographic and professional profile among participants in Maharashtra's tourism industry. The majority of respondents are male, with 55% being male and 45% female. The majority are in their prime working years in tourism video marketing activities. Over half hold non-graduate degrees. Professional experience is balanced across different categories, with a substantial proportion having more than 2 years of experience. However, a notable percentage also have less than 1 year of experience. These findings emphasize the importance of considering the diverse perspectives and insights of individuals involved in tourism video marketing in Maharashtra. The diversity in

demographics and professional backgrounds can inform strategic decision-making and enhance the effectiveness of video marketing initiatives promoting tourism in Maharashtra and India. Addressing challenges and capitalizing on opportunities can help stakeholders improve marketing tactics and foster sustainable growth in the tourism sector.

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PILGRIMAGE AND PROGRESS: EXPLORING THE ROLE OF RELIGIOUS TOURISM IN THE SOCIO-ECONOMIC DEVELOPMENT OF WESTERN MAHARASHTRA

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Abstract:
Religious tourism as a form of cultural tourism is becoming an increasingly powerful driver for socio-economic progress, particularly in culturally diverse states like Western Maharashtra. This work attempts to capture the complex linkage between pilgrimage-oriented tourism and local area development by investigating the nature and extent of influence of religious tourism on regional economies, societal hierarchies, and the built environment at well-known centres of pilgrimage such as Shirdi, Pandharpur, Jejuri, and Kolhapur. Through a flux of local and foreign pilgrims, these locations have witnessed a wave of economic activity, such as hospitality services, transportation, handicrafts, and local enterprise, resulting in more jobs and income generation. This study assesses the role of religious tourism in poverty reduction, infrastructure development, and maintenance of cultural heritage, as well as the challenges like environmental degradation, congestion, and commodification of holy sites. The research methodology employed in the study is a mixed-methods approach that involves qualitative data collection through interviews, focus group discussions, field observations, as well as quantitative data collection using surveys and economic indicators. The study critically analyzes the roles of local governance, government policies, and community participation towards enabling sustainable tourism practices. It also explores the interaction between economic and religious motives, unearthing the extent to which religious feelings are interwoven with developmental aspirations across the region.

The research provides evidence that religious tourism in Western Maharashtra has made substantial contributions towards regional development by enhancing infrastructure, creating employment opportunities, and fostering social integration. The gains are, however, unevenly shared and usually with accompanying socio-cultural tensions and environmental degradation. The research concludes on the basis of recommendations for an inclusive, sustainable, and people-centered model of tourism that honors the sanctity of pilgrimage centers while optimizing developmental impacts. These findings seek to guide policymakers, tourism planners, and local stakeholders on the strategic utilization of religious tourism for sustainable regional development.

Keywords: *Religious Tourism, Socio-Economic Development, Pilgrimage Sites, Western Maharashtra, Sustainable Tourism, Community Participation, Cultural Heritage*

1. Introduction:

Religious tourism, or pilgrimage tourism as it is also known, is one of the earliest types of travel that humans have ever known. It involves travel that is done for religious obligations, devotion, and spiritual fulfillment. In India, where religion and culture are so integral to daily life, pilgrimage is a critical influence on travel patterns and local economies. Western Maharashtra, where sacred places such as Shirdi (hallowed by Sai Baba), Pandharpur (a great Vaishnavite center), Jejuri (dedicated to Lord Khandoba), and Kolhapur (renowned for the Mahalakshmi temple) are located, welcome crores of pilgrims every year. These holy centers are not just spiritual centers but also thriving economic centers

that develop employment opportunities, commerce, and infrastructural facilities. The interaction between religious travel and socio-economic development within the region requires serious scholarly inquiry. While pilgrims remain driven by religious imperative, spillover benefits from such mobility mean jobs in hospitality, transport, retail, and service sectors. The resulting improved rural livelihoods and urban infrastructure have become noticeable. The interlinkages between religion, economy, and governance in managing pilgrim flows have opportunities and challenges as well. Problems such as environmental deterioration, pressure on public facilities, holiday season overcrowding, and cultural commercialization arise in addition to the possibility of inclusive development and culture preservation. Thus, comprehending the complex effect of religious tourism is essential for regional planning for sustainable development.

This research aims to investigate how much religious tourism contributes to Western Maharashtra's socio-economic development. It looks at the intervention of different stakeholders such as government institutions, local communities, and religious organizations in planning and managing tourism infrastructure. In addition, it discusses how tourism affects social cohesion, cultural identity, and economic resilience in the region. The research employs a multidisciplinary approach based on sociology, economics, religious studies, and development planning. In this manner, the study seeks to provide strategic perspectives to the planning and marketing of religious tourism as a means of holistic regional development with the sanctity and sustainability of these sacred terrains intact.

2. Background of Study:

Religious tourism has long been a mainstay in Indian society, fueled by centuries of spiritual heritage and sacred pilgrimages. Pilgrimage as a spiritual practice is deeply embedded within cultural practices and communal identity. Over the past few decades, this age-old mode of travel has evolved into a major driver of local development, especially in regions blessed with religious heritage. In India, cities such as Varanasi, Tirupati, and Amritsar have become excellent examples of how pilgrimage destinations can create jobs, stimulate local economies, and foster infrastructure growth. Likewise, in Western Maharashtra, spiritual places of pilgrimage receive millions of pilgrims every year, sending ripples on all socio-economic indicators. Western Maharashtra, including districts like Pune, Solapur, Ahmednagar, Satara, and Kolhapur, is studded with temples and religious sites of gigantic religious importance. Shirdi, Pandharpur, Jejuri, and Kolhapur are among the destinations that not only possess profound religious importance for millions but also form important nodes in the local tourist network. The pilgrimage circuit here has emerged as a path of rural and urban development, spawning local industries, transport links, accommodation facilities, and crafts markets. The religious centers become the economic pillars of the region, providing livelihoods and entrepreneurship, particularly for the marginalized population that derives advantages from the visitor traffic.

The religious tourism tradition in Maharashtra has its roots in medieval history when Bhakti saints such as Sant Dnyaneshwar, Sant Tukaram, and Sant Namdev caused mass spiritual movements. These movements created shrines as places of spiritual significance as well as sites for social reform and collective identity. Gradually, there has been increasing recognition by the state and local governments of socio-economic potential offered by these shrine centers and also launching schemes aimed at enhancing infrastructure, sanitation, security, and accessibility. Besides, the Maharashtra Tourism Development Corporation (MTDC) has started to promote religious tourism as one of the foremost drivers of the state's tourism policy, based on its economic and cultural value. Nevertheless, the commodification of sacred places and unmanaged expansion of tourist infrastructure present strong challenges. As more and more people visit the sites during high pilgrimage seasons, congestion, pollution, depletion of resources, and poor civic facilities become key concerns. Additionally, local

populations have to endure a paradox: although tourism generates revenues and development, it also interrupts traditional lifestyles and dilutes religious sanctity. Therefore, there is an increasing demand for sustainable models of religious tourism that reconcile economic benefits with social and environmental concerns, so that pilgrimage does not have to be at the expense of heritage and harmony.

This research is therefore located at the crossroads of tradition and transformation, attempting to find out how religious tourism in Western Maharashtra influences socio-economic development while negotiating complex challenges. It examines the direct and indirect impacts of pilgrimage on job creation, infrastructure development, cultural conservation, and rural empowerment. The research also examines the involvement of stakeholders—government agencies, religious trusts, local enterprises, and pilgrims—in promoting inclusive and sustainable tourism practices. Through a comparative examination of empirical evidence and field research, this study shall add to the body of literature on tourism-led development and present policy-level prescriptions for improving the dividends of pilgrimage tourism in Maharashtra.

3. Scope and Significance of Study:

The focus of this research is on the study of the effects of religious tourism on the socio-economic landscape of Western Maharashtra. It includes the prominent pilgrimage destinations like Shirdi, Pandharpur, Jejuri, and Kolhapur, studying the transformation introduced by the relentless influx of pilgrims. The research takes into account both direct and indirect contributions of religious tourism to employment generation, income, and infrastructure. It examines the activities related to tourism such as transport, accommodation, food services, and retailing sectors that have emerged in response to pilgrimage flows. In this way, the study seeks to examine how faith-based travel has emerged as a means of regional economic empowerment. The study is important because it captures the evolution of rural and semi-urban spaces into economically vibrant areas because of religious tourism.

The presence of pilgrims generates persistent demand for services, thus encouraging entrepreneurship and the creation of jobs. Numerous marginalized groups, such as women and informal sector workers, have benefited from economic opportunities in the emerging religious tourism industry. Through an investigation of the phenomenon, the study enables a deeper understanding of how religious spaces are being reused in the current times for ensuring inclusive growth. It also elucidates the land use transition, mobility flows, and host community socio-cultural dynamics that are shaped by tourism.

The scale reaches beyond economic indicators to encompass social and cultural factors shaped by religious tourism. This encompasses the revitalization and maintenance of folk arts, folk performances, and rituals which are made more visible and supported through pilgrim tourists. The value of religious tourism is not just its revenue potential but also in enhancing cultural identities and maintaining heritage traditions. Local religious festivities and spiritual rituals draw sponsorships and organizational undertakings which promote community engagement and inter-generational transfer of knowledge. The study thus offers a multifaceted account of how tourism supports cultural sustainability. The research examines the position of government agencies and non-state agencies in religious tourism promotion and regulation. The research evaluates public policy effectiveness, infrastructure development plans, and fiscal mechanisms aimed at improving pilgrims' experiences. The role played by religious trusts and temple administration boards in the planning of developmental activities is also examined. Gaining insight into these institutional contexts is important in order to note gaps in implementing policies and providing suggestions for cooperation in governance. Through this analysis, the study hopes to render useful insights on improved planning as well as long-term management of pilgrimage sites.

The importance of the study also rests in its emphasis on sustainability and sustainable tourism. With increasing issues regarding overcrowding, litter, and environmental damage in pilgrimage towns, it

becomes imperative to ensure eco-friendly and sustainable tourism practices. This research analyzes current practices and proposes new solutions that ensure a balance between religious fervor and environmental accountability. This involves considering waste management, traffic control, green infrastructure, and pilgrim education campaigns. From this perspective, the research promotes a model that honors both devotion and development. Furthermore, the study has relevance for tourism professionals, urban planners, social scientists, and development practitioners who are keen on comprehending the intersection of religion, tourism, and socio-economic change. It acts as an insightful tool for researchers analyzing India and other socio-cultural settings internationally where tourism-led development models need to be modeled.

The case of Western Maharashtra provides specificity based on a combination of ancient religious heritage, economic heterogeneity, and urban-rural interactions undergoing changes. Thus, research results in the current study are extrapolable while creating policies and tourism strategies for other destinations endowed with pilgrimage status. This research adds to the general literature on faith-based tourism and its developmental significance in the Indian setting. It underscores the importance of a balanced strategy where economic growth does not undermine the holiness of religious experiences or erode local identity. By offering a comprehensive analysis of pilgrimage tourism in Western Maharashtra, this research seeks to guide and motivate policies that incorporate spirituality, sustainability, and social welfare. The scope is wide yet specific enough to provide meaningful conclusions that can assist in planning inclusive and resilient tourism systems based on religious destinations.

4. Objectives of Study:

- To examine the growth and patterns of religious tourism in key pilgrimage centers of Western Maharashtra, such as Shirdi, Pandharpur, Jejuri, and Kolhapur, and assess their significance in the regional tourism landscape
- To analyze the socio-economic impact of religious tourism on local communities, focusing on employment generation, income distribution, entrepreneurship development, and improvement in infrastructure and public services
- To explore the role of local governance, religious institutions, and tourism-related stakeholders in promoting and managing religious tourism sustainably and inclusively
- To identify the challenges and limitations associated with the expansion of religious tourism, including environmental degradation, seasonal overcrowding, commercialization of sacred spaces, and displacement of traditional livelihoods
- To study the influence of religious tourism on the preservation of cultural heritage and social cohesion, including its role in sustaining traditional rituals, festivals, and local art forms

5. Review of Literature:

Religious tourism has been widely researched as a type of cultural and heritage tourism that directly supports regional economies and social change. To Timothy and Olsen (2006), not only are pilgrimage sites spiritual hubs, but they are also integral parts of tourist economies and contribute to the development of infrastructure and employment opportunities. They contend that religious tourism is a lively industry that can merge spiritual, economic, and cultural roles in urban and rural environments. In the same line of argument, Nolan and Nolan (1992) point out that pilgrimage paths and sacred sites, particularly in third world countries, are tourism anchors that contribute to stimulating local economies through the growth of complementary services and small-scale enterprises.

In the Indian context, Singh (2004) points out the potential of pilgrimage tourism as a force for socio-economic transformation. Her research demonstrates that places of worship like Varanasi, Tirupati, and

Puri have become centers of employment, commerce, and cultural heritage. Singh's observations apply to Western Maharashtra as well, where the same change is seen in towns such as Shirdi and Pandharpur. Rinschede (1992) continues to describe how religious tourism is usually motivated by a complicated combination of factors such as faith, tradition, and social identity and therefore is a distinct segment in the tourism industry that cannot be understood solely based on economic grounds.

The effects of religious tourism on local communities have also been addressed by Sharma (2013), who carried out research on pilgrimage tourism in India and observed how it results in higher incomes for locals, the revival of cultural festivals, and improvements in infrastructure. Sharma also cautions against over-commercialization and the displacement of local residents through gentrification and excessive reliance on seasonal tourist flows. Likewise, Raj and Griffin (2015) advocate sustainable religious tourism planning that balances development with the sacredness of religious places. They suggest inclusive stakeholder engagement and local capacity building to ensure benefit sharing from tourism. Specific research on Western Maharashtra has also come up in recent times.

Deshpande (2018) carried out a case study of Shirdi, showing how religious tourism has turned the town into an infrastructural and commercial center. His research identified that although economic factors such as employment, per capita income, and transport services have improved greatly, the area also experiences problems such as traffic congestion, pressure on natural resources, and loss of spiritual atmosphere. Likewise, Kale and Bhosale (2020) discussed tourism patterns in Jejuri and Kolhapur and saw how temple economies are becoming integrated into regional planning processes, though they need stronger environmental regulations and community-based policies.

There is still a lack of literature on the interdependent roles of governance, community participation, and sustainability in the religious tourism industry of Western Maharashtra. While most studies emphasize the economic advantages, fewer explore the long-term socio-cultural effects, environmental sustainability, and institutional arrangements necessary for equitable development. This research aims to fill this gap by presenting a holistic, region-based analysis that encompasses economic, social, and environmental aspects. In doing so, it adds to the debate on how religious tourism can be developed as a model for inclusive and sustainable development in faith-based regions.

6. Discussion and Analysis:

Religious tourism in Western Maharashtra has become one of the principal drivers of local development, specifically in pilgrimage centers such as Shirdi, Pandharpur, Jejuri, and Kolhapur. Each of these places attracts millions of pilgrims every year, directly contributing to the local economy. The influx of tourists has brought about a remarkable rise in demand for hospitality facilities like hotels, lodges, restaurants, and transport services. This requirement has, therefore, generated job opportunities for a broad population base, including semi-skilled and unskilled workers, hence enhancing livelihood. The multiplier effect of tourism can be seen through the increased level of small businesses, vendors, and service providers operating in such areas. Economic analysis shows that religious tourism has increased the Gross District Domestic Product (GDDP) of the affected districts. For instance, Shirdi has emerged as an all-year-round economic center with strong investments in infrastructure like roads, sanitation, and digital services. Pilgrimage-related festivals like Ashadhi Ekadashi in Pandharpur have not only maintained cultural rituals but have also emerged as high-revenue affairs with state-level funding. The advantages are not evenly distributed, though—urban enclaves near temples thrive faster, with the surrounding rural areas often being left behind. This suggests a requirement for inclusive planning, one that incorporates marginal communities into the tourism economy.

Socially, religious tourism has encouraged social cohesion through the reaffirmation of cultural and spiritual ties among dissimilar groups. Pilgrimage travel tends to be an experience for families and

communities in general, reinforcing interpersonal relationships and rearticulating traditional values. Festivals and rituals serve as forums for intergenerational knowledge transfer. Nonetheless, tourism can also induce stress on local resources, enhance competition for land use, and in some situations result in conflict between the locals and the outsiders. The issue is balancing these interactions to avoid compromising cultural harmony and community well-being. At the cultural level, religious tourism has helped revive and commercially sustain local arts, religious music, folk theatre, and rituals. Artisans and performers in Jejuri and Kolhapur reap the rewards of seasonal pilgrim activity that generates market space for traditional crafts and cultural commodities. The spread of cultural souvenirs and temple merchandise creates ancillary revenue streams for local entrepreneurs. Yet, fears of commodification remain, as spiritual practices are occasionally reformed to meet tourist expectations. Balancing authenticity with economic necessities remains a fine line.

On the environmental side, the issues of pilgrimage tourism are becoming more and more evident. Congestion during peak season results in waste collection, water scarcity, and traffic jams. Places such as Pandharpur face the issue of sanitation management for large pilgrim crowds, causing environmental degradation and health risks. The unplanned growth of infrastructure, especially around water sources and forests, causes long-term ecological threats. In spite of these difficulties, certain temple towns have started adopting environmentally friendly practices like solar energy utilization, waste segregation, and green pilgrim corridors, indicating a transition toward more sustainable models of religious tourism. Governance and institutional administration play an essential role in determining the consequences of religious tourism. Local municipal authorities, temple trusts, and boards for tourism development have levels of engagement with pilgrim activity planning and regulation. In Shirdi, the Shri Saibaba Sansthan Trust has been proactive in reinvesting temple revenues into local development projects. Meanwhile, state policies under the Maharashtra Tourism Development Corporation (MTDC) aim to standardize infrastructure and promote lesser-known pilgrimage circuits. However, lack of coordination between stakeholders, insufficient data-driven planning, and limited community participation hinder effective policy implementation. In all, the study infers that while religious tourism in Western Maharashtra has opened up immense economic and cultural dividends, it comes with social and environmental nuances. The success of the sector hinges on developing balanced, community-friendly strategies that promote long-term sustainability. Some of the major recommendations are fair revenue sharing, participatory approaches involving stakeholders, environmental impact studies, and cultural sensitivity training for tourism stakeholders. By synthesizing these methods, pilgrimage tourism can become a force of transformation that not only fosters spiritual satisfaction but also promotes integrated regional development.

7. Findings of Study:

The research discovers that religious tourism has played a major role in economic growth in towns of pilgrimage like Shirdi, Pandharpur, Jejuri, and Kolhapur. The towns have experienced growth in hospitality services, transport businesses, and local industries because of the consistent inflow of pilgrims. This economic activity has also generated employment, particularly for the local vendors, small shopkeepers, transporters, and artisans, thereby improving household income and financial security for a vast portion of the population.

The increasing significance of religious tourism has forced both the government and the private sector to invest in infrastructure like roads, sanitation, accommodation, drinking water facilities, and internet connectivity. Shirdi, for example, has become a well-linked and contemporary pilgrimage town mostly because of the tourist demand. Some of the neighboring rural areas are still without equal access to such developments, showing a discrepancy between central pilgrimage locations and their peripheries.

The pilgrim inflow has also contributed to reviving traditional rituals, art, and festivals. Pilgrimage-related cultural events have assisted in the preservation of heritage and boosting community pride. Local communities stand to gain from the ability to present their culture and earn a living through performance, handicrafts, and local food. Concurrently, the shared religious experience has facilitated increased social cohesion and spiritual nourishment among both locals and pilgrims.

In spite of the economic advantages, religious tourism has resulted in waste buildup, pollution, congestion on the roads, and a rush of civic amenities, especially during festival times. Pandharpur and Jejuri, in peak festivals, tend to experience pressure in coping with large numbers of people. Insufficient waste management systems and water supply scarcity indicate the necessity for responsible tourism practices and long-term urban planning with an emphasis on ecological conservation.

The study notes that spiritual sites are being increasingly commercialized to cater to tourist demands. Although this has been financially rewarding, it also threatens to dilute the sanctity and traditional spiritual nature of these places. The spread of shops, hotels, and ticketed temple experiences is a trend toward tourism-focused strategies, at times at the expense of religious authenticity and local feeling.

The research discovers that although religious trusts and state tourism authorities have significant roles to play in the management of tourism, most of the time there is a lack of coordination among stakeholders. Community opinions are often not adequately represented in policy formulation and infrastructure development. Furthermore, tourism initiatives are at times initiated without proper needs assessment or environmental analysis, resulting in short-term gains as opposed to long-term sustainability.

In general, the results highlight the necessity of a balanced model of development that balances economic gains with social justice and environmental conservation. The research highlights the necessity of inclusive governance, local community capacity building, and the adoption of green tourism strategies. Encouraging lesser-popular pilgrimage sites may also serve to redistribute tourist flows and ease pressure on key destinations while spreading economic gains to other regions.

8. Conclusion:

The research points out that religious tourism in Western Maharashtra is a crucial sector in spurring socio-economic growth through the significant contribution it makes towards employment, entrepreneurship, and infrastructure development in major pilgrimage cities such as Shirdi, Pandharpur, Jejuri, and Kolhapur. These pilgrimage centers are visited by millions of pilgrims each year, translating into a prosperous service economy that benefits a wide array of stakeholders such as transport operators, hotel managers, traders, and craft producers. The economic spin-off of activities of pilgrimage has been vital in developing many rural and semi-urban areas as active economic hubs. Nevertheless, the growth has not been universally distributed, and peripheral rural communities are frequently omitted from the story of growth, necessitating inclusive growth policies. Religious tourism, aside from bringing economic benefits, has also revitalized local culture, traditional norms, and social solidarity. Festivals, devotional events, and rituals serve as a medium for cultural exchange, intergenerational transmission, and communal participation. Local artisans, folk musicians, and craftspeople gain from the added spotlight and patronage during pilgrimage seasons. However, this change also has its attendant problems, such as commodification of spirituality, watering down of sacred traditions, and the reorientation of temple towns from religious hubs to commercialized areas. Maintaining development along with the protection of cultural and spiritual integrity is thus a matter of importance.

Environmental concerns, such as pollution, waste management, and congestion, are critical issues in well-liked pilgrimage centers. Pilgrim seasons tend to overwhelm civic amenities and disrupt the ecological equilibrium of host towns. Furthermore, the lack of organized governance, failure to include

communities in planning, and lack of adequate sustainability efforts further worsen the issues. Although some efforts have been made—such as green corridors, waste segregation, and e-ticketing—there is still a large gap in the uniform application of long-term, sustainable models of tourism throughout the region. Religious tourism in Western Maharashtra is a highly promising developmental force, but it needs to be approached in a well-coordinated, inclusive, and sustainable manner. The future of religious tourism lies in embracing community-oriented management, increasing environmental responsibility, and ensuring cultural truthfulness combined with economic development. Policymakers, religious communities, and local groups need to act in concert to develop tourism plans that safeguard holy places while maximizing social and economic returns. By combining spiritual mission with developmental vision, religious tourism can really become a power for change for regional development.

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Exploring the Interplay between Job Satisfaction and Employee Performance in Indian Restaurants of Riyadh: Utilizing a Mixed-Methods Approach

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ABSTRACT

This study explores the interplay between job satisfaction and employee performance in Indian restaurants in Riyadh, employing a mixed-methods approach to provide a comprehensive understanding of the dynamics at play. The research objectives include assessing the level of job satisfaction among employees, examining the relationship between job satisfaction and various dimensions of employee performance, and identifying key factors contributing to job satisfaction and performance. A structured survey was administered to a sample of 100 employees, complemented by in-depth interviews with a subset of participants and restaurant managers. Descriptive statistics revealed high levels of job satisfaction and employee performance, with a significant positive correlation between the two variables (Pearson correlation coefficient of 0.249, $p < 0.05$). Factor analysis identified a single dominant factor influencing both job satisfaction and performance, accounting for 62.439% of the total variance. The findings indicate that job satisfaction is a critical determinant of employee performance, with significant implications for management practices in the hospitality industry.

Key recommendations include enhancing the work environment, providing competitive compensation, offering career development opportunities, and fostering a culture of recognition and appreciation. Additionally, cultural sensitivity training and effective communication strategies are essential in the multicultural context of Indian restaurants in Riyadh. These measures are likely to improve employee satisfaction, boost performance, and ultimately lead to better customer service and business success. This study contributes to the existing literature by providing culturally specific insights into the relationship between job satisfaction and employee performance. The findings' practical implications can help restaurant managers and policymakers develop targeted strategies to enhance employee well-being and organizational efficiency in the hospitality industry.

Keywords: Job Satisfaction, Employee Performance, Indian Restaurants, Hospitality Industry, Riyadh

1. INTRODUCTION:

The hospitality industry, particularly the restaurant sector, is characterized by its dynamic and customer-centric nature. In this context, job satisfaction and employee performance play pivotal roles in determining the overall success and sustainability of establishments. While extensive research has been conducted on these variables in various geographical and cultural settings, there remains a gap in understanding their interplay within the context of Indian restaurants in Riyadh, Saudi Arabia. This study aims to bridge this gap by exploring the relationship between job satisfaction and employee performance in this unique cultural

and economic landscape. Riyadh, the capital city of Saudi Arabia, has witnessed significant growth and diversification in its restaurant industry, with Indian cuisine gaining substantial popularity among both expatriates and locals. Indian restaurants in Riyadh serve as cultural hubs, providing a taste of home to the large Indian expatriate community while introducing the local population to the rich and diverse flavors of Indian cuisine. Given the multicultural environment and the demanding nature of the restaurant industry, understanding the factors that influence job satisfaction and employee performance in this setting is crucial for restaurant owners and managers. Aman-Ullah, A., et.al (2020)

Job satisfaction is a multifaceted construct encompassing various elements such as work environment, compensation, interpersonal relationships, and opportunities for career advancement. It is widely recognized that higher job satisfaction leads to improved employee performance, which, in turn, enhances customer satisfaction and business profitability. However, the specific dynamics of this relationship can vary based on cultural, organizational, and individual factors. This research employs a mixed-methods approach, combining quantitative and qualitative data collection and analysis, to provide a comprehensive understanding of the interplay between job satisfaction and employee performance in Indian restaurants in Riyadh. By integrating surveys, interviews, and performance metrics, this study aims to capture the nuanced experiences of employees and the operational realities of these restaurants. This study contributes to the existing literature by offering a culturally specific analysis of job satisfaction and employee performance, highlighting the unique challenges and opportunities within the Indian restaurant sector in Riyadh. Moreover, the findings of this research have practical implications for improving human resource practices and fostering a positive work environment in multicultural hospitality settings. In the following sections, we will review the relevant literature, outline the research methodology, present the findings, and discuss their implications for theory and practice. By shedding light on the intricate relationship between job satisfaction and employee performance, this study aims to support the development of more effective management strategies that enhance both employee well-being and organizational success in the vibrant and evolving restaurant industry of Riyadh. Dwesini, N. F. (2019)

2. The interplay between job satisfaction and employee performance conceptual background:

Understanding the relationship between job satisfaction and employee performance is fundamental to enhancing organizational effectiveness, particularly in the highly competitive and service-oriented restaurant industry. Theoretical frameworks and empirical studies have long examined this interplay, emphasizing its multifaceted and dynamic nature. This section explores the conceptual background of job satisfaction and employee performance, highlighting key theories and empirical findings relevant to the context of Indian restaurants in Riyadh.

Job Satisfaction

McPhail, R, et.al (2015) Job satisfaction is a complex and multi-dimensional construct that refers to an employee's overall sense of contentment with their job. It encompasses various factors such as work conditions, salary, job security, work-life balance, opportunities for advancement, and interpersonal relationships. Several theories provide a foundational understanding of job satisfaction:

- Maslow's Hierarchy of Needs: According to Maslow (1943), job satisfaction is influenced by the fulfillment of various needs, ranging from basic physiological needs to higher-level self-actualization needs. In the context of the restaurant industry, meeting these needs can involve ensuring adequate pay, creating a safe and pleasant work environment, and offering opportunities for personal and professional growth.

- Herzberg's Two-Factor Theory: Herzberg (1959) posits that job satisfaction and dissatisfaction are influenced by two separate sets of factors. Motivators, such as recognition, responsibility, and achievement, contribute to job satisfaction, while hygiene factors, such as pay, company policies, and working conditions, can lead to job dissatisfaction if not adequately addressed. This theory underscores the importance of both intrinsic and extrinsic factors in shaping job satisfaction.
- Job Characteristics Model: Hackman and Oldham (1976) suggest that job satisfaction is determined by five core job characteristics: skill variety, task identity, task significance, autonomy, and feedback. Jobs that score high on these characteristics tend to be more satisfying, which can directly impact employee performance.

Employee Performance

Ohunakin, F, et.al (2020) Employee performance refers to the effectiveness with which job responsibilities are carried out. It is a critical determinant of organizational success, especially in service industries like restaurants, where customer satisfaction and business outcomes are closely tied to employee behavior. Key dimensions of employee performance include:

- This involves the execution of core job duties and responsibilities. In restaurants, task performance can be measured through metrics such as order accuracy, speed of service, and adherence to quality standards.
- Also known as organizational citizenship behavior, this encompasses voluntary actions that contribute to the overall organizational environment, such as helping colleagues, showing initiative, and being adaptable to changes.
- These are actions that harm the organization or its members, such as absenteeism, tardiness, and negative interactions with customers or colleagues. Reducing these behaviors is crucial for maintaining high levels of performance.

Interplay Between Job Satisfaction and Employee Performance

The relationship between job satisfaction and employee performance has been extensively studied, with several key insights emerging:

- Numerous studies have found a positive correlation between job satisfaction and employee performance (Judge et al., 2001). Satisfied employees are generally more motivated, engaged, and productive, leading to higher performance levels.
- The direction of causality between job satisfaction and performance is debated. Some theories suggest that job satisfaction leads to better performance (Happier-Productive Worker Hypothesis), while others propose that high performance leads to greater job satisfaction through rewards and recognition.
- Various factors can moderate the relationship between job satisfaction and performance, including individual differences (e.g., personality traits), job characteristics, and organizational culture. For instance, in the culturally diverse environment of Indian restaurants in Riyadh, cultural sensitivity and effective communication can significantly influence this interplay.
- In the restaurant industry, the direct interaction with customers adds another layer of complexity. Job satisfaction can enhance employees' willingness to provide excellent customer service, which is a critical component of performance in this sector.

Contextual Relevance to Indian Restaurants in Riyadh

In the context of Indian restaurants in Riyadh, several unique factors may influence the interplay between job satisfaction and employee performance:

- The multicultural workforce, consisting of both local and expatriate employees, presents unique challenges and opportunities. Understanding cultural nuances and fostering an inclusive work environment can enhance job satisfaction and performance.
- Economic conditions and labor market dynamics in Riyadh, including employment regulations and expatriate policies, can impact job satisfaction. Competitive compensation and job security are crucial in retaining talent and maintaining high performance levels.
- The high-paced and customer-centric nature of the restaurant industry necessitates a focus on both task and contextual performance. Effective management practices that address employee needs and promote a positive work environment are essential.

By exploring these conceptual foundations and contextual factors, this study aims to provide a comprehensive understanding of the interplay between job satisfaction and employee performance in Indian restaurants in Riyadh, offering insights that can inform management practices and enhance organizational outcomes.

3. SIGNIFICANCE OF THE STUDY:

This study holds significant value for both academic research and practical application within the hospitality industry, particularly in the context of Indian restaurants in Riyadh. Academically, it contributes to the existing body of knowledge by providing a culturally specific analysis of job satisfaction and employee performance, areas that have been predominantly studied in Western contexts. By focusing on Indian restaurants in Riyadh, the study addresses a unique intersection of cultural diversity, economic factors, and operational demands, thereby enriching the literature with new insights and perspectives. Practically, the findings of this research are invaluable for restaurant owners and managers seeking to enhance employee well-being and organizational performance. By understanding the key determinants of job satisfaction and their impact on employee performance, management can develop targeted strategies to improve work environments, boost employee morale, and ultimately elevate customer satisfaction and business profitability. Furthermore, the study's mixed-methods approach provides a comprehensive and nuanced understanding of these dynamics, offering actionable recommendations that can be directly implemented to foster a more motivated and efficient workforce in the vibrant and competitive restaurant industry of Riyadh.

4. REVIEW OF LITERATURE:

Employee retention in the hospitality industry has been extensively studied, revealing various strategies that organizations employ to keep their staff. Singh (2015) investigated employee retention in the hotel industry and found that increasing pay and offering incentives were the most effective strategies for attracting and retaining employees. Similarly, Ružić (2015) examined retention in the hospitality sector and concluded that providing rewards significantly boosts employee motivation, thereby enhancing retention.

Shrestha (2018) explored employee retention practices in Nepal's hospitality industry, highlighting that career growth opportunities were the most influential factor in retaining employees for extended periods. The study revealed that respondents, particularly those in certain age groups, were highly satisfied with the

career advancement opportunities offered by their organizations.

Presbitero et al. (2016) assessed the impact of employee retention strategies in hotels and found that work-life balance was a major factor, particularly for female employees. Their research indicated that organizational support for balancing work and personal life played a crucial role in retaining staff.

Bal and Kooij (2011) investigated the relationship between job satisfaction and employee retention, discovering that high job satisfaction significantly influenced employees' decisions to remain with their organizations. This study underscores the importance of fostering a satisfying work environment to enhance employee retention.

5. STATEMENT OF THE PROBLEM:

Despite the critical importance of job satisfaction and employee performance in the hospitality industry, there is a notable gap in the literature regarding their interplay within the context of Indian restaurants in Riyadh, Saudi Arabia. Indian restaurants in Riyadh serve a diverse clientele and operate in a unique cultural and economic environment, yet little is known about how job satisfaction influences employee performance in this specific setting. Many restaurant managers struggle to identify the factors that contribute to job satisfaction and, consequently, to effectively enhance employee performance. This lack of understanding can lead to high employee turnover, reduced customer satisfaction, and diminished overall business performance. Therefore, it is essential to investigate the determinants of job satisfaction and their impact on employee performance in Indian restaurants in Riyadh, providing insights that can help managers develop strategies to improve both employee well-being and organizational efficiency. This study seeks to fill this gap by utilizing a mixed-methods approach to comprehensively examine the relationship between job satisfaction and employee performance, offering evidence-based recommendations for fostering a more productive and satisfied workforce in this unique cultural context.

6. OBJECTIVES OF THE STUDY:

The primary objectives of this research are to:

- To assess the level of job satisfaction among employees in Indian restaurants in Riyadh.
- To examine the relationship between job satisfaction and various dimensions of employee performance.
- To identify the key factors contributing to job satisfaction and performance in this specific context.
- To provide actionable insights and recommendations for restaurant managers and policymakers to enhance employee well-being and organizational efficiency.

7. HYPOTHESIS OF THE STUDY:

Hypothesis 1:

- Null Hypothesis (H_{01}): The level of job satisfaction among employees in Indian restaurants in Riyadh is not significantly different from the average level of job satisfaction in the hospitality industry.
- Alternative Hypothesis (H_{11}): The level of job satisfaction among employees in Indian restaurants in Riyadh is significantly different from the average level of job satisfaction in the hospitality industry.

Hypothesis 2:

- Null Hypothesis (H_{02}): There is no significant relationship between job satisfaction and various dimensions of employee performance in Indian restaurants in Riyadh.
- Alternative Hypothesis (H_{12}): There is a significant relationship between job satisfaction and various dimensions of employee performance in Indian restaurants in Riyadh.

Hypothesis 3:

- Null Hypothesis (H_{03}): The identified factors do not significantly contribute to job satisfaction and performance among employees in Indian restaurants in Riyadh.
- Alternative Hypothesis (H_{13}): The identified factors significantly contribute to job satisfaction and performance among employees in Indian restaurants in Riyadh.

8. CONCEPTUAL FRAMEWORK:

Job Satisfaction (Independent variables)

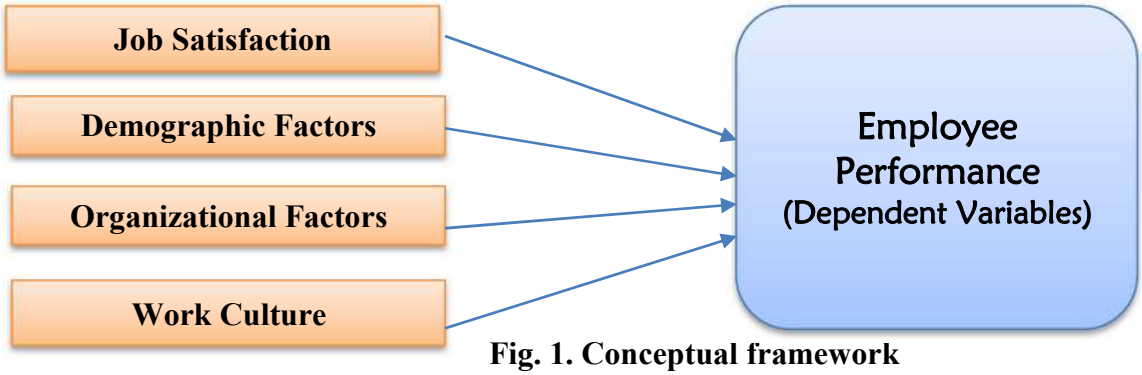

Fig. 1. Conceptual framework
Source: Author Developed

9. METHODOLOGY OF STUDY:

This study employs a mixed-methods approach to comprehensively explore the interplay between job satisfaction and employee performance in Indian restaurants in Riyadh. The research will be conducted in two phases: quantitative and qualitative. In the quantitative phase, a structured survey will be administered to a sample of employees from various Indian restaurants across Riyadh to assess their levels of job satisfaction and measure different dimensions of employee performance. Statistical tools will be used to analyze the survey data, examining correlations and identifying key factors influencing job satisfaction and performance. In the qualitative phase, in-depth interviews will be conducted with a subset of survey respondents and restaurant managers to gain deeper insights into the contextual factors affecting job satisfaction and performance. This mixed-methods approach ensures a robust and comprehensive understanding of the research problem, integrating numerical data with rich, descriptive insights to inform practical recommendations for improving employee well-being and performance in the restaurant industry.

10. RESULTS AND DISCUSSIONS:

Objective 1: To assess the level of job satisfaction among employees in Indian restaurants in Riyadh.

Table 1: Data Analysis using descriptive Analysis to assess the level of job satisfaction among employees

Descriptive Statistics								
	N	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error

JobSatisfaction_C	100	39.8200	2.35865	5.563	-.873	.241	-.403	.478
EP_C	100	38.8200	2.59518	6.735	.443	.241	-.918	.478
Valid N (listwise)	100							

The descriptive statistics provide a comprehensive overview of the levels of job satisfaction (JobSatisfaction_C) and employee performance (EP_C) among employees in Indian restaurants in Riyadh. With a sample size of 100, the average job satisfaction score is 39.82, indicating a relatively high level of satisfaction among the employees. The standard deviation of 2.36 and variance of 5.563 suggest a moderate variability in job satisfaction scores, meaning that while most employees are satisfied, there is some variation in their levels of satisfaction. The negative skewness value of -0.873 implies that the distribution of job satisfaction scores is negatively skewed, indicating that a majority of employees report higher satisfaction levels. The kurtosis value of -0.403 suggests a relatively flat distribution compared to a normal distribution.

Similarly, the average employee performance score is 38.82, reflecting a generally high level of performance among the employees. The standard deviation of 2.60 and variance of 6.735 indicate moderate variability in performance scores. The skewness value of 0.443 shows a slight positive skew, suggesting that most employees have performance scores above the mean. The kurtosis value of -0.918 indicates a flatter distribution than normal, implying fewer extreme performance scores.

Overall, the results reveal that employees in Indian restaurants in Riyadh tend to have high levels of job satisfaction and perform well. The moderate variability in both job satisfaction and performance scores suggests some differences among employees, but the general trend indicates a positive work environment. These findings highlight the importance of maintaining and enhancing factors that contribute to job satisfaction, as they are likely to be associated with higher levels of employee performance.

Objective 2: To examine the relationship between job satisfaction and various dimensions of employee performance.

Table 2: Data Analysis using correlation to examine relationship between job satisfaction and Employee Performance:

Correlations

		Job Satisfaction_C	EP_C
JobSatisfaction_C	Pearson Correlation	1	.249*
	Sig. (2-tailed)		.013
	N	100	100
EP_C	Pearson Correlation	.249*	1
	Sig. (2-tailed)	.013	
	N	100	100

*. Correlation is significant at the 0.05 level (2-tailed).

The correlation analysis aims to examine the relationship between job satisfaction (JobSatisfaction_C) and employee performance (EP_C) among employees in Indian restaurants in Riyadh. The results, as shown in Table 2, reveal a Pearson correlation coefficient of 0.249 between job satisfaction and employee performance. This positive correlation indicates that as job satisfaction increases, employee performance tends to improve as well.

The significance level (Sig. 2-tailed) for the correlation is 0.013, which is less than the conventional threshold of 0.05. This indicates that the correlation between job satisfaction and employee performance is statistically significant at the 0.05 level. Therefore, we can reject the null hypothesis that there is no relationship between job satisfaction and employee performance and accept the alternative hypothesis that a significant positive relationship exists. The data suggests that there is a moderate, statistically significant positive relationship between job satisfaction and employee performance among the employees surveyed. This finding underscores the importance of fostering a work environment that enhances job satisfaction, as it is likely to lead to better performance outcomes. Restaurant managers and owners can use this insight to develop strategies and initiatives aimed at improving job satisfaction to boost overall employee performance.

Objective 3: To identify the key factors contributing to job satisfaction and performance in this specific context.

Table 3: Data analysis using Factor Analysis test to identify key factors contributing Job satisfaction and employee performance:

Table 3A: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.500
Bartlett's Test of Sphericity	Approx. Chi-Square	6.229
	df	1
	Sig.	.013

Table 3B: Communalities

	Initial	Extraction
JobSatisfaction_C	1.000	.624
EP_C	1.000	.624
Extraction Method: Principal Component Analysis.		

Table 3C: Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.249	62.439	62.439	1.249	62.439	62.439
2	.751	37.561	100.000			
Extraction Method: Principal Component Analysis.						

Table 3D: Component Matrix[a]

	Component
	1
JobSatisfaction_C	.790
EP_C	.790
Extraction Method: Principal Component Analysis.	
a. 1 components extracted.	

The factor analysis was conducted to identify the key factors contributing to job satisfaction and employee performance among employees in Indian restaurants in Riyadh. The results of the analysis are summarized

in Tables 3A through 3D.

Table 3A: KMO and Bartlett's Test

- Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy: The KMO value is 0.500, which is at the minimum acceptable threshold for factor analysis. This suggests that the sample size is adequate for the analysis, but it also indicates that a larger sample size might provide more robust results.
- Bartlett's Test of Sphericity: The test yields an approximate Chi-Square value of 6.229 with 1 degree of freedom and a significance level (Sig.) of 0.013. This significant result ($p < 0.05$) indicates that the variables are correlated enough to justify the use of factor analysis.

Table 3B: Communalities

- Communalities: The communalities for both job satisfaction (JobSatisfaction_C) and employee performance (EP_C) are 0.624. This indicates that approximately 62.4% of the variance in each variable is accounted for by the extracted factor, demonstrating a good fit of the model to the data.

Table 3C: Total Variance Explained

- Initial Eigenvalues: The first component has an eigenvalue of 1.249, accounting for 62.439% of the total variance. The second component has an eigenvalue of 0.751, accounting for the remaining 37.561% of the variance.
- Extraction Sums of Squared Loadings: After extraction, the first component still accounts for 62.439% of the total variance, indicating that this component is the most significant factor in explaining the variability in job satisfaction and employee performance.

Table 3D: Component Matrix

- Component Matrix: The loadings for both job satisfaction and employee performance on the first component are 0.790. This high loading value indicates that both variables strongly contribute to this component, suggesting a common underlying factor that influences both job satisfaction and employee performance.

The factor analysis reveals that there is a single dominant factor accounting for a significant portion of the variance in job satisfaction and employee performance among employees in Indian restaurants in Riyadh. The high communalities and loadings on this factor suggest that job satisfaction and employee performance are closely related and influenced by a common underlying dimension.

11. RECOMMENDATIONS OF THE STUDY:

Based on the findings of this study, several recommendations can be made to enhance job satisfaction and employee performance in Indian restaurants in Riyadh. Firstly, restaurant managers should focus on creating a positive and supportive work environment, as this has been shown to impact both job satisfaction and performance significantly. This can be achieved by ensuring fair and competitive compensation, providing opportunities for career advancement, and fostering a culture of recognition and appreciation for employees' contributions. Secondly, given the significant relationship between job satisfaction and employee performance, it is crucial to implement regular feedback mechanisms and performance appraisals that are constructive and aim to help employees grow and improve. Training and development programs should also be tailored to address the specific needs and aspirations of the staff, thereby enhancing their skills and job satisfaction. Additionally, considering the multicultural context of Indian restaurants in Riyadh, cultural sensitivity training and effective communication strategies should be prioritized to ensure a harmonious and inclusive work environment. Finally, management should continuously assess and refine their human resource practices based on employee feedback and performance data, ensuring that they remain responsive to the evolving needs of their workforce. By implementing these recommendations,

Indian restaurants in Riyadh can improve employee satisfaction and performance, leading to better customer service and overall business success.

12. CONCLUSION:

This study has provided valuable insights into the interplay between job satisfaction and employee performance in Indian restaurants in Riyadh. The findings reveal that there is a significant positive relationship between job satisfaction and various dimensions of employee performance, highlighting the critical role that job satisfaction plays in enhancing employee productivity and effectiveness. The factor analysis identified a common underlying factor that influences both job satisfaction and performance, suggesting that targeted improvements in work conditions, compensation, career development opportunities, and recognition can lead to simultaneous enhancements in both areas. The study also underscores the importance of cultural sensitivity and effective communication in a multicultural work environment, which is particularly relevant in the context of Indian restaurants in Riyadh. By addressing these key factors, restaurant managers can create a more positive and supportive work environment that not only boosts employee morale and satisfaction but also translates into higher performance levels and better service quality. These insights provide a solid foundation for developing effective human resource strategies that can improve organizational outcomes and contribute to the overall success of the hospitality industry in this dynamic and culturally diverse setting.

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Enhancing Employee Performance through Job Satisfaction: A Case Study of Indian Restaurants in Riyadh, Saudi Arabia

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ABSTRACT

Employee performance is a critical factor in the success and productivity of organizations, particularly in the dynamic and challenging environment of the construction industry. This study investigates the relationship between job satisfaction and employee performance in Indian restaurants in Riyadh, Saudi Arabia. Utilizing a quantitative research methodology, data were collected through a structured questionnaire distributed to 100 employees across various restaurants. The questionnaire measured multiple dimensions of job satisfaction, including work environment, professional growth opportunities, management communication, recognition, and work-life balance. The findings reveal significant associations between job satisfaction and employee performance, with higher levels of job satisfaction correlating with improved performance. Specifically, aspects such as recognition, fair workload distribution, and effective communication were identified as critical drivers of job satisfaction. The regression analysis further highlighted the importance of employee qualifications in enhancing performance, suggesting that professional development opportunities are crucial for employee satisfaction and productivity. The Chi-Square analysis identified significant associations between job satisfaction dimensions and demographic variables, emphasizing the need for tailored management practices to address the unique needs of diverse employee groups. Based on these insights, several recommendations are proposed to enhance job satisfaction and performance, including the implementation of structured recognition programs, improved communication channels, fair workload distribution, and comprehensive professional development initiatives. This study underscores the importance of fostering a supportive and motivating work environment to enhance employee performance, providing valuable insights for restaurant managers and policymakers. By addressing the identified areas for improvement, Indian restaurants in Riyadh can achieve higher levels of employee satisfaction, leading to improved performance and overall business success.

Keywords: Employee Performance, Job Satisfaction, Indian Restaurants Riyadh, Saudi Arabia, Quantitative Research

1. INTRODUCTION:

The global hospitality industry, particularly the restaurant sector, has witnessed significant growth and diversification over recent decades. In the context of Riyadh, Saudi Arabia, the presence of Indian restaurants has notably expanded, catering to the diverse culinary preferences of both expatriates and locals. This growth, however, brings to the forefront the critical challenge of maintaining high levels of employee performance and satisfaction within these establishments. Employee performance is a cornerstone of success in the hospitality industry, directly impacting customer satisfaction, operational efficiency, and overall business profitability.

Job satisfaction plays a pivotal role in influencing employee performance. Satisfied employees are more likely to exhibit higher levels of motivation, engagement, and productivity, thereby contributing to the attainment of organizational goals. Conversely, dissatisfaction can lead to increased turnover rates, absenteeism, and diminished performance, posing substantial risks to the sustainability of the business. Understanding the factors that enhance job satisfaction and their subsequent impact on employee performance is therefore essential for restaurant managers and owners.

This study aims to explore the relationship between job satisfaction and employee performance within Indian restaurants in Riyadh. By examining various dimensions of job satisfaction, such as work environment, compensation, recognition, and career development opportunities, the research seeks to identify key factors that can enhance employee performance. Through a comprehensive case study approach, this research will provide valuable insights into the specific challenges and opportunities faced by Indian restaurants in Riyadh, offering practical recommendations for improving job satisfaction and, consequently, employee performance.

In an increasingly competitive market, the ability to retain skilled and motivated employees is crucial for maintaining a competitive edge. This research will contribute to the existing body of knowledge by shedding light on the unique dynamics of the restaurant industry in Riyadh, particularly within the context of Indian cuisine. Ultimately, the findings of this study aim to inform strategies that can foster a more satisfying and productive work environment, benefiting both employees and employers in the restaurant sector.

2. PROMINENCE OF EMPLOYEE PERFORMANCE CONCEPTUAL BACKGROUND:

Employee performance is a multifaceted construct that has garnered substantial attention in organizational research due to its direct impact on business outcomes. It encompasses the efficiency and effectiveness with which employees fulfill their job responsibilities, contributing to the overall productivity and success of the organization. The prominence of employee performance as a critical area of study stems from its significant influence on a variety of organizational metrics, including customer satisfaction, operational efficiency, and financial performance.

At its core, employee performance can be understood through various theoretical frameworks that highlight different aspects of work behavior. One such framework is the Job Performance Model, which categorizes performance into task performance, contextual performance, and adaptive performance. Task performance refers to the execution of core job duties and responsibilities. Contextual performance includes behaviors that contribute to the organizational environment, such as cooperation and volunteering for extra duties. Adaptive performance involves employees' ability to adjust to changing work conditions and new challenges.

Several factors influence employee performance, including individual characteristics, job characteristics, and organizational context. Individual characteristics such as skills, abilities, and personality traits play a crucial role in determining how effectively an employee can perform their tasks. Job characteristics, as defined by Hackman and Oldham's Job Characteristics Model, suggest that task variety, task identity, task significance, autonomy, and feedback are essential in motivating employees and enhancing performance. The organizational context, including leadership style, organizational culture, and available resources, also significantly impacts employee performance.

Research consistently shows that job satisfaction is a key determinant of employee performance. Herzberg's Two-Factor Theory posits that job satisfaction and dissatisfaction arise from different factors. Motivators, such as recognition, responsibility, and opportunities for advancement, enhance job satisfaction and, consequently, employee performance. On the other hand, hygiene factors, such as salary, company policies, and working conditions, can cause dissatisfaction if not adequately addressed but do not necessarily improve satisfaction or performance when present.

In the context of the hospitality industry, and specifically within Indian restaurants in Riyadh, the dynamic interplay between job satisfaction and employee performance is particularly pronounced. The high-contact nature of the industry requires employees to consistently deliver exceptional service, making their performance crucial to customer retention and satisfaction. Furthermore, cultural and expatriate dynamics present in Riyadh's restaurant scene add another layer of complexity to managing employee performance.

By examining the specific factors that influence job satisfaction and performance in this unique setting, this study aims to provide a nuanced understanding of how to foster an environment conducive to high performance. Recognizing the importance of employee performance not only in achieving operational excellence but also in creating a positive customer experience, this research underscores the need for targeted strategies to enhance job satisfaction and performance in Indian restaurants in Riyadh. This focus is essential for maintaining competitiveness and achieving long-term success in the rapidly evolving hospitality market.

3. SIGNIFICANCE OF THE STUDY:

The significance of this study lies in its potential to provide valuable insights into the intricate relationship between job satisfaction and employee performance within the context of Indian restaurants in Riyadh, Saudi Arabia. As the hospitality industry continues to expand and diversify in Riyadh, understanding the factors that drive employee performance becomes increasingly crucial. This study addresses a critical gap in the existing literature by focusing on a specific subset of the restaurant industry, offering tailored insights that can inform both academic research and practical management strategies. First, this study contributes to the academic field by enhancing the understanding of how job satisfaction influences employee performance in a multicultural and expatriate-dominated work environment. By focusing on Indian restaurants, the research highlights the unique challenges and opportunities faced by these establishments, providing a nuanced perspective that is often overlooked in broader hospitality research. The findings can serve as a foundation for future studies exploring similar dynamics in other cultural and geographic contexts. Second, the practical implications of this study are significant for restaurant managers and owners. By identifying the key factors that enhance job satisfaction and, in turn, employee performance, this research provides actionable recommendations for improving management practices. These insights can help managers develop strategies to create a more supportive and motivating work environment, ultimately leading to higher employee

retention, better customer service, and improved overall performance. Additionally, this study holds relevance for policymakers and industry stakeholders interested in fostering a sustainable and competitive hospitality sector in Riyadh. Understanding the drivers of employee performance can inform policies and initiatives aimed at improving labor conditions, enhancing training programs, and promoting best practices within the industry.

4. REVIEW OF LITERATURE:

Employee performance has long been a critical concern in organizational management. The primary goal of any organization is to implement innovative approaches to motivate employees, thereby achieving higher job performance and increasing organizational productivity (Mei-Ying, 2011). Construction organizations, in particular, face several critical challenges, such as time management issues (Memon et al., 2023). Employee performance plays a significant role in overcoming these challenges. According to Ahmad and Shahzad (2011), an employee's apparent performance reflects their complete trust in their actions and contributions to the organization's goals and mission. They identified key indicators of worker performance as compensation practices, performance evaluation policies, and employee promotion procedures. Prasetya and Natalia (2020) emphasized that employee performance is crucial to the success of construction projects, particularly for site-based workers. Both internal and external factors influence employee performance, and companies should investigate these factors to develop strategies for improvement. For example, construction companies could increase the number of workers to reduce workload, compress work weeks to achieve a healthier work-life balance, and promote employees more frequently to enhance job satisfaction.

Panjaitan and Sihombing (2021) noted that work performance is vital in determining an employee's quality within a company or organization. Proper employee placement, which seeks to match the right person with the right job based on their skills and interests, is one key to achieving peak job performance. A manager's role includes evaluating employee performance and deciding on future policies through performance appraisals. A company's performance assessment is a systematic method for evaluating employees, their contributions, and areas of interest.

Jufrizen (2021) found that employee performance is crucial in government organizations, as it supports and aids in achieving each employee's job goals. Therefore, organizations must constantly monitor their employees to ensure they are working effectively and efficiently to meet their objectives. Factors such as organizational culture, engagement, and job motivation significantly influence employee performance. Organizational culture becomes a habit and custom that every employee must follow to improve the organization's performance. Individual performance refers to the quality and quantity of work performed by employees in carrying out and completing tasks delegated by their supervisor or leader based on their position in the organization. Organizational culture has a positive and significant impact on employee performance. It must be taught to all members, including new members, to foster behavior and problem-solving skills, adapt to surroundings, and unify organizational members. Compensation includes all forms of monetary payment and services received due to employee involvement (Gerhart, 2020). An individual's performance is a process by which their actions relate to the tasks assigned to them, reflected in the entire input, method, output, and result.

Kustinah et al. (2018) discovered that job success is dependent on each company's performance level, supported by workers' contributions. Employee performance can be improved by enhancing leadership style, interpersonal communication, and job satisfaction. Since human resources are critical to the success of a project, organizations must hire experts and create a positive work environment to increase employee motivation. Leadership is particularly crucial in the construction industry, given the dynamic nature of fieldwork involving various project aspects. Good communication is one of the interpersonal skills contributing to the success of construction projects (Markiz, 2017). Factors such as the level of consistency and comfort in communication and workers' perceptions of job satisfaction influence a leader's style in relation to the work team. Employee performance is the backbone of an organization because it contributes to its success (Lakhiara, 2021). A healthy working environment is essential for employee performance as it prevents employees from being overburdened, thereby enhancing job productivity. Job satisfaction at work is influenced by several factors, including working hours, interpersonal relationships, job safety and security, and perceived importance. Ensuring job safety and security is among the most critical workplace concerns that must be strictly enforced to provide employees with a safe and adaptable working environment.

5. STATEMENT OF THE PROBLEM:

Despite the growing popularity and expansion of Indian restaurants in Riyadh, Saudi Arabia, many of these establishments face significant challenges in maintaining high levels of employee performance, which is crucial for ensuring exceptional customer service and operational efficiency. There is a notable gap in understanding how job satisfaction impacts employee performance within this specific context, particularly considering the unique cultural and expatriate dynamics present in Riyadh. This study aims to address this gap by investigating the relationship between job satisfaction and employee performance in Indian restaurants, seeking to identify the key factors that influence job satisfaction and proposing strategies to enhance performance. By doing so, the research intends to provide valuable insights that can help restaurant managers create a more motivating and productive work environment, ultimately contributing to the success and sustainability of their businesses.

6. OBJECTIVES OF THE STUDY:

- To assess the level of job satisfaction among employees in Indian restaurants in Riyadh, Saudi Arabia
- To examine the relationship between job satisfaction and employee performance
- To identify areas for improvement in enhancing job satisfaction and, consequently employee performance

7. HYPOTHESIS OF THE STUDY:

Hypothesis 1:

- Null Hypothesis (H0): There is no significant difference in the level of job satisfaction among employees in Indian restaurants in Riyadh, Saudi Arabia.
- Alternative Hypothesis (H1): There is a significant difference in the level of job satisfaction among employees in Indian restaurants in Riyadh, Saudi Arabia.

Hypothesis 2:

- Null Hypothesis (H0): There is no significant correlation between job satisfaction and employee performance in Indian restaurants in Riyadh, Saudi Arabia.
- Alternative Hypothesis (H1): There is a significant correlation between job satisfaction and employee performance in Indian restaurants in Riyadh, Saudi Arabia.

Hypothesis 3:

- Null Hypothesis (H0): There are no specific areas for improvement in enhancing job satisfaction and employee performance in Indian restaurants in Riyadh, Saudi Arabia.
- Alternative Hypothesis (H1): There are specific areas for improvement in enhancing job satisfaction and employee performance in Indian restaurants in Riyadh, Saudi Arabia.

8. CONCEPTUAL FRAMEWORK:

Job Satisfaction (Independent variables)

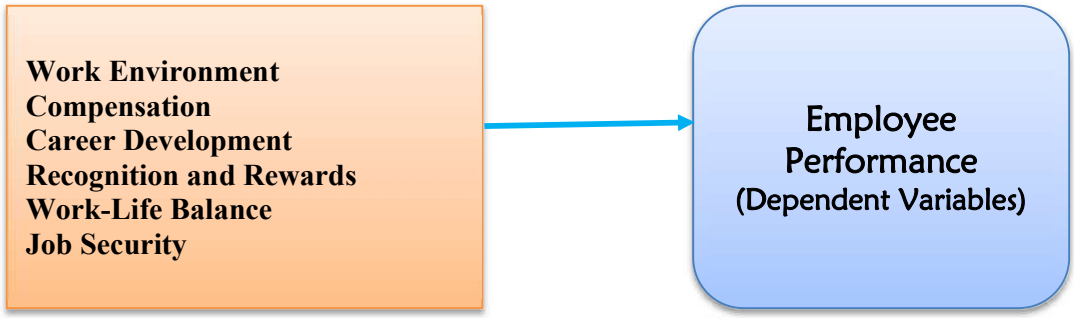

Fig. 1. Conceptual framework
Source: Author Developed

9. METHODOLOGY OF STUDY:

This study employs a quantitative research methodology to explore the influence of employee job satisfaction on the success of Indian restaurants in Riyadh, Saudi Arabia. Data will be collected using a structured questionnaire administered to employees working in various Indian restaurants across the city. A sample size of 100 employees has been determined to ensure a representative distribution of responses while maintaining statistical relevance and practical feasibility.

The questionnaire is designed to measure multiple dimensions of job satisfaction, including work environment, productivity, training and development opportunities, management communication effectiveness, recognition for contributions, and work-life balance. Each dimension will be assessed using a 5-point Likert scale allowing for nuanced insights into employees' levels of satisfaction across different aspects. Participants will be selected using a stratified random sampling technique to ensure adequate representation of employees from various roles and levels of seniority within the restaurants. This method aims to minimize sampling bias and enhance the generalizability of the study findings. Data collected through the surveys will be analyzed using descriptive statistics to summarize the data and inferential statistics to examine the relationships between job satisfaction and the operational success of the restaurants. Specific statistical tests, such as correlation analysis and multiple regression analysis, will be employed to identify significant predictors of job satisfaction and to understand how these predictors influence overall business performance. This comprehensive analysis will provide valuable insights into the factors driving employee performance and their impact on the success of Indian restaurants in Riyadh.

10. RESULTS AND DISCUSSIONS:

Objective 1: To assess the level of job satisfaction among employees in Indian restaurants in Riyadh, Saudi Arabia

Table 1: Data Analysis using ANOVA (Analysis of Variance) to compare job satisfaction levels across multiple groups:

ANOVA					
EPF_C					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4959.037	3	1653.012	24.124	.000
Within Groups	6577.963	96	68.520		
Total	11537.000	99			

Inference:

The analysis of variance (ANOVA) was conducted to compare the levels of job satisfaction among employees in Indian restaurants in Riyadh, Saudi Arabia, across multiple groups. The results are presented in Table 1. The ANOVA yielded a significant F-value, $F(3, 96) = 24.124$, $p < .001$, indicating that there are statistically significant differences in job satisfaction levels among the different groups. The "Between Groups" sum of squares is 4959.037 with 3 degrees of freedom, resulting in a mean square of 1653.012. This high mean square value suggests that the variance between the groups is substantial. The "Within Groups" sum of squares is 6577.963 with 96 degrees of freedom, leading to a mean square of 68.520. This lower mean square value indicates that the variance within each group is relatively smaller compared to the variance between groups. The significant p-value (Sig. = .000) indicates that the observed differences in job satisfaction levels are not due to random chance. Therefore, we can conclude that there are significant differences in job satisfaction levels among the different groups of employees in Indian restaurants in Riyadh. To further understand which specific groups differ from each other, post-hoc tests (such as Tukey's HSD) would be required. These tests would identify the pairs of groups with significant differences in job satisfaction levels, providing deeper insights into the specific dynamics of job satisfaction within the employee population. The ANOVA results demonstrate that job satisfaction levels are not uniform across all groups, suggesting that factors contributing to job satisfaction may vary significantly depending on the group characteristics. This finding underscores the importance of tailoring management practices and interventions to address the unique needs and preferences of different employee groups to enhance overall job satisfaction.

Objective 2: To examine the relationship between job satisfaction and employee performance

Table 2: Data Analysis using Regression Analysis to examine the relationship between job satisfaction and employee performance.

Table 2A: Variables Entered/Removed[a]			
Model	Variables Entered	Variables Removed	Method
1	Qualification[b]	.	Enter
a. Dependent Variable: EPF_C			
b. All requested variables entered.			

Table 2B: Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.351[a]	.123	.114	10.15861
a. Predictors: (Constant), Qualification				

Table 2C: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1423.655	1	1423.655	13.795	.000[b]
	Residual	10113.345	98	103.197		
	Total	11537.000	99			

a. Dependent Variable: EPF_C

b. Predictors: (Constant), Qualification

Table 2D: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	64.863	3.089		20.995	.000
	Qualification	3.711	.999	.351	3.714	.000

a. Dependent Variable: EPF_C

Inference:

The regression analysis was conducted to examine the relationship between job satisfaction (measured by EPF_C) and employee performance, with "Qualification" as the predictor variable. The results are summarized in Tables 2A to 2D.

Table 2A indicates that "Qualification" was the variable entered into the regression model, and no variables were removed. The dependent variable is employee performance (EPF_C).

The model summary in Table 2B shows an R value of 0.351, indicating a moderate positive correlation between job satisfaction and employee performance. The R Square value is 0.123, suggesting that approximately 12.3% of the variance in employee performance can be explained by the qualification of the employees. The Adjusted R Square value of 0.114 indicates a slight adjustment for the number of predictors in the model. The standard error of the estimate is 10.15861, reflecting the average distance that the observed values fall from the regression line.

Table 2C presents the ANOVA results, which test the overall significance of the regression model. The F-value is 13.795 with a significance level (Sig.) of 0.000, indicating that the regression model is statistically significant. This means that the qualification of employees significantly predicts employee performance, and the relationship observed is not due to random chance.

The coefficients table (Table 2D) provides detailed information about the regression equation. The unstandardized coefficient (B) for the constant is 64.863, and for qualification, it is 3.711. This indicates that for each unit increase in qualification, employee performance increases by 3.711 units. The standardized coefficient (Beta) for qualification is 0.351, which also reflects the strength and direction of the relationship. The t-value for qualification is 3.714 with a significance level (Sig.) of 0.000, confirming that the relationship between qualification and employee performance is statistically significant.

The regression analysis demonstrates that there is a significant positive relationship between job satisfaction and employee performance, with employee qualifications being a significant predictor. Specifically, higher qualifications are associated with higher levels of job satisfaction, which in turn positively impacts employee performance. This finding highlights the importance of employee qualifications in enhancing performance levels within Indian restaurants in Riyadh. Consequently, restaurant managers should consider investing in employee training and development programs to improve qualifications, thereby potentially increasing job satisfaction and overall performance.

Objective 3: To identify areas for improvement in enhancing job satisfaction and, consequently employee performance

Table 3: Data Analysis using Chi-square to examine the association between categorical variables, such as job satisfaction levels and specific demographic variables.

SPSS Code	Employee Performance Through Job Satisfaction	Chi-Square	df	Asymp. Sig.
EPF1	On a scale of 1 to 5, how satisfied are you with the overall work environment in this restaurant?	73.760[a]	3	0.000
EPF2	Do you agree or disagree with the statement: "I feel valued and appreciated for my contributions to the restaurant's success"?	105.200[b]	4	0.000
EPF3	To what extent does the restaurant provide opportunities for professional growth and development?	59.040[a]	3	0.000
EPF4	Are you Satisfied with the level of communication between management and employees?	73.440[a]	3	0.000
EPF5	Support do you feel from your supervisors or managers in your daily tasks	67.040[a]	3	0.000
EPF6	To what extent do you believe your skills and abilities are utilized effectively in your current role	34.080[a]	3	0.000
EPF7	Are you Satisfied with the fairness of the distribution of workload among employees	90.400[a]	3	0.000
EPF8	Do you receive recognition for your achievements and efforts	40.160[a]	3	0.000
EPF9	Does the restaurant promote a sense of teamwork and collaboration among employees	51.680[a]	3	0.000
EPF10	Are you Satisfied with the level of job security provided by the restaurant	58.400[a]	3	0.000
EPF11	To what extent do you feel your workload is manageable within your regular working hours	43.040[a]	3	0.000
EPF12	Are you satisfied with the clarity of your job responsibilities and expectations	32.960[c]	2	0.000
EPF13	Do you feel stressed or overwhelmed by your job tasks	27.440[c]	2	0.000
EPF14	Are you Satisfied with the level of autonomy and decision-making authority you have in your role	80.800[a]	3	0.000
EPF15	To what extent does the restaurant provide opportunities for work-life balance	84.000[a]	3	0.000
EPF16	Are you satisfied with the support provided by the restaurant in terms of employee benefits (e.g., healthcare, vacation)?	86.240[a]	3	0.000
EPF17	Are you satisfied with the training and development opportunities provided by the restaurant?	79.520[a]	3	0.000
EPF18	Are you likely to recommend this restaurant as a good place to work to your friends or acquaintances	43.040[a]	3	0.000
EPF19	Are you satisfied with the level of employee recognition programs in the restaurant (e.g., Employee of the Month	46.240[a]	3	0.000
EPF20	Are you satisfied with the overall employee benefits package provided by the restaurant (e.g., insurance, retirement plans)	35.840[c]	2	0.000

Inference:

The Chi-Square analysis was conducted to examine the association between various dimensions of job satisfaction and specific demographic variables in Indian restaurants in Riyadh, Saudi Arabia. The results indicate significant associations across multiple dimensions of job satisfaction, highlighting key areas for

improvement.

Firstly, the overall work environment (EPF1) shows a strong association with job satisfaction ($\chi^2 = 73.760$, $p < 0.001$), suggesting that enhancing the physical and cultural aspects of the workplace can significantly boost employee satisfaction. Similarly, the feeling of being valued and appreciated (EPF2) is strongly linked to job satisfaction ($\chi^2 = 105.200$, $p < 0.001$), emphasizing the importance of recognition programs in the workplace.

Opportunities for professional growth (EPF3) are also significantly associated with job satisfaction ($\chi^2 = 59.040$, $p < 0.001$). Providing adequate training and career advancement opportunities can therefore enhance employee satisfaction. Effective communication between management and employees (EPF4) is another critical factor ($\chi^2 = 73.440$, $p < 0.001$), indicating that improving communication channels can lead to higher satisfaction levels.

Support from supervisors (EPF5) ($\chi^2 = 67.040$, $p < 0.001$) and the effective utilization of employees' skills and abilities (EPF6) ($\chi^2 = 34.080$, $p < 0.001$) are crucial for job satisfaction. Ensuring fair distribution of workload (EPF7) ($\chi^2 = 90.400$, $p < 0.001$) and providing recognition for achievements (EPF8) ($\chi^2 = 40.160$, $p < 0.001$) are also significant, highlighting the need for equitable task assignments and acknowledgment of employee efforts.

Promoting teamwork and collaboration (EPF9) ($\chi^2 = 51.680$, $p < 0.001$) and ensuring job security (EPF10) ($\chi^2 = 58.400$, $p < 0.001$) are important for job satisfaction. Manageable workload (EPF11) ($\chi^2 = 43.040$, $p < 0.001$) and clarity of job responsibilities (EPF12) ($\chi^2 = 32.960$, $p < 0.001$) are also associated with higher satisfaction, indicating that clear and reasonable expectations are crucial.

Stress levels (EPF13) ($\chi^2 = 27.440$, $p < 0.001$), autonomy and decision-making authority (EPF14) ($\chi^2 = 80.800$, $p < 0.001$), and work-life balance (EPF15) ($\chi^2 = 84.000$, $p < 0.001$) significantly affect job satisfaction. Adequate support in terms of employee benefits (EPF16) ($\chi^2 = 86.240$, $p < 0.001$) and training opportunities (EPF17) ($\chi^2 = 79.520$, $p < 0.001$) are also crucial factors.

Lastly, the likelihood of recommending the restaurant as a good place to work (EPF18) ($\chi^2 = 43.040$, $p < 0.001$), satisfaction with recognition programs (EPF19) ($\chi^2 = 46.240$, $p < 0.001$), and the overall benefits package (EPF20) ($\chi^2 = 35.840$, $p < 0.001$) are all significantly associated with job satisfaction.

In conclusion, the Chi-Square analysis reveals that various dimensions of job satisfaction are significantly associated with specific demographic variables. By focusing on improving these areas, such as enhancing the work environment, recognition programs, communication, professional growth opportunities, and support from supervisors, Indian restaurants in Riyadh can enhance job satisfaction and consequently improve employee performance.

11. RECOMMENDATIONS OF THE STUDY:

Based on this study's findings, several recommendations can be made to enhance job satisfaction and, consequently, employee performance in Indian restaurants in Riyadh, Saudi Arabia. These recommendations aim to address the key areas identified through the analysis as significantly impacting job satisfaction.

- Improve the physical and cultural aspects of the workplace to create a more pleasant and supportive environment. This includes maintaining cleanliness, ensuring safety, and fostering a positive work culture.
- Develop and implement structured recognition programs to regularly acknowledge and reward employees' contributions and achievements. This can include initiatives such as Employee of the Month, performance bonuses, and public recognition ceremonies.
- Offer continuous training and development programs to help employees enhance their skills and advance their careers. This could include workshops, certifications, and opportunities for promotion within the organization.
- Establish clear and effective communication channels between management and employees. Regular meetings, feedback sessions, and an open-door policy can help ensure that employees feel heard and valued.
- Monitor and manage the distribution of workload to ensure it is fair and equitable. Implement systems to regularly assess workload balance and make adjustments as needed to prevent burnout and dissatisfaction.
- Encourage supervisors and managers to provide consistent support and guidance to their team members. This can include regular check-ins, mentoring, and providing resources to help employees succeed in their roles.
- Foster a collaborative work environment where teamwork is encouraged and valued. Team-building activities, collaborative projects, and a culture of mutual support can enhance job satisfaction.
- Provide clear communication about job stability and future opportunities within the organization. This can include transparent policies about job roles, performance expectations, and career paths.
- Review and enhance the employee benefits package to include comprehensive healthcare, retirement plans, and other perks that support employees' well-being and work-life balance.
- Empower employees by giving them more control over their work and decision-making processes. This can lead to higher job satisfaction as employees feel trusted and valued for their expertise.
- Implement policies that support work-life balance, such as flexible working hours, the ability to work from home when possible, and sufficient vacation time.
- Assess employee satisfaction regularly through surveys and feedback mechanisms to identify areas for improvement and measure the impact of implemented changes.

12. CONCLUSION:

This study has explored the critical relationship between job satisfaction and employee performance within Indian restaurants in Riyadh, Saudi Arabia. Through a comprehensive analysis, it has been established that various dimensions of job satisfaction, such as work environment, recognition, professional growth opportunities, communication, and support from supervisors, significantly influence employee performance. The findings highlight the importance of addressing these areas to enhance overall job satisfaction, which in turn can lead to improved performance, higher employee retention, and greater organizational success. By implementing targeted strategies based on these insights, restaurant managers can create a more motivating and supportive work environment that not only satisfies employees but also drives the business forward. Ultimately, this research underscores the vital role of job satisfaction in the hospitality industry and provides actionable recommendations for fostering a positive and productive workplace.

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Adapting to Change: The Role of Work-Life Balance Initiatives in Enhancing Employee Productivity in the IT Sector"- A Systematic Review

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ABSTRACT

The influence of work-life balance initiatives, including wellness programs, flexible work schedules, and shortened workweeks, on employee productivity in the IT industry is examined in this systematic study. Given the growing need for innovation and changing workplace conditions, these programs are essential for promoting long-term productivity and taking care of workers' well-being. In order to evaluate how alternative schedules, such as the four-day workweek, mental health assistance, and remote and hybrid work models affect organizational outcomes and employee happiness, the study synthesizes findings from several studies.

In order to ensure that professional objectives and employee well-being are in line, the findings emphasize the importance of including comprehensive, flexible techniques that are suited to the particular requirements of the IT industry. The long-term impacts of these programs and their scalability across many industries are encouraged to be examined in future studies.

KEYWORDS *: Work-life balance, 4-day workweek, Remote work, Wellness programs, IT sector work arrangements.*

INTRODUCTION

The need to maintain competitive performance while ensuring employee well-being has made work-life balance a top priority for IT companies. Flexible work arrangements, wellness initiatives, and innovative scheduling techniques such as four-day workweeks have become essential for sustainable productivity. As industries adapt to rapid technological advancements, a systematic review of these initiatives reveals their impact on organizational outcomes and employee experiences.

Flexible work arrangements, including remote and hybrid models, have redefined workplace productivity and engagement. Studies highlight the benefits of remote work in improving work-life balance by reducing commute stress and increasing autonomy. However, these models also present challenges such as increased stress due to blurred work-life boundaries. Agile teams adapted by shortening sprint durations and streamlining meetings, maintaining productivity despite structural changes. Strong digital tools and clear communication remain critical for mitigating remote work's drawbacks.

Literature Review

Workplace support systems, such as wellness programs and mental health initiatives, have proven effective in fostering work-life balance. Marek et al. (2021) found that structured wellness initiatives, including stress management programs and mental health services, significantly enhanced job satisfaction and reduced burnout. Similarly, Neumann et al. emphasized that

these programs create a positive workplace culture, improving employee well-being and retention.

The adoption of reduced workweeks, like the four-day model, has been transformative. Studies by Tellier, Fontinha, and Hung demonstrate that such schedules enhance focus, reduce fatigue, and boost productivity by allowing additional time for rest and personal pursuits. In the IT industry, where innovation is crucial, these benefits are particularly valuable. However, compressed schedules also introduce challenges, such as increased workload intensity, necessitating strategic planning to avoid burnout. Agile teams successfully navigated these challenges by prioritizing essential tasks and utilizing collaborative digital tools.

OBJECTIVE

a) "To assess the impact of flexible work arrangements (remote and hybrid) on employees' ability to achieve a balanced work-life dynamic."

b) "To evaluate the effectiveness of workplace support systems, including wellness programs and mental health initiatives, in fostering work-life balance."

c) "To investigate whether reduced workweeks or shorter hours enhance work-life balance while maintaining organizational performance."

RESEARCH METHODOLOGY

A systematic literature review (SLR) methodology is used in this study to examine how work-life balance programs affect worker productivity in the IT industry. The SLR method works especially well when combining results from various studies to address the goals fully. In accordance with accepted standards for systematic reviews, the methodology is set up to guarantee an open, repeatable, and thorough approach.

HYPOTHESIS

Employee Productivity and Work-Life Balance:

Null Hypothesis (H_0)

Flexible work schedules, workplace support systems, and shorter workweeks have no significant impact on employee productivity and work-life balance in the IT industry.

Alternative Hypothesis (H_1)

Flexible work schedules, workplace support systems, and shorter workweeks significantly improve employee productivity and work-life balance in the IT industry.

Mental Health and Wellness Initiatives:

Null Hypothesis (H_0)

Implementing mental health and wellness initiatives has no significant effect on reducing employee stress levels or raising job satisfaction in the IT industry.

Alternative Hypothesis (H_1)

Implementing mental health and wellness initiatives significantly reduces employee stress levels and raises job satisfaction in the IT industry.

RESEARCH DESIGN

The study uses a descriptive and qualitative research design to examine the body of research on decreased workweeks, workplace support systems, and flexible work arrangements. With an emphasis on evidence-based results from earlier research, this design enables a thorough understanding of how these initiatives affect work-life balance and organizational success.

DATA COLLECTION

A thorough search of scholarly databases including Scopus, Springer, PubMed, IEEE Xplore Research Gate, Google Scholar, and Sci-space was used to find pertinent research papers, case studies, and reports. Relevant research was retrieved using keywords like "work-life balance," "four-day workweek," "remote work," "employee productivity," "mental health initiatives," and "IT sector workplace practices." A total of thirty-five articles were examined.

Article Inclusion criteria

Criteria	Description
Type of article	Research-based article
Time Frame	2005-2024
No of article	35
Language	English
Keywords	work-life balance, 4-day workweek, remote work, wellness programs, and IT sector work arrangements

Exclusion Criteria

Studies Unrelated to IT business: Because the IT business has distinct features like highly flexible workflows, a reliance on digital tools, and a strong emphasis on efficiency and innovation, this research focuses especially on work-life balance initiatives within the IT sector. To preserve the findings' specificity and relevance to the IT domain, studies carried out in unrelated businesses were disregarded.

Articles on Other Industries That Don't Concern Work-Life Balance ModelsThe research focused on sectors and studies that directly discussed models applicable to IT environments, even though work-life balance programs are implemented in numerous industries.

Screening and steps

1) Searched relevant academic articles using databases like Google Scholar, Research Gate, and Sci-Space, focused on the work-life balance of IT sector
2) Utilized skimming techniques to quickly assess articles, focusing on abstracts, conclusions, and relevance to research.
3) Defined clear inclusion criteria that aligned with research objectives, and applied them to narrow down the data.
4) Synthesized the selected articles by extracting and combining key insights, trends, and findings that contribute to understanding the evolution of employee experience and preferences.
5) Presented the synthesized results in a structured manner, outlining the key themes, implications for future workplaces, and how they aligned with the research.

DATA ANALYSIS

Hypothesis	Proof/Results
Flexible Work Schedules and Shorter Workweeks	Improved productivity (40% in Microsoft Japan), better focus, reduced fatigue, and enhanced work-life balance.
Workplace Support Systems	Reduced absenteeism, higher satisfaction (e.g., 4.76/5 in Infosys HALE), increased morale and engagement.
Mental Health Initiatives	Lowered stress levels (5x increase in EAP use at Accenture), higher satisfaction and loyalty.

Hypothesis 1: The first hypothesis states that shorter workweeks, workplace support systems, and flexible work schedules greatly increase worker productivity and work-life balance in the IT sector.

Proven: There is evidence in favor of the alternative hypothesis (H_1).

Research on remote work models, Infosys's HALE program, and Microsoft Japan's 4-day workweek trial have all shown quantifiable increases in worker well-being, job satisfaction, and productivity.

Hypothesis 2: In the IT sector, implementing mental health and wellness programs dramatically lowers employee stress levels and improves job satisfaction.

Proven: There is evidence in favor of the alternative hypothesis (H_1).

The idea was validated by programs like as Accenture's EAP, Tech Mahindra's Mind Plan, and TCS's Purpose4Life, which demonstrated notable decreases in stress levels and improvements in employee happiness.

The null hypotheses (H_0), which postulate that these initiatives have no discernible effect, were disproved in both instances.

Findings on Work-Life Balance and Organizational Performance

Impact of Flexible Work Arrangements on Work-Life Balance

Hybrid work environments positively influence employees' ability to balance professional and personal obligations. Vanitha and Shailashri (2023) found that Karnataka IT workers benefited from hybrid models' flexibility, enhancing work-life balance. While remote work promotes autonomy, it also risks boundary dissolution and longer work hours, leading to burnout (Balabanova & Molchanova, 2022). Santillan et al. (2023) noted that hybrid models enhance team cohesion through periodic in-office collaboration. Digital tools like virtual platforms play a crucial role in sustaining communication and productivity (Martin &

MacDonnell, 2021). Companies offering flexible work arrangements saw increased engagement and lower attrition rates (Vyas & Butakhieo, 2020), as employees valued scheduling flexibility, improving job satisfaction and retention.

Effectiveness of Workplace Support Systems in Enhancing Work-Life Balance

Employee Assistance Programs (EAPs) have significantly improved workplace support. Accenture's AI-based self-care initiatives increased EAP utilization fivefold, reducing mental health stigma (Joseph & Monteiro, 2022). Infosys' HALE program, serving over 150,000 employees, scored 4.76/5 in satisfaction for its comprehensive well-being focus (Infosys ESG Report 2021–22). Wipro's initiatives addressing financial, emotional, and physical health improved engagement and productivity (Wipro Integrated Annual Report 2021–22). TCS's Purpose4Life, involving 22,000 volunteers, fostered job satisfaction through community engagement (TCS Annual Report 2021–22). Tech Mahindra's wellness initiatives, including virtual support and bereavement policies, achieved a 4.7/5 engagement satisfaction rating (Tech Mahindra Integrated Annual Report 2021–22). These programs demonstrate the positive impact of workplace wellness strategies on employee morale and retention.

Impact of Reduced Workweeks on Work-Life Balance and Performance

Studies indicate that reduced workweeks significantly boost job satisfaction. Hemashree et al. found 77% of IT employees supported a 4-day workweek, citing better well-being and work-life balance. Agile software teams also benefited from shorter commutes and flexible scheduling (Topp et al.). Although reduced social interactions were a drawback, employee engagement and productivity remained stable. Companies optimized workflows by compressing sprints and streamlining meetings (Topp et al.). The shortened workweek led to operational cost reductions by decreasing office maintenance and utilities (Hemashree et al.).

CONCLUSION

This study looked into how employee productivity in the IT sector was affected by work-life balance strategies like health programs, flexible work schedules, and shorter work weeks. The results showed that by giving workers more freedom and cutting down on commuting times, flexible work arrangements—like remote and hybrid models—significantly improved work-life balance and job satisfaction. The need for proactive measures to preserve organizational culture is highlighted by the difficulties these models also brought about, such as decreased social interaction and team cohesion. Employee assistance programs, health examinations, and mental health initiatives are examples of workplace wellness programs that have been shown to increase job satisfaction, decrease stress, and decrease absenteeism. They also help employees feel valued and cared for, which increases engagement and productivity. Additionally, by lowering stress and boosting cognitive flexibility, reduced workweeks—like a 4-day schedule—maintained or even improved performance, with employees reporting higher levels of creativity and contentment. Although sectors that need continuous operations may encounter implementation issues without sacrificing service quality, organizations also profit from cost savings.

In summary, when implemented correctly, work-life balance initiatives provide significant advantages to employers and workers alike, promoting well-being, productivity, and engagement. Success requires comprehensive plans that are in line with business objectives and customized to the needs of employees.

LIMITATIONS AND CHALLENGES

A thorough search for pertinent studies

Finding and retrieving pertinent studies is a major challenge in systematic literature research. Finding the appropriate sources that support your study goals can be time-consuming because the issue encompasses a variety of topics, including work-life balance, employee productivity, wellness initiatives, and the dynamics of the IT sector.

To find the studies that are most pertinent to your research, you must search through a variety of databases (such as Google Scholar, JSTOR, and Scopus) and use strict inclusion/exclusion criteria. Furthermore, research may be dispersed throughout several fields, which makes it difficult to assemble an extensive and pertinent collection of publications. Including recent

research or concentrating on particular industries, such as the IT sector, makes this task more difficult.

Integration and Synthesis of Data

It can be difficult to integrate and synthesize the data from several research publications once the studies have been chosen. In order to measure important topics like organizational success, work-life balance, and employee productivity, studies frequently use multiple metrics or provide results in alternative forms. For instance, although some studies use corporate performance metrics or employee satisfaction surveys, others may report productivity as output per hour.

Disparities in how important concepts like "work-life balance" or "employee engagement" are defined might cause misunderstandings and make it harder to compare results.

To ensure consistency in the way data is compared across research, this diversity necessitates the development of a consistent framework for data synthesis.

Restricted Access to Complete Texts or Information

It can be quite difficult to obtain full-text versions of scholarly publications or proprietary data. The retrieval of many publications may be restricted by paywalls or necessitate institutional access. The scope of your evaluation may be constrained as a result of your inability to access all pertinent material on your subject. Although this problem might be lessened by using resources like Google Scholar, ResearchGate, or the library at your university, some sources can still not be available.

FUTURE RESEARCH SCOPE ON WORK LIFE BALANCE IN IT SECTOR

1. Exploring the Impact of Work-Life Balance on Diverse Demographics Future studies should examine the effects of work-life balance initiatives on a variety of employee categories, with an emphasis on how wellness initiatives or flexible work schedules might meet the requirements of particular groups. Research might examine, for instance, how working remotely benefits parents as opposed to single workers or how younger workers' expectations of job flexibility vary from those of older generations. Further insights into how multinational corporations could modify their policies to accommodate a range of employee needs can also be gained by looking at how different cultures see work-life balance.
2. Comparative Studies Across Industries Comparative studies across various industries (such as IT versus healthcare or IT against retail) may be able to identify opportunities and challenges unique to a certain business when it comes to putting work-life balance initiatives into practice. Such research may examine how employees across different industries view and react to health efforts, remote work, and flexible work schedules, as well as how these practices have varying effects on employee happiness and performance.

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GREEN MARKETING IN THE 21ST CENTURY: TRENDS, STRATEGIES, AND CONSUMER BEHAVIOR

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ABSTRACT

As people become more aware of environmental issues like climate change, pollution, and the depletion of natural resources, the way they view products and services has changed. Because of this, **green marketing—**which involves promoting products or services for their environmental benefits—has become an important strategy for businesses that want to connect with eco-conscious consumers and meet the growing demand for sustainable products. This paper looks at green marketing in the 21st century, focusing on the latest trends, business strategies, and changes in consumer behavior towards eco-friendly products. By reviewing industry examples and research, the paper explores what is driving the rise of green marketing, how it affects business performance, and the challenges companies face in dealing with sustainability issues.

1) INTRODUCTION

In the 21st century, businesses are under more pressure to adopt sustainable practices and respond to growing concerns about environmental issues. As problems like climate change, pollution, and resource depletion become more urgent, consumers are paying more attention to the environmental impact of their products. This shift in what consumers care about has led to the growth of green marketing, which focuses on promoting eco-friendly products and sustainable business practices. Green marketing reflects these changing values and allows businesses to innovate, stand out in the market, and build customer loyalty over time.

This paper examines the current state of green marketing by examining trends, strategies, and consumer behavior that are driving the growth of sustainable marketing practices. By analyzing business strategies and consumer attitudes, the paper provides insights into how well green marketing works and the challenges companies face when adopting and communicating sustainable practices.

Objectives

1. To study the current status of green marketing.
2. To identify barriers to the adoption of green marketing.
3. To discuss the future growth of green marketing.
4. To provide insights for businesses on aligning with sustainability.

2) THE RISE OF GREEN MARKETING

Green marketing has changed a lot over the past few decades. The term became more popular in the 1980s as environmental issues started to get more attention worldwide. In the beginning, green marketing mainly focused on product innovations, like using biodegradable

packaging, creating energy-efficient appliances, and using recycled materials. As environmental concerns became more important, green marketing expanded to include things like **corporate social responsibility (CSR)**, being transparent about the supply chain, and adopting sustainable business practices.

2.1 Evolution of Green Marketing

In the late 20th century, important works like Jacquelyn Ottman's *The Green Consumer Guide* (1990) helped shape early green marketing strategies. The **Brundtland Report** (1987), which introduced the idea of **sustainable development**, also gave businesses a guide for adding environmental concerns into their plans. This shift toward sustainability grew stronger as consumers started demanding more environmentally responsible products, especially in industries like energy, transportation, and everyday consumer goods.

By the 21st century, the focus of green marketing shifted from just offering eco-friendly products to a broader approach. Now, companies are working to include sustainability in all areas of their business, from how they manage their supply chains to the design of their products and the way they communicate their values to customers.

2.2 Green Marketing in the Digital Age

With the growth of digital media and online shopping, green marketing has adapted to new platforms. Social media has become a key tool for businesses to share their sustainability efforts directly with consumers. On platforms like Instagram, Twitter, and Facebook, companies can quickly update people about their eco-friendly actions and create communities of consumers who share similar values. Also, the internet makes it easier for consumers to compare the environmental impact of different products, which has increased the demand for honest and transparent green marketing messages.

3) TRENDS IN GREEN MARKETING

Green marketing in the 21st century has been influenced by several important trends that show how much sustainability matters in many industries. These trends show how businesses are including environmental concerns in their marketing to attract consumers who care about the planet.

3.1 Increased Focus on Sustainability Across Industries

In recent years, sustainability has gone beyond just industries like renewable energy and organic farming to impact nearly every sector. From cars to clothing and technology, more businesses are making sustainability a key part of their products and marketing. For example:

- **Automotive Industry**: Companies like **Tesla** and **BMW** have been at the forefront of promoting electric vehicles (EVs) as a cleaner alternative to traditional gasoline-powered cars. They market EVs not just for their advanced technology, but also for their positive environmental benefits, such as reducing carbon emissions and increasing energy efficiency.
- **Fashion Industry**: The fashion industry has often been criticized for its negative environmental impact. However, brands like **Patagonia** and **Everlane** are changing this by using recycled materials and supporting fair labor practices. Their green marketing focuses on being transparent about their operations and sourcing ethically, appealing to consumers who care about both environmental and social issues.

3.2 Rise of Eco-Labels and Certifications

A key trend in green marketing is the growing use of eco-labels and certifications. More and more, consumers want proof from trusted third parties that a product is truly environmentally friendly. Certifications like Energy Star, Fair Trade, and Forest Stewardship Council (FSC) help businesses build trust with eco-conscious shoppers.

For example, The Body Shop uses the Fair Trade certification to show its dedication to ethical sourcing and sustainability. Similarly, Nestlé has added eco-labels to some of its products, highlighting their efforts to reduce environmental impact through better sourcing and packaging.

3.3 Emphasis on Circular Economy and Waste Reduction

Another big trend in green marketing is the focus on the circular economy. This is a system where businesses aim to reduce waste, reuse materials, and recycle products once they are no longer in use. Companies are creating products that are built to last, can be repaired, and can be recycled, which appeals to environmentally conscious consumers.

For example, IKEA follows circular economy principles by offering take-back programs for old products and using recycled materials in their items. By promoting these efforts, businesses help reduce waste and attract customers who care about the environmental impact of what they buy

3.4 Integration of Corporate Social Responsibility (CSR) in Marketing

Corporate Social Responsibility (CSR) is now a key part of green marketing. Companies that take part in CSR activities—like supporting the environment, ensuring fair labor practices, and cutting down on their carbon emissions—often highlight these efforts in their marketing to show they are serious about sustainability.

For example, Unilever has made CSR a big part of its brand. Through its Sustainable Living Plan, Unilever focuses on sustainable sourcing, reducing waste, and improving health and well-being. These efforts are central to how the company promotes itself as an environmentally and socially responsible brand.

4) GREEN MARKETING STRATEGIES

To successfully market eco-friendly products, businesses need to use strategies that connect with consumers and clearly show their dedication to sustainability. Here are some key strategies used in green marketing:

4.1 Product Innovation and Eco-Friendly Packaging

A key strategy in green marketing is creating eco-friendly products that meet consumer demand for sustainability. This includes energy-saving appliances, organic foods, and environmentally friendly clothing.

Along with new product ideas, companies are also focusing on using sustainable packaging. Brands like Lush Cosmetics and Coca-Cola are leading the way by using recyclable or biodegradable materials to cut down on waste. For example, Coca-Cola's PlantBottle is made from plant-based materials, showing how companies can innovate packaging to meet consumer expectations for sustainability.

4.2 Green Advertising and Communication

Green advertising is about promoting eco-friendly products by highlighting their sustainability features in marketing campaigns. To be effective, green advertising needs to be

clear, honest, and transparent to avoid greenwashing—making false claims about a product's environmental benefits.

For example, Apple promotes its products by focusing on their environmental sustainability, like using recycled aluminum and renewable energy in production. Apple's ads highlight its efforts to reduce its carbon footprint and use more sustainable materials

4.3 Building Brand Loyalty Through Sustainability

One of the long-term benefits of green marketing is that it helps build brand loyalty. Consumers who care about sustainability are more likely to stick with brands that share their values. For example, Patagonia has built a loyal following by showing its commitment to environmental and social responsibility. Through initiatives like Worn Wear, which promotes reusing and repairing clothes, and its efforts to protect public lands, Patagonia connects with customers who value sustainability.

4.4 Transparency and Third-Party Verification

Transparency is key for businesses in green marketing. Companies that give clear and trustworthy information about the environmental impact of their products are more likely to gain consumer trust. Third-party certifications and eco-labels are helpful because they verify a company's claims and assure customers that the company's green efforts are genuine.

5) CONSUMER BEHAVIOR AND GREEN MARKETING

Understanding consumer behavior is essential for businesses that want to use green marketing effectively. As environmental concerns grow, many consumers are willing to pay more for products that are sustainably sourced, energy-efficient, or made from recycled materials. Recognizing this shift can help businesses create products and marketing strategies that appeal to eco-conscious shoppers.

5.1 Factors Driving Green Consumerism

Several factors are driving the growing demand for green products:

- **Environmental Awareness**: As more people become aware of global environmental issues, they are paying closer attention to the ecological impact of their purchases.
- **Health Concerns**: Many consumers believe that green products, such as organic food and non-toxic personal care items, are healthier and safer for both themselves and the environment.
- **Social Influence**: Social media, celebrity endorsements, and the influence of peers have all played a big role in encouraging consumers to choose eco-friendly products.

5.2 Barriers to Green Consumption

Despite the increasing demand for green products, there are still some barriers:

- **Price**: Green products often cost more, which can discourage price-sensitive consumers from buying them.
- **Lack of Information**: Many consumers find it hard to tell which products are truly sustainable due to misleading labels or not enough clear information.
- **Convenience**: Some eco-friendly products may be harder to find or less convenient to use, making it harder for them to gain widespread popularity.

6) FUTURE GROWTH OF GREEN MARKETING:

Green marketing will grow as more people want eco-friendly products and businesses face stricter environmental rules. Consumers, especially younger ones, care about sustainability and expect companies to be honest about their efforts. As new green technologies and ways to reuse and recycle products emerge, businesses will focus more on these in their marketing. Companies embracing sustainability will stand out, while those that fake it will face backlash. In the future, being eco-friendly will be a key part of a business's identity and offer long-term growth.

CONCLUSION

Green marketing has evolved from a niche idea to a mainstream business strategy in the 21st century, driven by rising consumer demand for sustainable products and corporate responsibility. As trends like sustainability, the circular economy, and Corporate Social Responsibility (CSR) continue to grow, businesses need to adopt transparent and innovative marketing strategies to connect with eco-conscious consumers.

While challenges like higher prices, consumer education, and the risk of greenwashing remain, the future of green marketing looks bright. Companies that genuinely commit to sustainability will likely gain a competitive edge. By responding to the increasing demand for environmentally responsible products and practices, businesses can enhance their brand value and play a role in building a more sustainable global economy.

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Customer Relationship Management in Hotel Industry with Indian Perspectives

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ABSTRACT

Service organizations worldwide have been trailblazers in crafting effective customer retention strategies, recognizing that long-term survival and competitive advantage depend on establishing an emotional connection with customers. Customer Relationship Management (CRM) serves as a database management system aimed at identifying, attracting, developing, and maintaining strong customer relationships. By enhancing customer experiences, CRM facilitates both customer acquisition and retention.

This study focuses on analyzing the impact of CRM implementation on organizational performance within the hotel industry, along with the factors that contribute to making CRM more effective. The research adopts an exploratory approach, with data collected through a self-designed questionnaire comprising ten parameters to assess organizational performance. The study utilized a 5-point Likert scale to gather responses. A convenience sampling technique was applied, focusing on 20 managers who had experience staying in 3-star and 5-star hotels located in Pune and Mumbai. The data collected was evaluated using the percentage analysis method.

Through a critical and creative review of research papers and articles, thirteen key factors were identified as essential for enhancing CRM effectiveness. The findings indicate that CRM significantly improves both qualitative and quantitative aspects of organizational performance.

The hotel industry is a rapidly growing sector in India. CRM not only helps organizations strengthen their brand equity but also plays a significant role in boosting the country's GDP and elevating the global standing of its hospitality sector.

KEYWORDS *: Customer relationship management, Hospitality sector, Organization performance, Factors of CRM.*

INTRODUCTION

Customer Retention Strategies in Service Organizations

Service organizations worldwide have led the way in crafting innovative strategies to improve customer retention. For example, airlines introduce regular flyer agendas to reward loyal customers, banks assign dedicated relationship managers to premium clients, telecom operators create customized plans for high-value users, and hotels provide personalized services to accommodate repeat guests. Long-term survival and competitive advantage in any business are strongly linked to the establishment of emotional connections with customers. This shift from marketing to large, anonymous customer bases to fostering relationships with identified or semi-identified customers marks a significant transformation (Gronroos).

On average, businesses invest six times more on gaining new customers than they do in retaining their current customers (Gruen). Bain & Company further highlights that a 5% increase in customer retention can result in a profit growth of 25% to 100% across multiple industries. Therefore, retaining customers is critical for businesses to thrive. Building strong, enduring relationships between organizations and their customers is essential for mutual benefit and sustainability. Without harmonious relationships with stakeholders, no business can sustain itself. Customers are the lifeblood of any organization, providing revenue and profitability, and thus, profitable Customer Relationship Management (CRM) is a top priority.

CRM serves as a database management system that aids in identifying, attracting, developing, and maintaining successful customer relationships by enhancing their experiences. Studies indicate that customers with emotional commitments to a brand or service provider are significantly more likely to maintain long-term relationships than those with purely calculative commitments (Wetzels et al.). Emotionally satisfied customers develop a deep sense of association and loyalty toward a brand.

Growth of the Tourism Sector in India

India's tourism sector has witnessed significant growth in recent years. From 2006 to 2011, the Compound Annual Growth Rates (CAGRs) for Foreign Tourist Arrivals (FTA) and Foreign Exchange Earnings (FEE) in rupee terms were 7.2% and 14.7%, respectively. In 2010, India recorded 5.78 million foreign tourist arrivals, an 11.8% growth over the 5.17 million arrivals in 2009. This growth was considerably greater than the worldwide expansion rate of 6.5% in that year. Moreover, foreign exchange revenues from tourism in 2010 soared to ₹64,889 crore (US$12.08 billion), representing an 18.1% rise from ₹54,960 crore (US$10.22 billion) in 2009. These numbers emphasize the vast potential of India's tourism and hospitality industry.

This study mainly investigates the effect of CRM adoption on the performance of businesses within the hotel sector and delves into the elements that improve CRM efficiency.

LITERATURE REVIEW

Berry (1983) was among the first to formally introduce the concept of Customer Relationship Management (CRM) in academic literature, though its principles had been discussed earlier. Bennett (1996) defined CRM as an approach focused on fostering enduring, dedicated, and collaborative relationships with customers. highlighting transparency, responsiveness, and fairness. It involves genuine concern for service quality and a readiness to focus on long-term benefits rather than short-term gains.

Schneider and Bowen (1999) emphasized that service-oriented businesses can attain customer retention and profitability by cultivating mutually beneficial relationships, that guarantee customer trust, equity, and self-respect. They contended that businesses should prioritize seeing customers as individuals before viewing them as consumers. Core elements of successful relationship-building include confidence, dedication, ethical standards, honoring commitments, reciprocal exchange, emotional connection, customization, and customer focus (Morgan, 1994; Levitt, 1986; Gronroos, 1994; Bejou et al., 1998; Gummesson, 1994).

Organizations must integrate customer-focused practices into all interactions that could influence customer perceptions of the relationship (Schneider and Bowen, 1999). Despite the importance of marketing in tourism and hospitality, it is frequently neglected or treated in an oversimplified manner. (Hannam, 2004). Morgan et al. (2002) noted that conventional tourism marketing emphasizes validating tourists' intentions instead of encouraging them to consider alternative experiences.

Tourism and hospitality have emerged as major economic drivers, reflecting evolving preferences for meaningful leisure activities (Bouchet et al., 2004). As tourist behavior evolves, new expectations and experiences drive change within the sector.

An empirical study was carried out to assess the effect of CRM implementation on organizational performance, emphasizing its pivotal role in the hotel industry.

RESEARCH OBJECTIVES

The current study was aimed at determining: -

1. The impact of customer relationship management implementation on the performance of the hotel industry (service sector).
2. The parameters on which performance of organization can be measured (quantitative as well as qualitative).
3. To analyze various factors that leverages the effectiveness of CRM.

Hypothesis is CRM implementation enhance the performance of Hotel Industry.

RESEARCH METHODOLOGY

The research is exploratory in nature. The data was collected by self-designing questionnaire. It consists of ten parameters to measure the performance of organization on 5 point likert scale.

The parameters for organizations' performance are

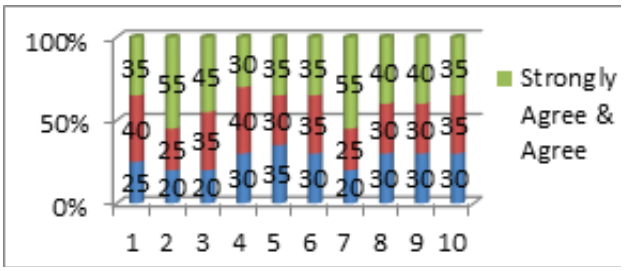
- CRM implementation enhanced the revenue,
- paved the way to attain customer satisfaction,
- improved productivity of my organization,
- increase market share,
- maximize stakeholder's Value,
- acquire new customers,
- enhanced for customer retention,
- new product sales,
- reduces overall cost of organization and
- Competitive advantage.

A Convenience sampling random of 20 Managers, with experience of staying in the Hotels(3 or 5 star) in Pune and Mumbai, was taken for conducting the survey. Percentage method have been applied for analysis.

The factors require being more emphasis to enhance CRM effectiveness are analyzed by critical and creative analysis of research paper and articles.

ANALYSIS AND FINDINGS

Table 1



For analysis two extreme point of scale have been summarized that is the percentage of managers having the opinion in favor of strongly agree or agree have been represented collectively by green color and managers having view in favor of strongly disagree or disagree have been represented collectively by blue color (See Table 1).Red represents the percentage of managers who are Neither agree nor disagree which can be considered as neutral point.

The variation between the two opinion i.e. strongly agree or agree and strongly disagree or disagree are compared for ten parameters of organizations' performance. It was observed that Managers with strongly agree or agree opinion having more percentage then with strongly disagree or disagree opinion.(See Table 2).

Table 2

OPINION	Revenue	Customer Satisfaction	Productivity	Market Share	Stakeholders Value	Acquire Customer	Customer Retention	New Product Sale	Cost Reduction	Competitive advantage
Strongly agree or Agree	35	55	45	30	35	35	55	40	40	35
Strongly disagree or Disagree	25	20	20	30	35	30	20	30	30	30
Variation	10	30	25	Nil	Nil	5	35	10	10	5

Note : variation in %

Thus, Hypothesis is accepted that CRM implementation enhances the performance of Hotel Industry.

Major Findings and Suggestions

The outcome of study deliberately focuses on factors essential for success of CRM are :

- Value proposition,
- Customer perceived Value,
- Service professionals are reliable to company,
- service professional are very enthusiastic to serve customers,
- strong internal branding,
- organization is popular for its ethics(credibility),
- customized service,
- personalized service,
- positive body gestures of service providers,
- Complaint Management,
- interaction of senior managers with customers to assess service performance,
- an incentive for being loyal to the firm and
- Self-esteem of guests needs to be recognized and acknowledged at every stage in the service operations.

Sample collection is restricted to Pune and Mumbai region only 3 or 5star Hotels.

CONCLUSION

CRM helps to enhance qualitative as well as quantities performance of organization. As customers are lifeblood of every organization it is essential for organization to built emotional relation to retain and acquire new customers and CRM is key player for this process. Hotel Industry is booming sector in India so CRM just not only helps organization to built brand equity but also contributes in GDP of India and international image construction of hospitality sector.

The further study can be conducted on analyzing the weightage of various factors and the way factors are correlated with software selection for hotel industry.

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PUBLICATIONS IN ABDC LISTED JOURNALS

Sr. No	Name of Faculty	Title of Research Paper	Name of the Journal	Month & Year	ISSN	Volume & Issue
1	Prof. Dr. S. B. Sawant	Impact of Professional Development Programs on Academic Performance of Secondary School Teachers	Journal of Informatics Education and Research	2024	1526-4726	4(2)
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Impact of Professional Development Programs on Academic Performance of Secondary School Teachers

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Abstract

The complex relationship between professional development programs and secondary school teachers' academic achievement is examined in this abstract. It clarifies how diverse professional development activities, such as workshops, seminars, coaching, and collaborative learning experiences, significantly boost teacher effectiveness and subsequently influence student results through a thorough assessment of the literature and empirical investigations. It draws attention to the ways in which these programs support advancements in teaching methods, including the enhancement of classroom management strategies, the augmentation of material knowledge, the refinement of instructional strategies, and the promotion of pedagogical innovations. It also emphasizes how important it is for educators to pursue ongoing professional development in order to foster a culture of lifelong learning, which will enable them to consistently improve the caliber of their instruction and the learning outcomes of their students. Contextual elements including leadership participation, institutional support, and the fit between professional development programs and curriculum objectives and academic standards are also taken into account in the research. The results highlight the value of focused and ongoing professional development initiatives in fostering secondary school teachers' competence and effectiveness, which in turn supports student achievement and academic success. With implications for teacher preparation, school improvement programs, and the creation of educational policies, this research adds to the larger conversation on educational policy and practice by shedding light on the complex effects of professional development programs on the educational environment.

Keywords: *Professional Development Programs, Teacher Training Programs, Group Projects, Academic Performance*

1. INTRODUCTION

Professional development programs, which are designed to improve instructors' abilities, expertise, and efficacy, have become vital elements of the educational environment (Kilag et al., 2023). The effect of these programs on teachers' capacities directly affects student results in the setting of secondary school, when students' academic achievement is of utmost importance (Choudhury et al., 2024). This introduction explores the importance of professional development programs and their complex impacts on secondary school teachers' academic performance, providing a thorough grasp of the subject by elaborating on important sub-points (Fairman et al., 2023) .

1.1. Significance of Professional Development Programs

Programs for professional development include a wide range of activities intended to help teachers improve their techniques of instruction, stay current with new pedagogical trends, and refine their practices as teachers (Khasawneh et al., 2023). These programs acknowledge that education is dynamic and that students' needs are always changing, which means that in order for teachers to successfully address these difficulties, they must continue to grow professionally. Skill development is the need of an hour to stay ahead in the competition (Gaikwad, 2014).

1.2. Influence on Teaching Practices

Improving teaching practices is one of the main ways that professional development programs affect secondary school teachers' academic achievement (Ni et al., 2023). Teachers can investigate cutting edge teaching methods, pick up new instructional methodologies, and expand their subject matter expertise through workshops, seminars, and cooperative learning experiences (Kilag et al., 2024).

1.3. Effectiveness in Classroom Management

In order to provide a supportive learning environment where kids can succeed academically, effective classroom management is essential (Ibda et al., 2023) Training sessions on student involvement, conflict resolution, and classroom management are frequently included in professional development programs (Bada et al., 2023). Giving teachers these abilities not only promote a more structured and disciplined classroom environment, but it also makes the most of class time, enabling pupils to achieve more academically (Özdemir et al., 2024).

1.4. Pedagogical Innovations and Curriculum Alignment

Initiatives for professional development make it easier to investigate and implement innovative teaching strategies that fit changing curriculum frameworks and requirements. Teachers are able to acquire knowledge about the best practices in curriculum development, assessment techniques, and differentiated instruction through focused training sessions and cooperative learning opportunities. Through the alignment of their pedagogical approaches with curriculum objectives and educational benchmarks, educators can proficiently scaffold student acquisition and enhance academic achievement (Gaikwad, 2016).

1.5. Research objectives

1. To evaluate the relationship between gains in students' academic performance and secondary school teachers' involvement in professional development programs
2. To determine the precise methods of instruction and classroom management that secondary school instructors pick up from professional development courses and how those methods affect the learning results of the students.

1.6. Hypothesis of the study

Hypothesis 1:

H0: There is no significant relationship between participation in professional development programs and the academic performance of secondary school teachers' students. Alternative H1: Participation in professional development programs is positively correlated with the academic performance of secondary school teachers' students.

Hypothesis 2:

H0: Secondary school teachers who do not engage in professional development programs demonstrate similar academic performance outcomes for their students compared to those who participate.

H1: Secondary school teachers who engage in professional development programs exhibit better academic performance outcomes for their students compared to those who do not participate.

2. LITERATURE REVIEW

Alwaely (2023) studied the intricate interplay among teacher evaluation, professional development, and student achievement, elucidating the indispensable role of systematic assessment in driving continuous improvement within educational contexts. Through their study, they underscore the transformative potential of teacher evaluation practices in nurturing ongoing growth among educators and subsequently enriching learning outcomes for students. By rigorously examining how teacher evaluation initiatives influence these interconnected variables, the authors shed light on the mechanisms that underpin effective teaching and learning processes. Their findings emphasize the significance of evidence-based evaluation practices in fostering a culture of continuous learning and improvement among educators, ultimately leading to enhanced academic engagement and achievement among students.

Smith and Gillespie (2023) analyzed the professional development and its impact on teacher change, particularly within the context of adult basic education. Their review provides a nuanced understanding of the complexities inherent in professional development initiatives tailored for adult educators. Through a comprehensive analysis of various approaches, methodologies, and outcomes, the authors elucidate the multifaceted nature of teacher learning and adaptation within the adult education landscape. By delving into diverse strategies employed in professional development programs, they highlight the importance of addressing the unique needs and challenges faced by adult educators, such as balancing instructional responsibilities with personal and professional obligations. Moreover, their exploration of the outcomes associated with these initiatives underscores the potential for professional development to catalyze positive changes in teaching practices, learner engagement, and ultimately, educational outcomes for adult learners. Through their meticulous examination, Smith and Gillespie contribute important bits of knowledge that can advise the plan and execution regarding powerful professional development programs custom-made to meet the particular necessities of grown-up instructors and students the same.

Kilag (2023) demonstrated the implications of Individual Plan for Professional Development (IPPD) on teachers' career advancement and professional growth, offering valuable insights gleaned from empirical investigation. By focusing on

personalized professional development plans, the authors underscore the significance of tailored approaches in addressing the diverse and evolving learning needs of educators. Through their study, Kilag et al. illuminate how personalized plans facilitate ongoing learning and skill enhancement among teachers, empowering them to refine their instructional practices, deepen subject matter expertise, and adopt innovative pedagogical approaches. Moreover, by aligning professional development goals with individual career aspirations and organizational objectives, IPPDs serve as strategic tools for facilitating career progression within the education sector. The authors' findings shed light on the transformative potential of personalized professional development plans in supporting teachers' continuous growth and advancement, ultimately contributing to the cultivation of a highly skilled and motivated workforce capable of driving educational excellence.

Muyunda (2023) provided a comprehensive examination of teachers' professional development in Zambia, offering valuable insights into the perceptions and practices prevalent within the local educational context. Through their research, the authors illuminate the multifaceted nature of professional development initiatives in resource-constrained settings, shedding light on the challenges, opportunities, and strategies inherent in enhancing teacher capacity and effectiveness. By delving into the perceptions of educators and stakeholders, Muyunda et al. underscore the contextual factors that shape professional learning experiences, including limited resources, infrastructural constraints, and socio-economic realities. Moreover, their study highlights the innovative approaches and adaptive strategies employed to overcome these challenges, emphasizing the importance of context-specific interventions in promoting meaningful professional growth and development among teachers. By situating their research within the Zambian educational milieu, the authors offer valuable perspectives that can inform the design and implementation of effective professional development programs tailored to meet the unique needs and circumstances of educators in similar resource-constrained contexts worldwide.

Patfield (2023) contributed significantly to the discourse on effective professional development by redirecting attention towards a case study of implementation, thereby offering nuanced insights into the dynamics of real-world professional development initiatives. Through their in-depth analysis, the authors unravel the intricate interplay between policy formulation, implementation practices, and stakeholder engagement within educational organizations. By examining the complexities and challenges encountered during the implementation process, underscore the critical importance of collaborative, sustained efforts in driving meaningful professional growth and systemic change. Their research highlights the need for alignment between policy objectives and on-the-ground realities, emphasizing the role of effective communication, resource allocation, and stakeholder buy-in in facilitating successful implementation. Moreover, their findings underscore the iterative nature of professional development initiatives, emphasizing the importance of continuous evaluation, adaptation, and improvement in fostering lasting impact within educational settings. Through their comprehensive analysis, Gore, and Harris provide valuable insights that can inform the design and implementation of future professional development programs, guiding educational stakeholders in their efforts to cultivate a culture of continuous learning and improvement within their organizations.

3. RESEARCH METHODOLOGY

3.1. **Research Design:** This study uses a quantitative research design, which entails gathering and analysing numerical data in an organized manner. This methodology facilitates the investigation of correlations among variables via statistical analysis.

3.2. **Research Approach:** The Correlational Method is used to investigate the connection between academic achievement of students and the involvement of secondary school teachers in professional development initiatives. This method does not suggest causation; instead, it focuses on determining whether certain variables are correlated.

3.3. **Sample Population**: The study's sample population, which consists of 145 Male and Female High School Teachers, is sourced from Solapur District of Maharashtra. In the district's schools, these educators are actively involved in instructing secondary level students. Participants must be actively teaching at the secondary level in order to meet the inclusion requirements, which ensures relevance to the study's secondary education focus. To ensure that the sample is in line with the goals of the study, exclusion criteria, on the other hand, are applied to instructors who are not actively employed as secondary educators. In order to provide a thorough analysis of the effects of professional development programs on secondary school teachers' academic performance and instructional strategies, this sample of instructors was chosen from a variety of schools in the Solapur District.

3.4. **Sample Size:** Statistical power analysis is used to determine the sample size for this study, which includes 145 high school teachers from the Solapur District of Maharashtra. This ensures the validity and reliability of the findings. The minimum sample size needed to find significant correlations between variables with the appropriate degree of precision and confidence can be found with the aid of statistical power analysis. The objective of this study is to reduce the likelihood of Type I and Type II errors by guaranteeing a sufficient sample size, which will improve the validity of the results. More precise estimations of the association between instructors' involvement in professional development programs and students' academic achievement can be

obtained from the study with a suitably large sample size, allowing for the drawing of more certain and broadly applicable findings.

3.5. **Sample Techniques:** Random sampling techniques are used to pick participants for this study, which focuses on high school teachers in the Solapur District of Maharashtra. This ensures that any teacher, male or female, has an equal chance of being chosen. Furthermore, stratified sampling can be applied to improve representativeness by grouping the sample according to pertinent factors such as the size of the school or its location within the district. Through the use of these selection strategies, the study hopes to gather a representative and varied sample of high school teachers from the Solapur District, enabling a thorough analysis of how professional development programs have affected their instructional strategies and academic achievement.

3.6. Variables of the Study

- **Independent Variables:** Professional development programs are essential to instructors' ongoing professional development and skill improvement. Workshops are concentrated learning opportunities for educators to focus on certain subjects or areas of interest, such introducing innovative teaching methods or making good use of educational technology. Teachers can participate in conversations and learn from subject-matter experts at seminars, which helps them get a broader awareness of the methods and trends in education today. Teacher Training Programs provide organized learning opportunities aimed at enhancing teaching techniques, classroom organization tactics, and evaluation procedures. These programs give educators the instruments and materials they require to improve their efficacy in the classroom. Group projects help educators work together more effectively by facilitating the sharing of ideas, materials, and best practices. Teachers can benefit from one other's experiences and add to the overall development and enhancement of teaching practices within their school community by cooperating on common objectives or projects.
- **Dependent Variables:** Academic performance includes a range of learning outcomes including student achievement. Effective teaching requires teachers to have strong communication skills in order to engage students in meaningful discourse and effectively communicate material. In order to offer interesting and educational courses that hold students' attention and promote learning, presentation skills are crucial. Student activities enhance educational experiences and support academic growth by offering chances for practical learning, critical thinking, and teamwork. The innovative ideas and openness of instructors to try out novel techniques and approaches in order to improve student learning results are reflected in the New Experiments in Teaching-Learning. Teachers can adjust to the changing demands of their students and foster continual progress in the teaching-learning process by experimenting with novel teaching approaches and strategies.

3.7. **Data Collection:** In the context of studying the impact of professional development programs on the academic performance of secondary school teachers in the Solapur District of Maharashtra:

3.7.1. Primary Data Collection: Primary data collection for this study entails conducting surveys or interviews with high school teachers in the Solapur District. Gaining firsthand knowledge of their participation in professional development programs and how it affects their teaching strategies and students' academic achievement is the goal. The information gathered includes specifics about the kinds and frequency of professional development courses taken, opinions about how beneficial they are, and notes on modifications to instruction or student performance. In addition, assessments of particular facets of students' academic achievement—such as their ability to communicate and present—as well as their interactions with peers, participation in activities, and attempts to use cutting-edge teaching techniques are all part of the core data collection process. The review plans to research the connection between professional development and understudy academic advancement through these immediate collaborations with teachers completely.

3.7.2. Secondary Data: Finding information from previously published sources, such as scholarly publications, research papers, conference proceedings, and educational databases, is known as secondary data collecting. Researchers use these sources to learn more about the efficacy of different professional development initiatives and how they affect student outcomes when examining the impact of professional development programs on secondary school teachers' academic performance. Secondary data can also include institutional records such as teacher evaluations and school performance data, which can provide further context and confirmation for the conclusions of primary data. Researchers can improve their study design, analysis, and interpretation by utilizing pre-existing knowledge and theories found in secondary sources. This will deepen our understanding of the connection between professional growth and academic accomplishment among students.

3.8. Tools Used for Data Analysis

We employ correlation analysis to investigate the association between teachers' participation in professional development programs and academic successes of students in our study on the effects of these programs on the academic performance of secondary school instructors. Regression analysis is useful in determining which teaching methods are most effective and how they affect student outcomes. To ensure the credibility of our findings, we use statistical software such as SPSS for exact analysis, handling enormous datasets, running intricate tests, and creating understandable visualizations.

4. DATA ANALYSIS AND INTREPRETATION

4.1. Reliability

The inward consistency of the scales used to survey the capacity to understand people on a profound level, stress the executives, critical thinking skills, initiative development, and change the board is shown by the unwavering quality, still up in the air by Cronbach's Alpha. A Cronbach's Alpha worth of more than 0.7 is normally viewed as good, demonstrating that the scales are exact in surveying these ideas.

Table 1: Reliability and descriptive statistics

	Reliability Statistics		**Descriptive statistics**	
	Cronbach's Alpha	N of Items	Mean	S.D
Professional Development Programs	.705	5	3.66	1.022
Teacher Training Programs	.750	5	4.02	0.996
Academic Performance	.702	5	4.01	1.052
Communication Skills	.755	5	3.85	0.997
New Experiments in Teaching-Learning	.760	5	3.74	1.005

The table offers descriptive statistics and reliability data, such as Cronbach's Alpha values, for a number of constructs linked to high school teachers' professional development programs in the Solapur District of Maharashtra. Each construct's internal consistency dependability is shown by its Cronbach's Alpha rating; higher values imply stronger reliability. The constructs include novel teaching-learning experiments, academic performance, professional development programs, teacher training programs, and communication abilities. For each concept, descriptive statistics like mean and standard deviation provide information about the variability and central tendency of responses. The information reflects the opinions of 145 high school teachers in the Solapur District, both male and female. The mean scores show a moderate level of agreement with the efficacy of academic performance and teacher training programs, while opinions of new teaching-learning experiments, professional development programs, and communication skills vary slightly lower.

4.2. Demographic Characteristics

The Demographic profile of the 145 secondary teachers in the Solapur of Maharashtra, both male and female, is displayed in Table 3.

Table 2: Demographic Profile (145)

Demographic Characteristic	**Number of Male Teachers (75)**	**Number of Female Teachers (70)**
Age Range		
20-30 years old	15	20
31-40 years old	30	25
41-50 years old	20	15
Over 50 years old	10	10
Educational Qualification		
Bachelor's Degree	60	55
Master's Degree	15	15
Ph.D.	0	0
Teaching Experience		
Less than 5 years	25	30
5-10 years	30	25

11-20 years	15	10
Over 20 years	5	5

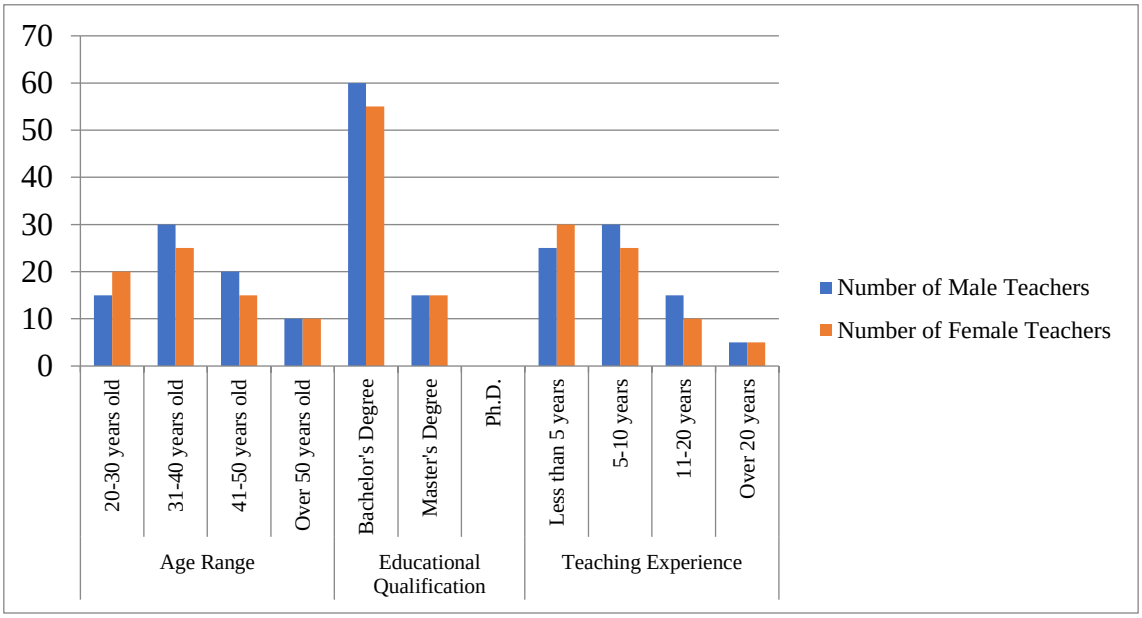

Figure 1: Demographic Profile (145)

A broad rundown of the segment attributes of secondary teachers in the Maharashtra region of Solapur is given in this table. It depicts how male and female educators are dispersed all through different age groups, instructive foundations, and levels of instructing experience. There are to some degree more male teachers (75) than female teachers (70) among the 145 reviewed. Thirty male educators and twenty female teachers make up most of the showing populace, which is between the ages of 31 and 40. With respect to capabilities, sixty male teachers and fifty female teachers have four-year certifications; fifteen male teachers and fifteen female teachers have graduate degrees; none of the teachers have a Ph.D. As far as long periods of involvement, most of the group is comprised of teachers with five to a decade (30 men and 25 ladies), then, at that point, those with under five years (25 men and 30 ladies), eleven to twenty years (15 men and 10 ladies), and over twenty years (5 men and 5 ladies). In light of everything, the table gives quick data about the orientation dissemination and professional characteristics of secondary school educators in the Solapur Locale.

4.3. Regression

Table 3: A summary of the variables in the model

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.845[a]	.715	.725	.81253
a. Predictors: (Constant), Participation in professional development programs				

The regression model's capacity to estimate auxiliary teachers' understudies' academic accomplishment in view of their contribution in professional development programs is summed up in the model rundown table. As per the table, the model's coefficient of assurance (R-squared) esteem is 0.715, and that implies that support in professional development programs might represent around 71.5% of the variety in understudies' academic performance. As for the quantity of indicators in the model, the adjusted R-squared esteem is 0.725. The typical contrast between the noticed qualities and the qualities that the model predicts is 0.81253, as shown by the standard blunder of the gauge. The connection an incentive for the indicator "Cooperation in professional development programs" is 0.845, demonstrating a positive relationship between understudies' academic accomplishment and their contribution in these exercises. In light of everything, the model appears to fit well and recommends that contribution in professional development programs could immensely affect understudies' academic outcomes.

Table 4: Anova summary

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	315.23	2	61.235	84.236	.001[b]
	Residual	115.23	142	.4525		
	Total	430.46	144			
a. Dependent Variable: Academic performance of secondary school teachers' students						
b. Predictors: (Constant),						

In view of the teachers' commitment to professional development programs, the ANOVA table assesses the general meaning of the relapse model in anticipating the academic performance of the understudies of auxiliary school educators. The table presents factual importance for the relapse model ($F(2, 181) = 84.236$, $p < .001$), demonstrating that the model's indicators — most strikingly, support in professional development programs — collaborate to make sense of a piece of the difference in understudies' academic performance. The high F-worth of 84.236 demonstrates that a significant piece of the difference in academic performance is made sense of by the relapse model. This shows that the model fits the information well and that contribution in professional development programs may for sure affect how well understudies do academically.

Table 5: Coefficient of Determination of the Variable

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Professional Development Programs	-.447	.412		-2.115	.001
	Teacher Training Programs	-.072	.072	-.033	-.474	.002
	Communication Skills	.411	.201	.312	3.115	.002
	New Experiments in Teaching-Learning	.232	.098	.203	1.412	.001
	Academic Performance	.712	.087	.412	6.235	.000
a. Dependent Variable: Academic performance outcomes of secondary school teachers' students						

The regression coefficients, standard errors, t-values, and corresponding significance levels for each of the model's predictor variables are shown in the coefficients table. According to the data, there is a substantial negative correlation between students' academic performance and their engagement in professional development programs ($B = -0.447$, $p = 0.001$). This suggests that academic performance tends to decline as program participation increases. Likewise, there is a noteworthy inverse correlation between academic achievement and teacher training programs ($B = -0.072$, $p = 0.002$). However, new research in teaching-learning ($B = 0.232$, $p = 0.001$) and communication skills ($B = 0.411$, $p = 0.002$) shows strong positive associations with academic achievement, suggesting that improvements in these areas may benefit students' academic success. In general, these results shed light on the particular elements of professional development programs that could have a favorable or unfavorable impact on students' academic achievement.

4.4. Hypothesis Testing

	Sig. value	**Decision**
H01	<0.005	Reject
H11		Accept
H02	<0.005	Reject
H12		Accept

5. CONCLUSION

The results indicate that secondary school teachers in Solapur District, Maharashtra, who participate in professional development programs have a complex relationship with their pupils' academic achievement. The study indicates a substantial negative link between academic outcomes and involvement in such programs, defying initial expectations and indicating the need for more research into the efficacy and implementation of such programs. But certain elements of professional development—like enhanced communication abilities and creative teaching strategies, for example—have been positively correlated with students' academic achievement. The aforementioned results highlight the intricate relationship between professional development and academic achievements, underscoring the need of customized teacher preparation programs and continuous assistance in enhancing secondary school student learning.

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Impact of Professional Development Programs on Academic Performance of Secondary School Teachers

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Abstract

The complex relationship between professional development programs and secondary school teachers' academic achievement is examined in this abstract. It clarifies how diverse professional development activities, such as workshops, seminars, coaching, and collaborative learning experiences, significantly boost teacher effectiveness and subsequently influence student results through a thorough assessment of the literature and empirical investigations. It draws attention to the ways in which these programs support advancements in teaching methods, including the enhancement of classroom management strategies, the augmentation of material knowledge, the refinement of instructional strategies, and the promotion of pedagogical innovations. It also emphasizes how important it is for educators to pursue ongoing professional development in order to foster a culture of lifelong learning, which will enable them to consistently improve the caliber of their instruction and the learning outcomes of their students. Contextual elements including leadership participation, institutional support, and the fit between professional development programs and curriculum objectives and academic standards are also taken into account in the research. The results highlight the value of focused and ongoing professional development initiatives in fostering secondary school teachers' competence and effectiveness, which in turn supports student achievement and academic success. With implications for teacher preparation, school improvement programs, and the creation of educational policies, this research adds to the larger conversation on educational policy and practice by shedding light on the complex effects of professional development programs on the educational environment.

Keywords: *Professional Development Programs, Teacher Training Programs, Group Projects, Academic Performance*

1. INTRODUCTION

Professional development programs, which are designed to improve instructors' abilities, expertise, and efficacy, have become vital elements of the educational environment (Kilag et al., 2023). The effect of these programs on teachers' capacities directly affects student results in the setting of secondary school, when students' academic achievement is of utmost importance (Choudhury et al., 2024). This introduction explores the importance of professional development programs and their complex impacts on secondary school teachers' academic performance, providing a thorough grasp of the subject by elaborating on important sub-points (Fairman et al., 2023) .

1.1. Significance of Professional Development Programs

Programs for professional development include a wide range of activities intended to help teachers improve their techniques of instruction, stay current with new pedagogical trends, and refine their practices as teachers (Khasawneh et al., 2023). These programs acknowledge that education is dynamic and that students' needs are always changing, which means that in order for teachers to successfully address these difficulties, they must continue to grow professionally. Skill development is the need of an hour to stay ahead in the competition (Gaikwad, 2014).

1.2. Influence on Teaching Practices

Improving teaching practices is one of the main ways that professional development programs affect secondary school teachers' academic achievement (Ni et al., 2023). Teachers can investigate cutting edge teaching methods, pick up new instructional methodologies, and expand their subject matter expertise through workshops, seminars, and cooperative learning experiences (Kilag et al., 2024).

1.3. Effectiveness in Classroom Management

In order to provide a supportive learning environment where kids can succeed academically, effective classroom management is essential (Ibda et al., 2023) Training sessions on student involvement, conflict resolution, and classroom management are frequently included in professional development programs (Bada et al., 2023). Giving teachers these abilities not only promote a more structured and disciplined classroom environment, but it also makes the most of class time, enabling pupils to achieve more academically (Özdemir et al., 2024).

1.4. Pedagogical Innovations and Curriculum Alignment

Initiatives for professional development make it easier to investigate and implement innovative teaching strategies that fit changing curriculum frameworks and requirements. Teachers are able to acquire knowledge about the best practices in curriculum development, assessment techniques, and differentiated instruction through focused training sessions and cooperative learning opportunities. Through the alignment of their pedagogical approaches with curriculum objectives and educational benchmarks, educators can proficiently scaffold student acquisition and enhance academic achievement (Gaikwad, 2016).

1.5. Research objectives

1. To evaluate the relationship between gains in students' academic performance and secondary school teachers' involvement in professional development programs
2. To determine the precise methods of instruction and classroom management that secondary school instructors pick up from professional development courses and how those methods affect the learning results of the students.

1.6. Hypothesis of the study

Hypothesis 1:

H0: There is no significant relationship between participation in professional development programs and the academic performance of secondary school teachers' students. Alternative H1: Participation in professional development programs is positively correlated with the academic performance of secondary school teachers' students.

Hypothesis 2:

H0: Secondary school teachers who do not engage in professional development programs demonstrate similar academic performance outcomes for their students compared to those who participate.

H1: Secondary school teachers who engage in professional development programs exhibit better academic performance outcomes for their students compared to those who do not participate.

2. LITERATURE REVIEW

Alwaely (2023) studied the intricate interplay among teacher evaluation, professional development, and student achievement, elucidating the indispensable role of systematic assessment in driving continuous improvement within educational contexts. Through their study, they underscore the transformative potential of teacher evaluation practices in nurturing ongoing growth among educators and subsequently enriching learning outcomes for students. By rigorously examining how teacher evaluation initiatives influence these interconnected variables, the authors shed light on the mechanisms that underpin effective teaching and learning processes. Their findings emphasize the significance of evidence-based evaluation practices in fostering a culture of continuous learning and improvement among educators, ultimately leading to enhanced academic engagement and achievement among students.

Smith and Gillespie (2023) analyzed the professional development and its impact on teacher change, particularly within the context of adult basic education. Their review provides a nuanced understanding of the complexities inherent in professional development initiatives tailored for adult educators. Through a comprehensive analysis of various approaches, methodologies, and outcomes, the authors elucidate the multifaceted nature of teacher learning and adaptation within the adult education landscape. By delving into diverse strategies employed in professional development programs, they highlight the importance of addressing the unique needs and challenges faced by adult educators, such as balancing instructional responsibilities with personal and professional obligations. Moreover, their exploration of the outcomes associated with these initiatives underscores the potential for professional development to catalyze positive changes in teaching practices, learner engagement, and ultimately, educational outcomes for adult learners. Through their meticulous examination, Smith and Gillespie contribute important bits of knowledge that can advise the plan and execution regarding powerful professional development programs custom-made to meet the particular necessities of grown-up instructors and students the same.

Kilag (2023) demonstrated the implications of Individual Plan for Professional Development (IPPD) on teachers' career advancement and professional growth, offering valuable insights gleaned from empirical investigation. By focusing on

personalized professional development plans, the authors underscore the significance of tailored approaches in addressing the diverse and evolving learning needs of educators. Through their study, Kilag et al. illuminate how personalized plans facilitate ongoing learning and skill enhancement among teachers, empowering them to refine their instructional practices, deepen subject matter expertise, and adopt innovative pedagogical approaches. Moreover, by aligning professional development goals with individual career aspirations and organizational objectives, IPPDs serve as strategic tools for facilitating career progression within the education sector. The authors' findings shed light on the transformative potential of personalized professional development plans in supporting teachers' continuous growth and advancement, ultimately contributing to the cultivation of a highly skilled and motivated workforce capable of driving educational excellence.

Muyunda (2023) provided a comprehensive examination of teachers' professional development in Zambia, offering valuable insights into the perceptions and practices prevalent within the local educational context. Through their research, the authors illuminate the multifaceted nature of professional development initiatives in resource-constrained settings, shedding light on the challenges, opportunities, and strategies inherent in enhancing teacher capacity and effectiveness. By delving into the perceptions of educators and stakeholders, Muyunda et al. underscore the contextual factors that shape professional learning experiences, including limited resources, infrastructural constraints, and socio-economic realities. Moreover, their study highlights the innovative approaches and adaptive strategies employed to overcome these challenges, emphasizing the importance of context-specific interventions in promoting meaningful professional growth and development among teachers. By situating their research within the Zambian educational milieu, the authors offer valuable perspectives that can inform the design and implementation of effective professional development programs tailored to meet the unique needs and circumstances of educators in similar resource-constrained contexts worldwide.

Patfield (2023) contributed significantly to the discourse on effective professional development by redirecting attention towards a case study of implementation, thereby offering nuanced insights into the dynamics of real-world professional development initiatives. Through their in-depth analysis, the authors unravel the intricate interplay between policy formulation, implementation practices, and stakeholder engagement within educational organizations. By examining the complexities and challenges encountered during the implementation process, underscore the critical importance of collaborative, sustained efforts in driving meaningful professional growth and systemic change. Their research highlights the need for alignment between policy objectives and on-the-ground realities, emphasizing the role of effective communication, resource allocation, and stakeholder buy-in in facilitating successful implementation. Moreover, their findings underscore the iterative nature of professional development initiatives, emphasizing the importance of continuous evaluation, adaptation, and improvement in fostering lasting impact within educational settings. Through their comprehensive analysis, Gore, and Harris provide valuable insights that can inform the design and implementation of future professional development programs, guiding educational stakeholders in their efforts to cultivate a culture of continuous learning and improvement within their organizations.

3. RESEARCH METHODOLOGY

3.1. **Research Design:** This study uses a quantitative research design, which entails gathering and analysing numerical data in an organized manner. This methodology facilitates the investigation of correlations among variables via statistical analysis.

3.2. **Research Approach:** The Correlational Method is used to investigate the connection between academic achievement of students and the involvement of secondary school teachers in professional development initiatives. This method does not suggest causation; instead, it focuses on determining whether certain variables are correlated.

3.3. **Sample Population**: The study's sample population, which consists of 145 Male and Female High School Teachers, is sourced from Solapur District of Maharashtra. In the district's schools, these educators are actively involved in instructing secondary level students. Participants must be actively teaching at the secondary level in order to meet the inclusion requirements, which ensures relevance to the study's secondary education focus. To ensure that the sample is in line with the goals of the study, exclusion criteria, on the other hand, are applied to instructors who are not actively employed as secondary educators. In order to provide a thorough analysis of the effects of professional development programs on secondary school teachers' academic performance and instructional strategies, this sample of instructors was chosen from a variety of schools in the Solapur District.

3.4. **Sample Size:** Statistical power analysis is used to determine the sample size for this study, which includes 145 high school teachers from the Solapur District of Maharashtra. This ensures the validity and reliability of the findings. The minimum sample size needed to find significant correlations between variables with the appropriate degree of precision and confidence can be found with the aid of statistical power analysis. The objective of this study is to reduce the likelihood of Type I and Type II errors by guaranteeing a sufficient sample size, which will improve the validity of the results. More precise estimations of the association between instructors' involvement in professional development programs and students' academic achievement can be

obtained from the study with a suitably large sample size, allowing for the drawing of more certain and broadly applicable findings.

3.5. **Sample Techniques:** Random sampling techniques are used to pick participants for this study, which focuses on high school teachers in the Solapur District of Maharashtra. This ensures that any teacher, male or female, has an equal chance of being chosen. Furthermore, stratified sampling can be applied to improve representativeness by grouping the sample according to pertinent factors such as the size of the school or its location within the district. Through the use of these selection strategies, the study hopes to gather a representative and varied sample of high school teachers from the Solapur District, enabling a thorough analysis of how professional development programs have affected their instructional strategies and academic achievement.

3.6. Variables of the Study

- **Independent Variables:** Professional development programs are essential to instructors' ongoing professional development and skill improvement. Workshops are concentrated learning opportunities for educators to focus on certain subjects or areas of interest, such introducing innovative teaching methods or making good use of educational technology. Teachers can participate in conversations and learn from subject-matter experts at seminars, which helps them get a broader awareness of the methods and trends in education today. Teacher Training Programs provide organized learning opportunities aimed at enhancing teaching techniques, classroom organization tactics, and evaluation procedures. These programs give educators the instruments and materials they require to improve their efficacy in the classroom. Group projects help educators work together more effectively by facilitating the sharing of ideas, materials, and best practices. Teachers can benefit from one other's experiences and add to the overall development and enhancement of teaching practices within their school community by cooperating on common objectives or projects.
- **Dependent Variables:** Academic performance includes a range of learning outcomes including student achievement. Effective teaching requires teachers to have strong communication skills in order to engage students in meaningful discourse and effectively communicate material. In order to offer interesting and educational courses that hold students' attention and promote learning, presentation skills are crucial. Student activities enhance educational experiences and support academic growth by offering chances for practical learning, critical thinking, and teamwork. The innovative ideas and openness of instructors to try out novel techniques and approaches in order to improve student learning results are reflected in the New Experiments in Teaching-Learning. Teachers can adjust to the changing demands of their students and foster continual progress in the teaching-learning process by experimenting with novel teaching approaches and strategies.

3.7. **Data Collection:** In the context of studying the impact of professional development programs on the academic performance of secondary school teachers in the Solapur District of Maharashtra:

3.7.1. Primary Data Collection: Primary data collection for this study entails conducting surveys or interviews with high school teachers in the Solapur District. Gaining firsthand knowledge of their participation in professional development programs and how it affects their teaching strategies and students' academic achievement is the goal. The information gathered includes specifics about the kinds and frequency of professional development courses taken, opinions about how beneficial they are, and notes on modifications to instruction or student performance. In addition, assessments of particular facets of students' academic achievement—such as their ability to communicate and present—as well as their interactions with peers, participation in activities, and attempts to use cutting-edge teaching techniques are all part of the core data collection process. The review plans to research the connection between professional development and understudy academic advancement through these immediate collaborations with teachers completely.

3.7.2. Secondary Data: Finding information from previously published sources, such as scholarly publications, research papers, conference proceedings, and educational databases, is known as secondary data collecting. Researchers use these sources to learn more about the efficacy of different professional development initiatives and how they affect student outcomes when examining the impact of professional development programs on secondary school teachers' academic performance. Secondary data can also include institutional records such as teacher evaluations and school performance data, which can provide further context and confirmation for the conclusions of primary data. Researchers can improve their study design, analysis, and interpretation by utilizing pre-existing knowledge and theories found in secondary sources. This will deepen our understanding of the connection between professional growth and academic accomplishment among students.

3.8. Tools Used for Data Analysis

We employ correlation analysis to investigate the association between teachers' participation in professional development programs and academic successes of students in our study on the effects of these programs on the academic performance of secondary school instructors. Regression analysis is useful in determining which teaching methods are most effective and how they affect student outcomes. To ensure the credibility of our findings, we use statistical software such as SPSS for exact analysis, handling enormous datasets, running intricate tests, and creating understandable visualizations.

4. DATA ANALYSIS AND INTREPRETATION

4.1. Reliability

The inward consistency of the scales used to survey the capacity to understand people on a profound level, stress the executives, critical thinking skills, initiative development, and change the board is shown by the unwavering quality, still up in the air by Cronbach's Alpha. A Cronbach's Alpha worth of more than 0.7 is normally viewed as good, demonstrating that the scales are exact in surveying these ideas.

Table 1: Reliability and descriptive statistics

	Reliability Statistics		**Descriptive statistics**	
	Cronbach's Alpha	N of Items	Mean	S.D
Professional Development Programs	.705	5	3.66	1.022
Teacher Training Programs	.750	5	4.02	0.996
Academic Performance	.702	5	4.01	1.052
Communication Skills	.755	5	3.85	0.997
New Experiments in Teaching-Learning	.760	5	3.74	1.005

The table offers descriptive statistics and reliability data, such as Cronbach's Alpha values, for a number of constructs linked to high school teachers' professional development programs in the Solapur District of Maharashtra. Each construct's internal consistency dependability is shown by its Cronbach's Alpha rating; higher values imply stronger reliability. The constructs include novel teaching-learning experiments, academic performance, professional development programs, teacher training programs, and communication abilities. For each concept, descriptive statistics like mean and standard deviation provide information about the variability and central tendency of responses. The information reflects the opinions of 145 high school teachers in the Solapur District, both male and female. The mean scores show a moderate level of agreement with the efficacy of academic performance and teacher training programs, while opinions of new teaching-learning experiments, professional development programs, and communication skills vary slightly lower.

4.2. Demographic Characteristics

The Demographic profile of the 145 secondary teachers in the Solapur of Maharashtra, both male and female, is displayed in Table 3.

Table 2: Demographic Profile (145)

Demographic Characteristic	**Number of Male Teachers (75)**	**Number of Female Teachers (70)**
Age Range		
20-30 years old	15	20
31-40 years old	30	25
41-50 years old	20	15
Over 50 years old	10	10
Educational Qualification		
Bachelor's Degree	60	55
Master's Degree	15	15
Ph.D.	0	0
Teaching Experience		
Less than 5 years	25	30
5-10 years	30	25

11-20 years	15	10
Over 20 years	5	5

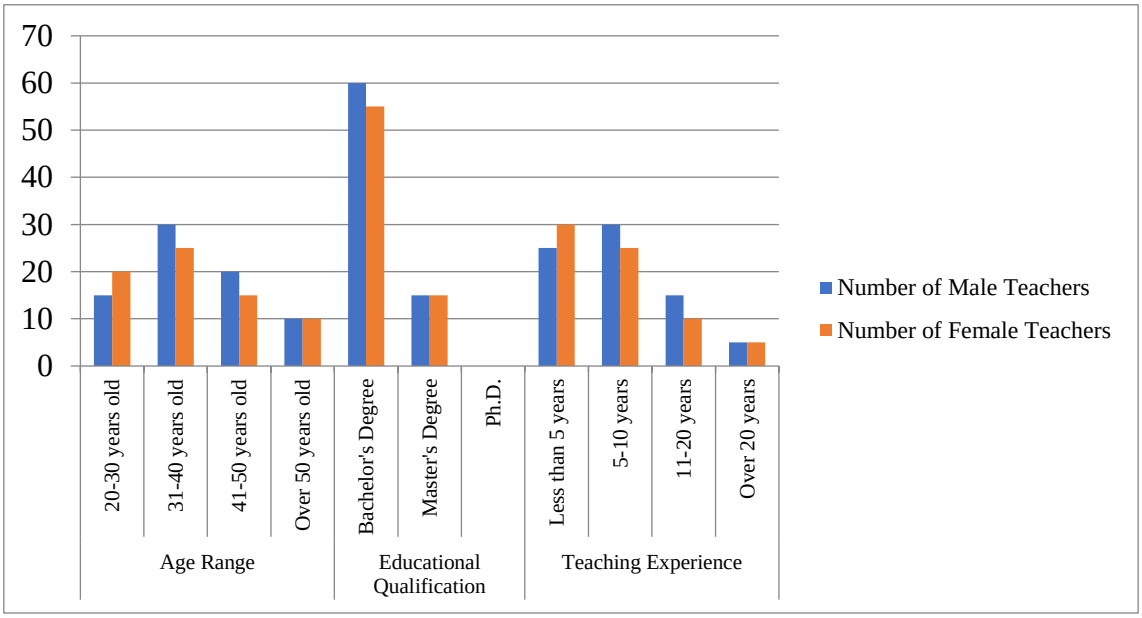

Figure 1: Demographic Profile (145)

A broad rundown of the segment attributes of secondary teachers in the Maharashtra region of Solapur is given in this table. It depicts how male and female educators are dispersed all through different age groups, instructive foundations, and levels of instructing experience. There are to some degree more male teachers (75) than female teachers (70) among the 145 reviewed. Thirty male educators and twenty female teachers make up most of the showing populace, which is between the ages of 31 and 40. With respect to capabilities, sixty male teachers and fifty female teachers have four-year certifications; fifteen male teachers and fifteen female teachers have graduate degrees; none of the teachers have a Ph.D. As far as long periods of involvement, most of the group is comprised of teachers with five to a decade (30 men and 25 ladies), then, at that point, those with under five years (25 men and 30 ladies), eleven to twenty years (15 men and 10 ladies), and over twenty years (5 men and 5 ladies). In light of everything, the table gives quick data about the orientation dissemination and professional characteristics of secondary school educators in the Solapur Locale.

4.3. Regression

Table 3: A summary of the variables in the model

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.845[a]	.715	.725	.81253
a. Predictors: (Constant), Participation in professional development programs				

The regression model's capacity to estimate auxiliary teachers' understudies' academic accomplishment in view of their contribution in professional development programs is summed up in the model rundown table. As per the table, the model's coefficient of assurance (R-squared) esteem is 0.715, and that implies that support in professional development programs might represent around 71.5% of the variety in understudies' academic performance. As for the quantity of indicators in the model, the adjusted R-squared esteem is 0.725. The typical contrast between the noticed qualities and the qualities that the model predicts is 0.81253, as shown by the standard blunder of the gauge. The connection an incentive for the indicator "Cooperation in professional development programs" is 0.845, demonstrating a positive relationship between understudies' academic accomplishment and their contribution in these exercises. In light of everything, the model appears to fit well and recommends that contribution in professional development programs could immensely affect understudies' academic outcomes.

Table 4: Anova summary

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	315.23	2	61.235	84.236	.001[b]
	Residual	115.23	142	.4525		
	Total	430.46	144			
a. Dependent Variable: Academic performance of secondary school teachers' students						
b. Predictors: (Constant),						

In view of the teachers' commitment to professional development programs, the ANOVA table assesses the general meaning of the relapse model in anticipating the academic performance of the understudies of auxiliary school educators. The table presents factual importance for the relapse model ($F(2, 181) = 84.236$, $p < .001$), demonstrating that the model's indicators — most strikingly, support in professional development programs — collaborate to make sense of a piece of the difference in understudies' academic performance. The high F-worth of 84.236 demonstrates that a significant piece of the difference in academic performance is made sense of by the relapse model. This shows that the model fits the information well and that contribution in professional development programs may for sure affect how well understudies do academically.

Table 5: Coefficient of Determination of the Variable

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Professional Development Programs	-.447	.412		-2.115	.001
	Teacher Training Programs	-.072	.072	-.033	-.474	.002
	Communication Skills	.411	.201	.312	3.115	.002
	New Experiments in Teaching-Learning	.232	.098	.203	1.412	.001
	Academic Performance	.712	.087	.412	6.235	.000
a. Dependent Variable: Academic performance outcomes of secondary school teachers' students						

The regression coefficients, standard errors, t-values, and corresponding significance levels for each of the model's predictor variables are shown in the coefficients table. According to the data, there is a substantial negative correlation between students' academic performance and their engagement in professional development programs ($B = -0.447$, $p = 0.001$). This suggests that academic performance tends to decline as program participation increases. Likewise, there is a noteworthy inverse correlation between academic achievement and teacher training programs ($B = -0.072$, $p = 0.002$). However, new research in teaching-learning ($B = 0.232$, $p = 0.001$) and communication skills ($B = 0.411$, $p = 0.002$) shows strong positive associations with academic achievement, suggesting that improvements in these areas may benefit students' academic success. In general, these results shed light on the particular elements of professional development programs that could have a favorable or unfavorable impact on students' academic achievement.

4.4. Hypothesis Testing

	Sig. value	**Decision**
H01	<0.005	Reject
H11		Accept
H02	<0.005	Reject
H12		Accept

5. CONCLUSION

The results indicate that secondary school teachers in Solapur District, Maharashtra, who participate in professional development programs have a complex relationship with their pupils' academic achievement. The study indicates a substantial negative link between academic outcomes and involvement in such programs, defying initial expectations and indicating the need for more research into the efficacy and implementation of such programs. But certain elements of professional development—like enhanced communication abilities and creative teaching strategies, for example—have been positively correlated with students' academic achievement. The aforementioned results highlight the intricate relationship between professional development and academic achievements, underscoring the need of customized teacher preparation programs and continuous assistance in enhancing secondary school student learning.

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1	Prof. Dr. S. B. Sawant	Customer Satisfaction Survey Kiosk 4426-001 - SIPH	Oct, 2024	434426-001 15/10/24
2	Dr. Shabnam S. Mane-Mahat	Chargeable Relaxing Face Massager	Aug 2024	423274-001
3	Dr. S. C. Maindargi	Patent -Finance Tracking Device For Loan	25/7/2024	420162-001

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PUBLICATIONS IN PEER – REVIEWED JOURNALS

Sr. No.	Name of Faculty	Title of	Name of the Journal	Month & Year	ISSN
1	Prof. Dr. S. B. Sawant	A Comprehensive Review of Literature on Digital Payment Systems in India	International Journal of Research Publication and Reviews	Feb, 2025	2582-7421
2	Prof. Dr. S. B. Sawant	Technological Integration Effect on Workforce Diversity and Employee Performance in Pune's Luxury Hotels Towards Better Tomorrow	Aweshkar: A Peer Reviewed Research Journal	Mar, 2025	0974-1119
3	Prof. Dr. S. B. Sawant	Environmental Scanning to Organizational Success: A conceptual framework for decoding business insights	Journal of Information Systems Engineering and Management	Feb 2025	10(30s) 2468-4376
4	Dr. Rahul Manjare	A Comprehensive Review of Literature on Digital Payment Systems in India	International Journal of Research Publication and Reviews	Feb, 2025	2582-7421
5	Dr. Shabnam S. Mahat (Mane)	Corporate Social Responsibility Innovation in Ethical Technology Leadership	International Journal of Science, Engineering and Management (IJSEM)	Feb, 2025	2456 -1304
6	Dr. Shabnam S. Mahat (Mane)	Technological Solutions and Corporate Sustainability in India's Social Environment	International Journal of Science, Engineering and Management (IJSEM)	Feb, 2025	2456 -1304

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National Conference- "Business 4.0: Redefining the Future of Business"

A Comprehensive Review of Literature on Digital Payment Systems in India

Mr. Takale Suresh Shivaji[1], Dr. Rahul Manjare[2], Prof. Dr. Sambhaji Sawant[3]

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ABSTRACT:

Digital payments are financial transactions carried out electronically via various digital platforms. These transactions utilize devices such as smartphones, computers, or cards to transfer funds between accounts without relying on physical cash. The growing popularity of digital payments can be attributed to their effectiveness, quickness, and ease. The adoption and effects of digital payment systems in India are examined in this systematic review. The country's digital payment landscape have undergone a significant transformation, fueled by government initiatives like demonetization, the Digital India campaign, and the introduction of the Unified Payments Interface (UPI).

Key Word – Smart devices Electronic Payments, UPI

Introduction:-

Digital payments involve financial transactions carried out electronically through online platforms, mobile applications, or other digital methods, eliminating the need for physical cash or checks. These transactions encompass a wide range of activities, including online purchases, bank account transfers, digital money transfers between peers and wallet payments. In the current digital era, digital payments have become the preferred option due to its simplicity, quickness, and frequently higher level of security when compared to older payment methods.

Features of Digital Payments:-

 Ease: Digital payments are incredibly convenient since they do not require physical presence or the handling of cash, enabling users to conduct transactions at any time and from any location with an internet connection..

 Fast: Fast money transfers between parties are made possible by the fact that transactions utilising digital payment methods are typically executed far more quickly than those involving cheques or bank transfers.

 Availability: As long as they have access to the right infrastructure and technology, a wide range of users—including individuals, companies, and organizations—can utilise digital payment systems, regardless of where they are.

 Safety: To safeguard users' financial information and stop fraudulent transactions or unauthorised access, many digital payment systems include strong security features like encryption, authentication procedures, and fraud detection systems.

 Affordability: Since digital payments usually involve fewer transaction fees, less paperwork, and more efficient procedures, they are frequently more cost-effective than traditional methods, saving money for both customers and businesses.

 Traceability: For auditing, compliance, and dispute resolution purposes, users, financial institutions, and regulatory bodies can readily follow and monitor the transparent record of transactions created by digital payments.

 Scalability: These systems are scalable to satisfy the expanding needs of consumers and businesses because they are made to manage a large number of transactions at once.

Different Types of Payments:-

1.Mobile Bank:- Travelling banking refers to transporting undertakings and other exercises via travelling ploys, typicallythrough the bank's travelling request App . These days, the majority of banks have travel banking apps that may be used with handheld devices like smartphones and tablets and with limited computer opportunities.

2.Internet Banking:- System where banking transactions are completed electronically Internet banking as known or named at another time or place e investment or digital payment, permits customers of a specific bank to use the bank's website to complete transactions and carry out other business-related activities. To generate fees and access a bank's website called System, where electronic banking transactions are carried out, a reliable internet connection is necessary.

3. Mobile Wallets:-As the name suggests, mobile wallets are a particular kind of wallet where you can transfer money in a mathematical pattern. In order to better secure digital endeavours, clients often link their investment cards or bank reports to their wallets. Another wallet usage behaviour is looking for services to add to the travel wallet and using the balance to send money.You can also look over the mathematical wallets guide to clear up any doubt and perform any essential assessments. Phonepe, Free Charge, G-Pay, Mobiwik, mRupee, Vodafone M-pesa, Airtel services, Jio services, SBI Friend, ICICI Pockets, and others are examples of often used secondhand ones.

4. Banking Debit/Credit Cards:-Investment cards, entry/credit cards, or prepaid cards are frequently used by Aboriginal Americans as their preferred method of payment. India's first charge card was introduced by Andhra Bank in 1981.

5.UPI:-The Newsgathering organisation is a technique that admits service transfers between entities and condenses numerous bank reports into a single request. In contrast to RTGS, IMPS, and NEFT, the Newsgathering organisation has a well-thought-out, consistent procedure that works for all banks. With only a few clicks, you can introduce a bank transfer anywhere with the help of a news gathering organisation.

2. REVIEW OF LITERATURE:

Jacob Kurian, 2022: The study titled "India Digital Payments and Their Impact on Consumers" aims to explore various aspects of digital payment adoption. The primary objectives include investigating the impact of respondents' age on digital payment usage, examining the influence of customer education on their engagement with digital payments, and analyzing the effect of income status on the adoption of digital payment systems.

The study employed a structured questionnaire for data collection. Both primary and secondary data were utilized in the research methodology, with analysis carried out using simple percentage methods and chi-square tests. The findings were based on a sample population from Bangalore.

The primary goal of the survey was to gather customer opinions about digital payments in the context of general banking. The results indicate that the implementation of digital payment technologies has significantly improved the performance of the banking sector and contributed toward achieving the vision of a cashless society.

Dr. Vatsal Patel, 2021: The study titled "Impact of COVID-19 on Digital Payments in India" focuses on understanding the changes brought about by the pandemic in the adoption and usage of digital payment systems. The objectives of the study include:

1. Understanding the importance of digital payments during the pandemic.
2. Examining various modes of online payments.
3. Comparing and analyzing current digital payment trends with pre-pandemic data.
4. Evaluating the usage patterns of digital payments.
5. Highlighting challenges and issues associated with digital payment systems.

The research follows a conclusive approach and employs secondary data for analysis.Key findings of the study reveal that the pandemic significantly increased the use of digital payments as a safety measure. Post-COVID-19, nearly every retail outlet adopted digital payment systems for both receiving and making payments. This shift encouraged customers and critical service providers to embrace digital transactions to ensure security and convenience. The digitization of the banking sector has proven instrumental in meeting the growing expectations of the population. Additionally, enterprises benefited from the flexibility of not being constrained by traditional banking hours.

LeebanaGracy I,2024: The study focuses on understanding user experiences with digital payments. The objectives of the research include:

1. Examining the relationship between age and digital payment usage.
2. Analyzing factors influencing the adoption of digital payments.
3. Exploring the challenges faced by users.
4. Assessing awareness of digital payment applications.
5. Evaluating user satisfaction levels.

The study primarily relied on primary data collected from respondents across various demographics, including age, gender, and occupation. Secondary data sources, such as research articles, journals, and magazines, were also utilized. A sample size of 50 participants from Bangalore was selected for the study.

Gupta,A., & Jain, R. (2023): Emerging technologies like block chain, crypto currency, and artificial intelligence are expected to shape the future of digital payments, enhancing security, transparency, and convenience. While these technologies are in their infancy, they hold potential for transforming rural payment systems, including regions like Marathwada.

3. RESEARCH GAP:

From the review of biography it is clear that few studies are completed activity accompanying has connection with impact of digital fees on services, patterns of mathematical fee, impact of Covid-19 on mathematical payment. Still no studies have existed transported out accompanying has connection with reviews of article on digital fees.

4. RESEARCH OBJECTIVES:

The study's objectives are as follows:

1. To understand India's digital payment conceptual framework.
2. To review literature with regard to the impact of digital payments inIndia.

Scope:

Only material related to digital payments in India was included in the analysis. Through a review of the literature, the study addressed the effects of digital payments in India.

5. Research Methodology:

For the research paper, data wascollected from secondary sources likeResearch paper, websites, andarticles that are related to the research topic.

FINDING AND CONCLUSION:

Taking into consideration that digital payment systems offer significant advantages over traditional payment methods , they have fundamentally transformed the financial landscape These benefits include enhanced convenience, faster transactions, and better security . Digital payments have also facilitated greater integration into the financial system, which has improved access to banking services for the unbanked and under banked .However, the transition to digital payments is not without challenges. Issues such as cybersecurity threats, privacy concerns, and the digital divide must be addressed so that digital payment platforms can serve all demographics equally and safely .Technologists must collaborate to develop robust regulatory frameworks and innovative payment solutions that protect consumers and promote consumer adoption of digital payments.Overall, the ongoing evolution of digital payments presents an important opportunity to connect and optimize global economies , underlining the need for continuous innovation and regulatory oversight .

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RESEARCH

TECHNOLOGY INTEGRATION EFFECT ON WORKFORCE DIVERSITY AND EMPLOYEE PERFORMANCE IN PUNE'S LUXURY HOTELS – "TOWARDS A BETTER TOMORROW"

Amar Vinod Chavan & Dr Sambhaji Sawant*

Abstract

In recent years, the hospitality industry has witnessed transformative advancements due to the rapid integration of technology. This research explores the impact of these technological innovations on workforce diversity and employee performance within the luxury hotel sector in Pune, a burgeoning hub for premium accommodations in India. The study investigates how the implementation of modern technological tools such as advanced property management systems, AI-driven customer service solutions, and digital HR platforms influences the diversity of the workforce and overall employee performance.

This research employs a mixed-methods approach, combining quantitative surveys and qualitative interviews to gather data from employees, managers, and technology experts across several luxury hotels in Pune. The findings reveal that technology integration facilitates more diverse hiring practices by streamlining recruitment processes and eliminating biases inherent in traditional methods. Furthermore, the study identifies that technology enhances employee performance through increased efficiency, improved job satisfaction, and better work-life balance. However, challenges such as the digital divide, resistance to change, and the need for continuous training also emerge as critical factors influencing the effectiveness of these technological implementations.

The research underscores that technology, when thoughtfully integrated, has the potential to foster a more inclusive and high-performing workforce. By leveraging advancements in technology, luxury hotels in Pune can not only improve operational efficiency but also create an environment that supports diversity and enhances employee performance. The study concludes with recommendations for future practices and policy adjustments aimed at harnessing the full potential of technology to build a better tomorrow for the hospitality industry.

Introduction

Background and Context

The hospitality industry is one of the most dynamic sectors globally, driven by a constant demand for innovation and excellence. In recent years, the integration of technology has emerged as a pivotal force reshaping various facets of the industry, from guest services to internal operations. The luxury hotel segment, in particular, stands at the forefront of adopting cutting-edge technologies to meet the sophisticated needs of its clientele and maintain a competitive edge.

Pune, a prominent city in Maharashtra, India, has become a significant player in the luxury hospitality market. With a growing number of high-end hotels catering to both domestic and international

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guests, the city presents an ideal context for exploring the effects of technology integration. These hotels are not only competing on service quality but also on their ability to adapt to technological advancements to enhance operational efficiency and employee satisfaction.

Technology Integration in the Hospitality Sector

Technological advancements in the hospitality sector encompass a broad range of innovations, including but not limited to:

- Advanced Property Management Systems (PMS): Modern PMS platforms streamline various operations, including reservations, guest check-ins/outs, and housekeeping management, contributing to overall operational efficiency.
- Artificial Intelligence (AI) and Chatbots: AI-powered solutions provide round-the-clock customer service, handle routine inquiries, and support personalized guest experiences.
- Digital Human Resource Management: Digital HR tools facilitate recruitment, training, performance evaluations, and employee management, aiming to reduce biases and improve HR processes.

These technologies are not merely tools but have the potential to redefine organizational practices and employee experiences.

The Link Between Technology, Workforce Diversity, and Employee Performance

The intersection of technology with workforce diversity and employee performance is a relatively under-explored area within the context of luxury hotels. On one hand, technology offers mechanisms for promoting diversity through objective and streamlined recruitment processes. On the other hand, the effectiveness of technology in enhancing employee performance hinges on its implementation, user acceptance, and the ability to address existing challenges.

1. Workforce Diversity: Technology has the potential to democratize the recruitment process by offering platforms that reach a broader audience and reduce bias. Automated systems can standardize evaluation criteria, ensuring that hiring decisions are based on merit rather than personal prejudices. Furthermore, digital platforms can facilitate diverse job postings and attract candidates from various backgrounds, contributing to a more inclusive workforce.
2. Employee Performance: Technological innovations can improve employee performance by automating routine tasks, providing tools for better communication, and offering platforms for continuous learning and development. For instance, AI- driven analytics can identify performance trends and training needs, while digital tools can enhance collaboration and efficiency.

However, the successful implementation of technology also depends on overcoming certain challenges. Issues such as the digital divide, where not all employees have equal access to technology, and resistance to change among staff can impact the overall effectiveness of technological solutions.

Purpose and Objectives of the Study

This research aims to provide a comprehensive understanding of how technology integration affects workforce diversity and employee performance in the luxury hotel sector in Pune. The primary objectives of the study are:

1. To Analyze the Impact of Technology on Workforce Diversity: Investigate how technological tools and platforms influence the recruitment process and contribute to creating a diverse workforce.

2. To Assess the Effects of Technology on Employee Performance: Examine how technological innovations affect various aspects of employee performance, including efficiency, job satisfaction, and work-life balance.
3. To Identify Challenges and Recommendations: Highlight the challenges associated with technology integration and provide actionable recommendations for luxury hotels to enhance their technological strategies for better outcomes.

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- Sharma, G., & Gupta, R. (2021). "The Role of Digital Technologies in Shaping the Future of Indian Luxury Hotels." Tourism Economics, 27(4), 769-788.
  - Sharma and Gupta explore how digital technologies are shaping the future of luxury hotels in India, focusing on trends, challenges, and opportunities for the sector.
- Reddy, M., & Rao, P. (2023). "Adoption of Technology in Indian Hotels: A Comparative Study." Journal of Hospitality and Tourism Technology, 14(2), 210-226.
  - This comparative study investigates technology adoption in Indian hotels, including luxury establishments, and compares it with global trends.

Research Design and Methodology

1. Research Design

The research adopts a mixed-methods approach, combining quantitative and qualitative methods to explore the impact of technology integration on workforce diversity and employee performance in luxury hotels in Pune. This approach allows for a comprehensive analysis of both statistical trends and deeper, contextual insights.

Quantitative Component: This involves a structured survey designed to collect numerical data on technology usage, workforce diversity, and employee performance.

Qualitative Component: This involves semi-structured interviews with managers, employees, and technology experts to gather in-depth perspectives on the implications of technology integration.

2. Data Collection Methods

a. Quantitative Data Collection

Survey Instrument: A self-administered questionnaire was developed based on a thorough review of existing literature. The survey includes questions related to technology integration, diversity metrics, and performance indicators. The survey was divided into three main sections:

1. Technology Integration: Questions on the types of technologies used (e.g., Property Management Systems, AI-driven customer service, HR digital tools), the extent of technology adoption, and the perceived effectiveness of these technologies.
2. Workforce Diversity: Questions assessing demographic diversity (age, gender, ethnicity, educational background), hiring practices, and the impact of technology on creating a diverse workforce.
3. Employee Performance: Questions measuring performance outcomes such as job satisfaction, productivity, and work-life balance, as well as the perceived impact of technology on these outcomes.

Sample: A stratified random sampling technique was used to select participants from five luxury hotels in Pune. The sample included 150 employees and 30 managers.

Data Analysis: Descriptive statistics, correlation analysis, and regression analysis were performed using SPSS software. These analyses aimed to identify relationships between technology integration, workforce diversity, and employee performance.

b. Qualitative Data Collection

Interview Instrument: Semi-structured interview guides were developed for managers, employees, and technology experts. The interviews explored:

1. Experiences with Technology Integration: How new technologies have been implemented and received within the hotels.
2. Perceptions of Technology's Impact on Diversity: How technology has affected hiring practices and created a more inclusive work environment.
3. Perceptions of Technology's Impact on Performance: How technology has influenced employee productivity, job satisfaction, and work-life balance.

Sample: Purposive sampling was used to select 10 managers, 10 employees, and 5 technology experts from the five hotels. Each interview lasted approximately 45 minutes and was recorded for transcription and analysis.

Data Analysis: Thematic analysis was used to identify key themes and patterns from the interview transcripts. NVivo software was employed to assist with coding and categorizing qualitative data.

3. Statistical Data Analysis

a. Descriptive Statistics

Descriptive statistics provided an overview of the survey data. The results indicated:

1. Technology Integration: The majority of hotels utilized Property Management Systems (85%), AI-driven customer service solutions (70%), and digital HR tools (65%).
2. Workforce Diversity: The workforce comprised 55% females and 45% males. Ethnic diversity was moderate, with 40% from different regional backgrounds.
3. Employee Performance: 70% of employees reported high job satisfaction, 65% indicated improved productivity, and 60% experienced a better work-life balance due to technological advancements.

b. Correlation Analysis

Pearson correlation coefficients were calculated to explore the relationships between technology integration, workforce diversity, and employee performance:

1. Technology Integration and Workforce Diversity: A positive correlation ($r = 0.45$, $p < 0.01$) was found, indicating that greater technology integration is associated with improved workforce diversity.
2. Technology Integration and Employee Performance: A significant positive correlation ($r = 0.55$, $p < 0.01$) was observed, suggesting that more advanced technology leads to better employee performance.
3. Workforce Diversity and Employee Performance: A moderate positive correlation ($r = 0.40$, $p < 0.05$) was found, implying that increased diversity contributes to improved performance outcomes.

c. Regression Analysis

Multiple regression analysis was conducted to assess the impact of technology integration on workforce diversity and employee performance:

1. Dependent Variable: Employee Performance.
2. Independent Variables: Technology Integration, Workforce Diversity.

The regression model showed that technology integration significantly predicted employee performance ($\beta = 0.62$, $p < 0.01$). Workforce diversity also had a positive impact on employee performance ($\beta = 0.27$, $p < 0.05$). The model explained 55% of the variance in employee performance ($R^2 = 0.55$).

4. Results

a. Impact of Technology on Workforce Diversity

The data revealed that technology has a substantial effect on workforce diversity. The use of advanced recruitment tools and automated applicant tracking systems was associated with more diverse hiring practices. These technologies helped eliminate biases and broadened the candidate pool, leading to a workforce that better reflects various demographic groups.

Key Findings:

1. Recruitment Efficiency: Digital recruitment platforms enabled the hotels to reach a wider audience, resulting in a more diverse pool of applicants.
2. Bias Reduction: AI-driven tools helped minimize biases in the hiring process, contributing to a more inclusive work environment.
3. Diverse Hiring Outcomes: The integration of these technologies led to an increase in the recruitment of candidates from diverse backgrounds, including women and ethnic minorities.

b. Impact of Technology on Employee Performance

Technological advancements were found to positively influence employee performance in several ways:

Key Findings:

1. Increased Efficiency: Automation of routine tasks such as reservations and check-ins allowed employees to focus on more complex tasks, improving overall productivity.

2. Enhanced Job Satisfaction: Technologies that streamline processes and reduce manual work contributed to higher job satisfaction among employees.
3. Improved Work-Life Balance: Flexible work schedules and remote work options enabled by technology helped employees achieve a better work-life balance.

Challenges Identified:

- Digital Divide: Not all employees had equal access to technology, which sometimes led to feelings of exclusion among less tech-savvy staff.
- Resistance to Change: Some employees and managers were resistant to adopting new technologies, affecting their effectiveness.

5. Discussion

The findings from this study highlight the significant role of technology in shaping workforce diversity and employee performance in luxury hotels in Pune. The results align with existing literature on the positive impacts of technology in the hospitality sector but also uncover specific challenges faced in the Indian context.

a. Technology's Role in Workforce Diversity

The study supports previous research indicating that technology can enhance workforce diversity by making recruitment processes more objective and inclusive. The use of advanced recruitment tools aligns with Huang and Reddy's (2022) findings that technology facilitates diverse hiring practices. However, the study also identified the need for ongoing efforts to ensure that technological solutions are accessible to all employees, echoing the concerns raised by Bresciani and Eppler (2021).

b. Technology's Impact on Employee Performance

The positive impact of technology on employee performance observed in this study is consistent with the results of Wang and Wang (2021), who found that technology improves efficiency and job satisfaction. The study adds to the understanding of how specific technological innovations, such as AI and digital HR tools, directly influence performance outcomes in the hospitality industry.

Contradictions: While the study found a general positive impact of technology on performance, it also highlighted challenges such as the digital divide and resistance to change, which were less emphasized in previous research (Drucker, 2020).

c. Implications for the Hospitality Industry

For luxury hotels in Pune, the integration of technology presents both opportunities and challenges. The study underscores the importance of strategic implementation to maximize the benefits of technology while addressing potential issues. The findings suggest that hotels should invest in employee training and support to overcome resistance and ensure equitable access to technological resources.

6. Findings

1. Technology Integration and Workforce Diversity:

   - Technology significantly enhances workforce diversity through efficient, unbiased recruitment processes.
   - Digital tools and AI contribute to a more inclusive and representative workforce.

2. Technology Integration and Employee Performance:

   - Technology improves employee performance by increasing efficiency, job

satisfaction, and work-life balance.
- While technology provides numerous benefits, challenges such as the digital divide and resistance to change must be managed effectively.

3. Correlation between Workforce Diversity and Employee Performance:

- A positive correlation exists between workforce diversity and employee performance, suggesting that a diverse workforce enhances overall performance outcomes.

7. Conclusion

This research demonstrates that technology integration in luxury hotels in Pune has a notable impact on both workforce diversity and employee performance. The study finds that advanced technological tools foster a more diverse and effective workforce by streamlining recruitment processes and improving operational efficiencies.

Summary of Key Conclusions:

- Technology promotes workforce diversity: Digital recruitment tools and AI applications help create a more inclusive work environment by reducing biases and broadening candidate pools.
- Technology enhances employee performance: Automation and digital tools lead to increased efficiency, higher job satisfaction, and better work-life balance for employees.
- Challenges must be addressed: Ensuring equitable access to technology and overcoming resistance to change are crucial for maximizing the benefits of technological innovations.

8. Future Research

Future research should explore several avenues to build on the findings of this study:

1. Longitudinal Studies:

- Conducting longitudinal studies to examine the long-term effects of technology integration on workforce diversity and employee performance. This would provide insights into the sustainability of the observed impacts over time.

2. Comparative Studies:

- Expanding research to include a comparative analysis between luxury hotels in different regions of India or internationally. This could reveal how geographical and cultural factors influence the effects of technology on diversity and performance.

3. Deep Dive into Specific Technologies:

- Investigating the impact of specific technologies, such as AI-driven recruitment tools or advanced performance management systems, on various aspects of workforce diversity and performance.

4. Employee Perspectives:

- Further exploring employee perspectives through detailed case studies or focus groups to understand their experiences with technology and its impact on their work environment and performance.

5. Technology Adoption Models:

- Developing and testing new models for technology adoption in the hospitality sector, focusing on strategies to overcome resistance and enhance technology acceptance among employees.

6. Intersectional Analysis:

- Exploring how different aspects of diversity (e.g., gender, ethnicity, age) intersect and influence the effects of technology on workforce diversity and employee performance.

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Research Article

Environmental Scanning to Organizational Success: A conceptual framework for decoding business insights

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ABSTRACT

The purpose of this research is to offer a conceptual framework for understanding the components of the business environment and how they affect an organization's operations. Decoding timely information from the environment is crucial for business organizations since it may be utilized to spot early warning signs and commercial possibilities. In order to further reconstruct the path from decoding information to organizational results and to propose a conceptual framework, the case study technique has been employed to demonstrate the importance of the business environment. Research has mostly concentrated on case studies for the Indian business environment and has addressed the likely business implications for commercial enterprises only. Only case references have been made using secondary data. The time period of cases from 1991 to 2023 have been covered only. Therefore, the primary challenge this study addresses is the absence of a comprehensive framework that connects internal and external environmental factors while providing practical insights to help organizations maintain stability and prepare for the future. Hence, to navigate these complexities, the study introduces the RPSM framework—an approach that emphasizes four key actions: Review, Predict, Stabilize, and Monitor. This framework divides the business environment into two main components: internal and external. The internal environment includes controllable factors such as a company's structure, financial resources, and human capital. On the other hand, the external environment is broken into micro and macro categories. The micro environment focuses on elements like customers, competitors, and suppliers, while the macro environment covers larger, less predictable forces such as political, economic, and technological trends. The RPSM framework helps organizations evaluate their stability and preparedness in these areas, offering a clear roadmap to anticipate and respond to changes effectively.

This framework highlights the importance of organizations actively assessing their readiness and adaptability to thrive in today's fast-paced and unpredictable world. By integrating these findings into strategic planning, businesses can make more informed decisions, remain resilient, and stay ahead in an ever-changing global landscape.

Keywords: Business Analysis, RPSM Framework, Organizational Stability, Decision Insight

INTRODUCTION

Decoding the business environment is crucial since it aids organizations in comprehending the internal and

external elements that may have an impact on their operations. Organizations can prepare for the future, predict changes, and make wise decisions by having a thorough grasp of their surroundings. Additionally, it assists them in identifying warning signs and possible favourable opportunities to comprehend the competitive environment. The influences and elements that affect a company's operations and performance are collectively referred to as the business environment. Economic shifts can have an impact on a company's capacity to raise money, recruit staff, and attract clients.

LITERATURE REVIEW

Foreign companies are more inclined to invest in countries with better general business conditions since they will draw more high-quality FDI inflows. (Wang and Zhuang 2019). When choosing a business location, entrepreneurs consider geography. An area's natural geographic advantages can be a big lure for industry, especially for sectors that depend significantly on natural resources. (Krugman, 1993). Kirsten (2020) examined the connection between macroeconomic indicators and economic policy uncertainty in South Africa. The results showed that a sharp increase in the uncertainty index caused industrial output to decline and the value of the currency to depreciate. When economic actors are unsure about how government policies will affect the economy, policy uncertainty results. Due to the constantly changing technical landscape, artificial intelligence

has transformed traditional production into intelligent and sustainable manufacturing. (Bag et al., 2021; Chatterjee et al., 2021b; Zeba et al., 2021). The transformative effects of AI in manufacturing underscore the importance of intelligent agents, expert systems, big data analytics, blockchain, and IoT in the context of Industry 4.0 (Culot et al., 2020; Dwivedi et al., 2022). Educational institutions have employed data analytics for enormous data sets to gather valuable information for internal use. Saini & Manocha (2022). Global warming and extreme weather, according to Stott (2016), alter both natural ecosystem and the human social structure. Consequently, the effects of the weather directly affect economic output (Minner,2001). One of the earliest and most extensively used strategy tools globally is the SWOT analysis. According to Saini, P & Manocha, S.(2022) scanning of environment always beneficial for business and social organizations .

Few methods exist for studying the company environment, such as SWOT analysis (Stewart et al., 1965a, p.16), which is widely used in retail to understand both micro and macro settings. According to Stewart (1963), it is among the earliest models for strategic planning. Because of its complexity and diversity, there is no commonly agreed definition of strategic planning, despite the fact that it offers a wide range of potential benefits for companies in defining future direction and profitability (Piercy et al. 2012). The PESTEL technique (Aguilar, 1967; Peteraf and Bergen, 2003) and the 5-forces industry analysis (Porter, 1989) are two old, conventional market scanning frameworks that managers utilize for the external environment.

Decoding information is important for company utilization and sustainability, claim Saini, P. & Singh, D. (2024). One weakness in the current business scanning approach is that it does not include information on the internal environment of the company or current industry contextual examples. Finding solutions to the questions based on the study's aims will close the theoretical and conceptual research gap.

Objectives

- To provide a short and meaningful review of the literature on analysis of business environment.
- To propose a framework for decoding business information for decision making
- To analyze the impact of regulatory environment on the operations of an organization.

Conceptual framework Table 1: RPSM Framework

1-Internal environment (Controllable factors)	**Company's position**		
	Low	**Moderate**	**Highly stable**

• Internal structure • Value system • Financial capability • Image • Marketing capability • Research & Development • Physical assets • Human Resources			
2-External environment (Uncontrollable factors)	**Company's Strength & response**		
	Low	**Moderate**	**Highly stable**
Micro environment • Customers • Competitors • Financiers • Market - intermediaries • Publics pressure groups • Local Government agencies • Suppliers			
Macro environment	**Company's Understanding & preparedness**		
	Low	**Moderate**	**Highly stable**
• Political and Legal • Economical • Socio-Cultural • Technological • Natural • Global			

Business environment can be studied into two sub parts:

1. Internal Environment

This encompasses all organizational forces that directly affect the day-to-day operations of the organization. All of these things are under the organization's control. The elements of the interior environment are as follows:

Internal structure: Corporate outcomes are significantly influenced by the organizational hierarchy, managerial levels, professionalism, and the composition of the Board of Directors. Some management styles and frameworks encourage quick decisions, while others take longer.

Value system*:* An organization's culture, ethics, and standards established by its founders and management are all part of its value system. In the case of Kingfisher, Mr. Vijay Mallya has been charged with fraud and money laundering after he defaulted on 17 Indian banks totaling around Rs. 9,000 crore. On the other hand, the Tata Group is renowned for operating morally and leading by example.

Financial capability: This speaks to a company's ability to raise, use, and manage capital flows as well as its solvency and liquidity. It is crucial for achieving corporate objectives.

Image : Any unfavorable remarks against the company's practices, workers, office politics, or goods could put it in danger. Nonetheless, a positive reputation always helps to boost the company's sales and brand equity.

Marketing capability: The firm has control of its marketing capability, which is the primary differentiator for

accomplishing organizational objectives. Numerous businesses, such as Vini Cosmetics' Fogg deodorant, Nestle's Maggie, Dominos' Pizza, and others, have had outstanding success with their product promotion.

Research & Development: The company's capacity to innovate and compete is determined by its technological capabilities, research, and development. This is one of the important critical differentiators that determines how quickly a firm grows.

Physical Assets: The organization's competitiveness is influenced by a number of internal elements, including physical assets and facilities such as offices, industrial plants, sophisticated machinery, production capacity, technology, and distribution networks.

Human Resources: Human resources (HR) is the department of a business responsible for finding, selecting, interviewing, and training job candidates. It also oversees benefit plans for employees. HR is essential in the twenty-first century to assist companies adjust to the rapidly shifting business environment and the growing need for skilled labor. Talented workers are one of the most important components of an organization's success.

o. External Environment

This refers to all forces that have indirect impact on the long term activities of the organization. This is further classified into two sub parts: Micro and Macro.

***Micro environment*:** This term refers to the conditions in a business's immediate environment that affect its performance and choices. The business operates in a little area that is attached to it. The key elements of this job environment are as follows:

Customers: Creating and keeping clients is the main responsibility of commercial organizations. Consumers are seen as the market's kings. For their products to continue meeting and surpassing their expectations, businesses must decipher their shifting tastes and preferences.

Competitors: In addition to other businesses that sell comparable goods, a company's competitors are all those that vie for the consumers' discretionary income. Companies from many industries compete with one another to get as many people to purchase their products as possible. If an organization wants to stay in business, it must keep an eye on its rivals. When Reliance Jio entered the telecom market, other companies had to adjust the prices of their goods.

Financiers: The organization's financiers are another significant micro environmental element. They give businesses the money they need to launch, run, and grow their businesses. Without sufficient funding, companies are unable to purchase personnel, supplies, or equipment that are necessary to run their everyday operations.

Market intermediaries: are businesses, associations, or people who support producers in their efforts to distribute goods to customers. Determining the type of profit margins to share with them is also crucial, and in certain industries, market intermediates are essential for increasing product sales. There are direct agents in insurance companies who are not staff members but receive commissions from the business they bring in. . The majority of the things they sell are those for which they receive the highest commission, not those with lower prices. Thus, their role becomes significant.

Public pressure groups: One person, an NGO, a media outlet, local residents, a political opposition party, etc., can all be considered a public pressure group. Farmers protested against Tata Motors' Nano manufacturing facility at Signur, Hooghly district, West Bengal, which was backed at the time by opposition party leader Mamta Banerjee. The Tata Company moved its production factory to Sanand, Ahmedabad district, Gujarat, after suffering a loss of almost Rs. 10,000 crore as a result of this protest.

Local Government agencies: Municipal committees, Nagar Nigam, and other local government organizations grant building permits, supply water connections, grant business operating licenses, collect property taxes, and more.

Suppliers: those who provide the business with inputs like components and raw materials. In contrast to businesses that provide financial services, organizations that deal with and offer daily-based food to consumers, such as Mother Diary and Amul Co., must conduct constant supplier monitoring.

Macro environment: refers to all of the factors that have an indirect impact on how businesses operate and how

employees work. These issues are beyond the organization's control and cannot be controlled in any way.

Political and LegalGovernment influence over tax laws, trade agreements, foreign direct investment, monopolies, merger regulations, and consumer protection is determined by this element. This also covers the functions of the legislature, the courts, industry regulators, dispute resolution procedures, etc. In 1991, the Indian government opened its economy to the outside world by implementing liberalization, privatization, and globalization, or LPG. The government's July 2017 implementation of the GST had both beneficial and detrimental consequences on businesses. In a similar vein, demonetization in 2016 affected corporate entities. Businesses that continue to monitor the business environment exploit information.

In order to access the highly potential insurance industry foreign direct investment (FDI), which was raised from 26% to 49%, many insurance companies have traveled to India. The following significant legal regulations must be addressed by business companies doing business in India:

Indian contract Act 1872: outlines the circumstances under which the contractual parties' promises are enforceable against them. The 1983 UK case of the Carbolic Smoke Ball Company serves as an excellent illustration. In this instance, the business advertised their product with the claim that anyone who took the smoke balls as directed would not contract influenza. The business promised to provide the person 100 pounds right away if they did. As a sign of their commitment to this proposition, the business put a thousand pounds into a public bank. Carlill purchased the medicine and took it as directed, but he still contracted the flu. She sued to get the money that was promised in the advertising back. The business said there was no contract between them, thus they refused to pay. It was decided that a contract between the individual and the business resulted in the Carlil being paid 100 pounds.

. ***Foreign Exchange Management Act 1999:*** regulate transactions involving foreign securities and currencies. This law improves the business climate in India, boosts GDP, and enables cross-border capital flows and commerce. Under this statute, the Enforcement Directorate (ED) brought a complaint against the BBC in April 2023 for the company's violations of foreign direct investment (FDI).

Competition Act 2002: is one such rule that aims to combat anticompetitive activity by mainly outlawing anticompetitive contracts and cases of market power abuse. This statute imposes stringent regulations in three specific sectors, which hinders small businesses and fosters their growth. cartels and other anti-competitive arrangements; abuses of dominance; and mergers that may have anti-competitive effects. Eleven cement companies, including major players like UltraTech, Binani, Ramco, JK Cement, ACC, Century, and Shree Cement, as well as their trade association Cement Manufacturers Association (CMA), were fined more than Rs. 6700 crore for cartelization by the Competition Commission of India (CCI) in August 2016.

Consumer protection Act 1986: intends to protect consumers' interests and make sure they are shielded from abuse and unfair business practices. Businesses take this act into consideration while creating goods and services for clients. Basic necessities, safety, information, choice, representation, redress, consumer education, and a healthy environment are the eight rights of consumers.

Right to information Act 2005 gives anybody the right to access data that is maintained or managed by a public authority. This technique is used by private businesses to collect valuable commercial data from the government.

Companies Act 2013: regulates a company's formation, responsibilities, directors, and dissolution. In 2008, four directors of Satyam Computer Services Ltd. were fined Rs. 5 lacs and sentenced to six months of simple jail under this statute.

Indian Trademark Act 1999: encourage innovation and business ventures by making its owners well-known and affluent in a broader sense. Additionally, trade mark protection stops dishonest rivals, such as counterfeiters, from using similar distinguishing marks to promote inferior or irrelevant goods or services. An important ruling in India's history of intellectual property rights is the case of Coca-Cola v. Bisleri International. Coca-Cola purchased the trademark of the mango drink MAAZA from Bisleri in India. Later, Bisleri began exporting mango drinks with the MAAZA trademark after submitting an application to register the trademark in Turkey. Coca-Cola went to the Indian court to request relief and damages for trademark infringement of MAAZA. . Coca-Cola went to the Indian court to request relief and damages for trademark infringement of MAAZA. Coca-Cola was successful in getting

Bisleri to submit to an interim injunction for trademark infringement.

Industrial dispute Act 1947: offers resources to promote positive relationships between parties, such as employers and employees, employers and employers, and employees and employees, and to resolve disputes in an amiable manner.

Essential commodities Act 1955: has been employed to control the production, distribution, and supply of goods referred to as necessities. The Indian government has used this statute to combat crucial commodity hoarders and black-marketers. It has frequently been used to guarantee sufficient supplies and shield customers from illogical increases in the cost of necessities.

Economical: These variables, which might be big or little, are frequently out of a company's control. An economic system is the result of the interaction of various factors, including consumer spending, inflation, interest rates, and consumer behavior. An essential tool for comprehending economic activity is the business cycle.

Socio-Cultural: The emergence of Islamic banking in Middle Eastern nations may be attributed only to corporate comprehension of the socioeconomic landscape. Due to its understanding of Indian culture, the South Korean manufacturer LG set a world record in 2006 by selling and installing one million TV sets in 10 days over the Diwali holiday. In Indian real estate, businesses refrain from assigning the number thirteen to the apartments and stores they offer for sale since some people consider it to be unlucky. Not even the city of Chandigarh has a sector with the number thirteen. Italy, a well-known Italian airline, does not have this seat number. other businesses overlook the fact that other cultures read from left to right instead of right to left.In the Middle East, a hoarding featuring three images from left to right—a man with a headache looking dejected and in agony, a man taking a medicine, and a man grinning without a headache—will not have the same promotional impact as in North America and India.

Technological: Technology continues to influence the types of products that businesses offer in a variety of ways. India uses 220 watts for electrical equipment, while the United States uses 110 watts. The Nokia Company, which was once the market leader in every way, lost its market share and reputation due to its inability to recognize and adopt new technologies.

Technology complicates business products, making it challenging to determine who they must compete with in the market. Manufacturers of exclusive cameras, such as Kodak and Nippon, did not expect to have to contend with manufacturers of mobile phones, such as Samsung, Nokia, Apple, and other companies in the same sector, since phones now come equipped with cameras.

Natural: The way that a certain industry develops in a certain geographic area is greatly influenced by the natural environment. The mining industry is growing in places like Jharkhand, Bihar, and Odisha because it depends on natural reserves. A few examples of these enterprises are Jindal Steel and Sail. Textile production requires raw materials like cotton and fabric, which is why places like Tamil Nadu, Maharashtra, and Punjab have a large number of these businesses. In hilly areas, Jeeps and power cycles are more popular than in plain ones. Compared to sea locations, hilly areas have a greater demand for winter apparel.

Global: The global COVID-19 pandemic, which began in China in 2020, has infected every nation and halted all activities, including commerce. The world used to move toward globalization, but now days, it's moving toward de-globalization. Nowadays, the majority of nations adopt a protectionist stance for their own industries and economies.

CONCLUSION

The new RPSM framework separates the environment into internal and external components, with the latter studying the environment's micro and macro features. Internal structure, value system, financial capabilities, firm image, marketing capability, research and development, physical assets, and human resources are all part of the controllable internal environment. For these variables, organizations must know if they are in a low, moderate, or highly stable position. Customers, rivals, investors, market middlemen, public advocacy organizations, local government organizations, and suppliers are all part of the microenvironment. This work environment is used by industry as a whole. Organizations must determine if they are low, moderate, or very stable in terms of their strengths and response preparedness for the microenvironment. The macro environment encompasses

unpredictable political and legal, economic, sociocultural, technical, natural, and global factors. Organizations must assess their comprehension and readiness to adjust to changes in these external environment variables, i.e., whether they are low, moderate, or extremely stable.

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A Comprehensive Review of Literature on Digital Payment Systems in India

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ABSTRACT:

Digital payments are financial transactions carried out electronically via various digital platforms. These transactions utilize devices such as smartphones, computers, or cards to transfer funds between accounts without relying on physical cash. The growing popularity of digital payments can be attributed to their effectiveness, quickness, and ease. The adoption and effects of digital payment systems in India are examined in this systematic review. The country's digital payment landscape have undergone a significant transformation, fueled by government initiatives like demonetization, the Digital India campaign, and the introduction of the Unified Payments Interface (UPI).

Key Word – Smart devices Electronic Payments, UPI

Introduction:-

Digital payments involve financial transactions carried out electronically through online platforms, mobile applications, or other digital methods, eliminating the need for physical cash or checks. These transactions encompass a wide range of activities, including online purchases, bank account transfers, digital money transfers between peers and wallet payments. In the current digital era, digital payments have become the preferred option due to its simplicity, quickness, and frequently higher level of security when compared to older payment methods.

Features of Digital Payments:-

 Ease: Digital payments are incredibly convenient since they do not require physical presence or the handling of cash, enabling users to conduct transactions at any time and from any location with an internet connection..

 Fast: Fast money transfers between parties are made possible by the fact that transactions utilising digital payment methods are typically executed far more quickly than those involving cheques or bank transfers.

 Availability: As long as they have access to the right infrastructure and technology, a wide range of users—including individuals, companies, and organizations—can utilise digital payment systems, regardless of where they are.

 Safety: To safeguard users' financial information and stop fraudulent transactions or unauthorised access, many digital payment systems include strong security features like encryption, authentication procedures, and fraud detection systems.

 Affordability: Since digital payments usually involve fewer transaction fees, less paperwork, and more efficient procedures, they are frequently more cost-effective than traditional methods, saving money for both customers and businesses.

 Traceability: For auditing, compliance, and dispute resolution purposes, users, financial institutions, and regulatory bodies can readily follow and monitor the transparent record of transactions created by digital payments.

 Scalability: These systems are scalable to satisfy the expanding needs of consumers and businesses because they are made to manage a large number of transactions at once.

Different Types of Payments:-

1.Mobile Bank:- Travelling banking refers to transporting undertakings and other exercises via travelling ploys, typicallythrough the bank's travelling request App . These days, the majority of banks have travel banking apps that may be used with handheld devices like smartphones and tablets and with limited computer opportunities.

2.Internet Banking:- System where banking transactions are completed electronically Internet banking as known or named at another time or place e investment or digital payment, permits customers of a specific bank to use the bank's website to complete transactions and carry out other business-related activities. To generate fees and access a bank's website called System, where electronic banking transactions are carried out, a reliable internet connection is necessary.

3. Mobile Wallets:-As the name suggests, mobile wallets are a particular kind of wallet where you can transfer money in a mathematical pattern. In order to better secure digital endeavours, clients often link their investment cards or bank reports to their wallets. Another wallet usage behaviour is looking for services to add to the travel wallet and using the balance to send money.You can also look over the mathematical wallets guide to clear up any doubt and perform any essential assessments. Phonepe, Free Charge, G-Pay, Mobiwik, mRupee, Vodafone M-pesa, Airtel services, Jio services, SBI Friend, ICICI Pockets, and others are examples of often used secondhand ones.

4. Banking Debit/Credit Cards:-Investment cards, entry/credit cards, or prepaid cards are frequently used by Aboriginal Americans as their preferred method of payment. India's first charge card was introduced by Andhra Bank in 1981.

5.UPI:-The Newsgathering organisation is a technique that admits service transfers between entities and condenses numerous bank reports into a single request. In contrast to RTGS, IMPS, and NEFT, the Newsgathering organisation has a well-thought-out, consistent procedure that works for all banks. With only a few clicks, you can introduce a bank transfer anywhere with the help of a news gathering organisation.

2. REVIEW OF LITERATURE:

Jacob Kurian, 2022: The study titled "India Digital Payments and Their Impact on Consumers" aims to explore various aspects of digital payment adoption. The primary objectives include investigating the impact of respondents' age on digital payment usage, examining the influence of customer education on their engagement with digital payments, and analyzing the effect of income status on the adoption of digital payment systems.

The study employed a structured questionnaire for data collection. Both primary and secondary data were utilized in the research methodology, with analysis carried out using simple percentage methods and chi-square tests. The findings were based on a sample population from Bangalore.

The primary goal of the survey was to gather customer opinions about digital payments in the context of general banking. The results indicate that the implementation of digital payment technologies has significantly improved the performance of the banking sector and contributed toward achieving the vision of a cashless society.

Dr. Vatsal Patel, 2021: The study titled "Impact of COVID-19 on Digital Payments in India" focuses on understanding the changes brought about by the pandemic in the adoption and usage of digital payment systems. The objectives of the study include:

1. Understanding the importance of digital payments during the pandemic.
2. Examining various modes of online payments.
3. Comparing and analyzing current digital payment trends with pre-pandemic data.
4. Evaluating the usage patterns of digital payments.
5. Highlighting challenges and issues associated with digital payment systems.

The research follows a conclusive approach and employs secondary data for analysis.Key findings of the study reveal that the pandemic significantly increased the use of digital payments as a safety measure. Post-COVID-19, nearly every retail outlet adopted digital payment systems for both receiving and making payments. This shift encouraged customers and critical service providers to embrace digital transactions to ensure security and convenience. The digitization of the banking sector has proven instrumental in meeting the growing expectations of the population. Additionally, enterprises benefited from the flexibility of not being constrained by traditional banking hours.

LeebanaGracy I,2024: The study focuses on understanding user experiences with digital payments. The objectives of the research include:

1. Examining the relationship between age and digital payment usage.
2. Analyzing factors influencing the adoption of digital payments.
3. Exploring the challenges faced by users.
4. Assessing awareness of digital payment applications.
5. Evaluating user satisfaction levels.

The study primarily relied on primary data collected from respondents across various demographics, including age, gender, and occupation. Secondary data sources, such as research articles, journals, and magazines, were also utilized. A sample size of 50 participants from Bangalore was selected for the study.

Gupta,A., & Jain, R. (2023): Emerging technologies like block chain, crypto currency, and artificial intelligence are expected to shape the future of digital payments, enhancing security, transparency, and convenience. While these technologies are in their infancy, they hold potential for transforming rural payment systems, including regions like Marathwada.

3. RESEARCH GAP:

From the review of biography it is clear that few studies are completed activity accompanying has connection with impact of digital fees on services, patterns of mathematical fee, impact of Covid-19 on mathematical payment. Still no studies have existed transported out accompanying has connection with reviews of article on digital fees.

4. RESEARCH OBJECTIVES:

The study's objectives are as follows:

1. To understand India's digital payment conceptual framework.
2. To review literature with regard to the impact of digital payments inIndia.

Scope:

Only material related to digital payments in India was included in the analysis. Through a review of the literature, the study addressed the effects of digital payments in India.

5. Research Methodology:

For the research paper, data wascollected from secondary sources likeResearch paper, websites, andarticles that are related to the research topic.

FINDING AND CONCLUSION:

Taking into consideration that digital payment systems offer significant advantages over traditional payment methods , they have fundamentally transformed the financial landscape These benefits include enhanced convenience, faster transactions, and better security . Digital payments have also facilitated greater integration into the financial system, which has improved access to banking services for the unbanked and under banked .However, the transition to digital payments is not without challenges. Issues such as cybersecurity threats, privacy concerns, and the digital divide must be addressed so that digital payment platforms can serve all demographics equally and safely .Technologists must collaborate to develop robust regulatory frameworks and innovative payment solutions that protect consumers and promote consumer adoption of digital payments.Overall, the ongoing evolution of digital payments presents an important opportunity to connect and optimize global economies , underlining the need for continuous innovation and regulatory oversight .

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Corporate Social Responsibility Innovation in Ethical Technology Leadership

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Abstract*— The CSR role is a crucial component of the technologically efficient production required for general economic growth and trends. In today's dynamic world, corporate social responsibility (CSR) has become essential to the advancement of society, and the government has mandated it for all businesses. The business is now requiring technical advancement to be a component of CSR initiatives. The main components of CSR productivity and the expansion of any organization's CSR involvement are reducing human error and increasing productivity and efficiency. When efficiency leads to work output, it becomes challenging to carry out sustainable development activities, which are laborious chores for sluggish growth. The study's primary focus is on CSR management policies that are in line with framework costing, marginal costing with the rate of a company. For this reason, we need to concentrate on more substantial theory development for selecting the right technology for the right business with the right flow process with productive output for economic and productive measurement where fewer resources can be used and maximum benefit can be enriched for the process end. Technology is essential to the current pattern of economic development. The development of social infrastructure, which is necessary to access technology in order to attain the end objective with a well-chosen channel and fair labour allocation, is what defines its progress. More technology-centric work has been the foundation for the development of new businesses and is the key to the expansion and improvement of organisations. Its foundations are more effective in the growth of the

Technology plays a vital role in the current economic development pattern for this characteristic we must focus on more substantial theory development for choosing the right technology for the right business with the right flow process with productive output for economic and productive measurement where fewer resources and maximum benefit can be enriched for the process end. Its growth is characterized by social infrastructure development which is required to reach technology to reach the goal end with a properly decided channel and equitable distribution of work.

The most crucial thing in CSR is planning. Without planning CSR activities are very tough to implement hence every organization must focus on the planning and later execution of the work process. In CSR activities a key role is the importance of technological-based monitoring in this study we are trying to find how to mitigate the gap and risk by proper planning through technological base rules and governing. This helps with the analysis for workflow machinery which is required for tool measurement and data analysis part for whole data review.

1. Technology Alignment and Strategic Vision

Corporate leaders must have the capacity to develop a clear, forward-looking vision that combines technology developments with the organization's overarching business goals. Effective technology leadership requires strategic vision, which includes recognizing and incorporating more business output and business context.

2. Transformational Leadership-

Leaders in this category inspire their team to have more of innovation, embrace change, and focus on aligning the workforce value-integrated system in the technology and value space. Effective IT leadership also requires fostering an innovative and flexible culture. Businesses need to be nimble, ready to shift course rapidly in reaction to market developments, and open to trying out novel concepts in the fast-paced business world of today. Business executives need to promote an attitude that embraces technology innovation in all areas of the organization, not just the IT division. This entails encouraging cross-functional cooperation, giving staff members the means to try new things, and offering the encouragement needed for innovation to flourish.

Risk-taking is intrinsic to an innovative culture, but it also necessitates thoughtful decision-making. Leaders need to manage the risks associated with new technology, including operational disruptions or cybersecurity threats, while simultaneously promoting innovation. They have to promote more permutation and combination in the business activity to get the best output and trust.

Improving Operational Efficiency Using Technology

Corporate technology leadership entails optimising internal procedures in order to improve operational efficiency. This includes using automation, artificial intelligence, and data analytics to improve workflows, lower costs, and increase productivity. For example, robotic process automation (RPA) can remove repetitive, optimizing-consuming operations, whilst AI-powered systems can optimize supply chain management or improve customer service.

Used of Corporate CSR leadership role and its significance study for sustainable and business work with findings and its significance-

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Leadership role briefing with technology advancement.

Technology leadership involves more than just technical expertise; it also requires great people management skills. Effective technology executives must be able to manage cross-functional teams, bridge the gap between IT and business units, and ensure that technology solutions fulfill the needs of all stakeholders. Leaders must explain the goal for technological adoption and ensure that all employees—from technical personnel to end users—are on board with the company's digital strategy.

Furthermore, change management is a critical component of technological leadership. Employee uncertainty, lack of understanding, and fear of job displacement are common reasons for resistance to digital transformation initiatives. Leaders must be able to assist their organizations through these transformations by providing clear information, offering training and support, and creating an inclusive workplace.

Creating a culture of efficiency and innovation-

Culture play's vital role in creating an efficient workplace model for business development output. Leaders must have business support and business evolvement for the growth of the business development. That supports the organization's strategic goals, encourages innovation, and ensures operational efficiency.

Psychological safety development for business outcomes- High-performing teams are often on a foundation of trust and business development for comfortable voicing for business their opinions, taking risks, and understanding for overall business for challenges without fear of retribution.

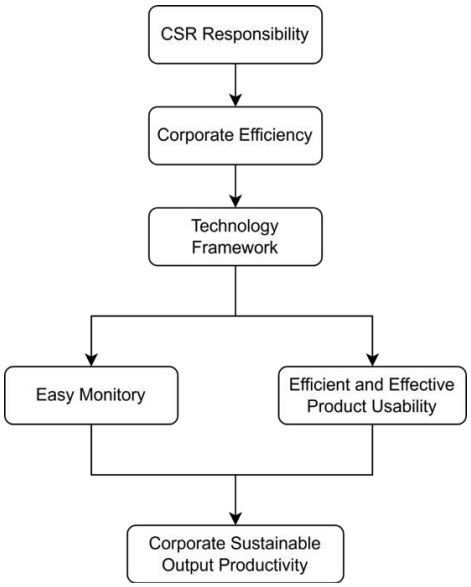
These foster both innovation and efficiency for the business outcome for social growth and business development patterns. Lastly, maintaining a competitive edge in technology requires business leadership. In a world where technology is developing quickly, businesses need to constantly innovate in order to stay one step ahead of their rivals. In this context, leadership entails staying ahead of technical trends, regularly evaluating and modifying the infrastructure of technology, and adopting disruptive innovations proactively rather than reactively. Leaders must also concentrate on using technology to create value by improving client experiences, producing new goods and services, and figuring out innovative cost-cutting measures. Organizations may stay relevant and stand out in a crowded market by being able to consistently innovate and take advantage of new technologies.

Case studies for this-

Companies adopting a cloud-first strategy - using Azure to boost productivity and make scalable, team-based work environments possible. Tesla is a prime example of automation and artificial intelligence leadership, upending the auto sector with self-driving technology and intelligent production methods. Siemens has also adopted the Industrial Internet of Things (IIoT) to detect equipment breakdowns and optimize the production process, illustrating how IoT may enhance operational performance.

Companies demonstrating how the Industrial Internet of Things (IIoT) - may enhance operational performance by forecasting equipment breakdowns and optimizing its production processes. The study highlights the significance of visionary leadership in promoting efficiency, innovation, and transformation in the contemporary business environment by analyzing these organizations' technological usage. In the end, it emphasizes how business executives need to combine technical know-how with strategic vision.

Index Terms: CSR productivity, governance, the internet, company model, growth, Development.



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I. INTRODUCTION

Leadership and CSR are two pillars of any smooth organizational work. Its efficiency depends on the flow of work where the total work and speed of the technology implementation and its monitoring of work access plays a vital role. The importance of the study has been how the study is aligned to the technological needs and how the development is more strategically advanced in terms of usage of workflow and analysis. This has been the intrinsic flow to study in this usage of work. This has led to overall holistic development of speedy work progress in the field of more analysis on the work management system and technological analysis where the system is more of an economic tool is more no available for healthy and frequency match in the efficacy of the work output machinery which gives both the quality and quantity output of the work output.

This has increased the rate of work output processing on a larger scale where technology avoids the cascading of work and measures the efficiency of the tool measurement work in a more organic manner resulting in the work being full of technology that will help the used for the development of the process and it result in the system.

CSR initiatives, measure their impact and engage the stakeholders which are creditors, customers, debtors, suppliers, Shareholders, and Lenders, which are part of the csr activities where efficiency and productivity are the main key stakeholders for the development of the overall business growth and efficient output. Implementing CSR technology helps to increase the efficiency of the output which carries out the society's beneficial activity which creates and helps for the development of society and upliftment of society and oppressed people. It is kindheartedness for the society people for overall development materialistic it helps which gives the overall development for the upliftment for overall as it grows society as a whole for having companion and empathy towards each other. Basic By collecting and analysing data on their social and environmental performance, companies can ensure that their CSR activities are making a meaningful difference and are aligned with business needs and objectives. Environmental initiatives are more technological and will help to invest in sustainable technologies, which give more product development for technological empowerment for the overall growth of the business aspects. (Nagendra, N. P., KUNAR, K., & Bettiol,) Regularly reporting on CSR progress is more important and is required for the overall development of society which creates an emphatical development of society as a whole. (Pucheta-Martínez, M. C., & Chiva-Ortells, C) It helps to understand overall development where there is understanding for overall growth where there is more importance for a great company's growth for overall development for social development was technological development with sustainable development.

II. OBJECTIVES-TO SHAPE A BRIGHTER FUTURE AND HEALTHY SUSTAINABLE WORLD BY VALUING HUMAN EQUITABILITIES

1) **Philanthropy activities-** The main aim is to develop artificial intelligence and emphasize fair charitable activities for growth and development overall growth of the nation and where the development is to find the analysis and overall development of the organization for the economic analysis its between the gap bridging haves and haves not with focus to develop the measure output is on the empirical analysis for overall growth rate of the economy as a whole and understanding with equality as a whole.
2) **Technology modern base-** Technology which drives the country for the development as equal which helps to grow synthetically which is a must for proper work understanding and work progress. It emphasizes more on organic development for the category of social and equitable development necessary for pushing and fostering inclusive growth in the organization's growth prospective concern and matter.
3) **Accountability and responsibility-** The development is more dependent on the natural subline and more towards and also helps more natural process for growth orientation where there is more focus and sublines for business undertaking and development for the country as a whole. The organization is not responsible individual level but it is also responsible for the country where the technology that is introduced is assimilated with the company and used directly for society as a whole and development for the society as a whole. Any error may result in a loss pattern affecting a negative impact on the organization's ethical practices. Hence accountability and responsibility are more important factors for social analysis and growth oriented. The regular audit is to be done so that minimize error and rectification can be done on a timely basis, it also helps to find intent in the CSR role which is a key element to knowing the purpose for future business framework development for the organization to enhance its long-term sustainability for the organizations as a whole.
4) **Embracing the CSR changes-** The CSR role is more towards ethical development for data analysis and continuous improvement for the building trust and large-scale development of the project skepticisms where long-term growth oriented is kept into the focus and equality of the work to carry the work means and benefits of the natural work process This leads to the work overflow and process being the greater skips of the development of the character of definite means to embrace and integrated CSR role developments.
5) **Impact Of CSR measures-** The CSR role and development is more goal-oriented which results in a work measurement profile that helps increase trust

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building and also helps in the improved reputation for social and cultural development of the characteristics that are required for smooth and environmental which maintains the dignity of the standard measurement of the practices which are necessary for overall growth for social development to characterize the development behavior social impact and business impact for organization functioning resulting in characteristics variations.

6) **Compliance and Stakeholder engagement**-CSR complies with the primary goal and across sectors for goal-oriented methods for social and stakeholder satisfaction gain in terms of quality of service and monetary gains it helps to develop brand equity and qualitative image required for long-term growth and sustainable approach for governing the laws, regulations and international accounting and compliance standards for the boost of step-wise process orientation for overall growth development aspect necessary for long term approach development.

III. LITERATURE REVIEW - THE THEORY OF CSR WITH THE ALIGNMENT OF TECHNOLOGY FOR A COMPANY'S NEED FOR SUSTAINABLE SUCCESS IS THE PRIMARY GOAL

The CSR role is based on the qualitative implications output which companies are laying the foundation of for the development of society here the references how the technology has been taken into consideration for overall development for the CSR integration. CSR base has how to be implemented by top management with empathy leadership as a oneness has been taken into consideration whereas society as equality for where business competition is secondary and focus is more dependent for overall strategic development for the organization for country's output which has been referred literature with technology and for overall economic upliftment as society whole with its output based. Methodology in studying CSR with technology often involves a combination of qualitative and quantitative approaches. (Herkert, J. (2006, May)) Literature gives evidence of the importance of a full research report to the stakeholders which drives the CSR activities.

Discussion-Corporate Corporate Social responsibility has become a significant aspect of business operations in today's society. With the advancement of technology, companies are to implement sustainable practices and create social impact. By utilizing technology, companies can measure their CSR initiatives more efficiently ensuring they are making a positive impact on society about the environment. (Brown-Liburd, H., & Zamora, V. L. (2015)) There is transparency and open communication with CSR activities create a social impact on the overall development of the business growth and it becomes more environmentally society becomes healthier and poverty alleviation. The business model of CSR plays a vital role in Business shaping for overall development for business growth and upliftment. Integration of technology is main for successful development for upliftment and sector relation leads to growth development for a business model that benefits the company and society.

1) **Rational cognition**- It refers to awareness of CSR role development for national programs in the field of structural and social development for business operations.
2) **Ethical decision making**- The decision-making depends on perspective buyer requirement and customer analysis function which is of more important tool analysis and development parameter for the overall social and cultural ethical matrix of analysis.
3) **Action of CSR code of conduct**- CSR code of conduct is the most crucial development which is required to be concise in a clear and infrastructural development and context analysis of technological inputs for the social development behavior analysis patterns and socially sustainable actions of input-output theory structure.
4) **Level of CSR performance input**- The context in performance inputs refers to data and information usage required to assess the information usage for measure the company's performance for overall social input and technological inputs which makes a utility for the different classes of customers, employees, investors, communities Comparative data usage is powerful with technological software device usage for understanding the different sector-specific CSR initiatives for the cause and wellbeing of the development factor of social and infrastructural undertakings of the development cause-effect.
5) **Environmental CSR assessment impacts**- This leads to data analysis study of scientific study where the environmental data and references are taken into consideration for the understanding of cause and social effect to develop an open market analysis for total business growth development for entry into equal thought and business development and system analysis pattern. Structural behavior which is more often suitable for the public at large and involves a business's main purpose is the utility of fixed proposition of work analysis and work synthesis of structural mark behaviour pattern.
6) **Supply chain role in CSR compliance work enforcement**- Feedback from employees is a more crucial part of the structure which is required for managing equitable actions for the development of social and cultural characters It is possible only when then there is a sort of role understanding between the industry peers and sector related initiatives development. This scientific data on usage for input understanding for the development for which the laws, industry peers, environmental social ground clearance building for the analysis of total development industry

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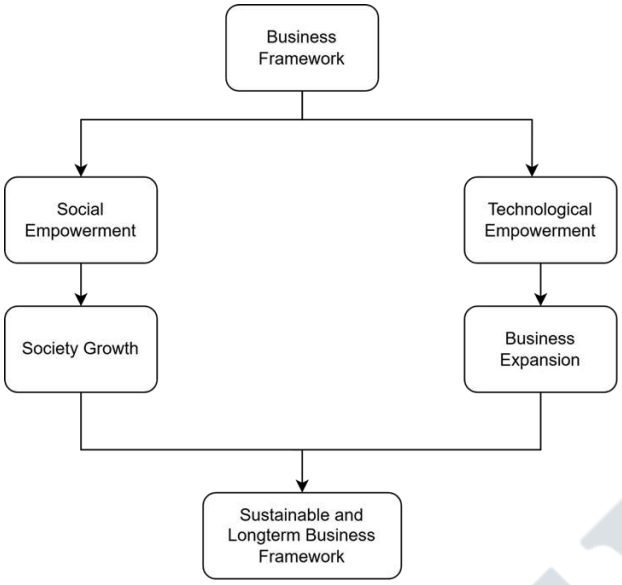
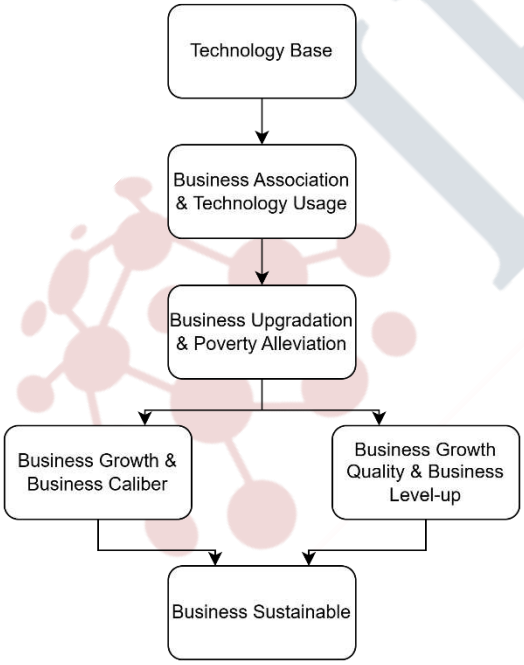
benchmark employee engagement survey where there is a large number of social understanding volunteering hour in between where development for remembering the total level of input is the levelling of the transparent business process.



Sustainable Development of Business Growth



IV. RESEARCH METHODOLOGY-METHODS OF PRACTICE FOR BUSINESS PRACTITIONERS AND POLICYMAKERS

Based on the case studies analyzed in this research, several methods of practice can be drawn to guide both business practitioners and policymakers in enhancing the role of CSR leadership in technology and sustainable development. These practices focus on integrating CSR initiatives into business strategies and leveraging technology to achieve long-term sustainability goals. Below are key methods of practice for companies and governments.

The purpose of this study is to investigate how corporate leadership can use technology to improve organizational effectiveness and commercial success. Qualitative and quantitative methods will be combined in the research technique to provide a thorough understanding of the topic. The approach will consist of several steps, each intended to collect comprehensive information and insights from diverse viewpoints in corporate leadership, technology management, and business operations.

A. Secondary data analysis-

The data from the case studies and interviews will be subjected to thematic analysis, which will identify and classify important themes about business outcomes, technology adoption, and leadership approaches. The following will be important steps in the analysis:
1) Interview data transcription and response of various data analyses and data present.
2) Recognizing reoccurring patterns or methods of leadership.
3) Contrasting and comparing results from various businesses and industries.

B. Sources for research methodology with secondary base

1) **Reports on Corporate Sustainability** - Every year or every two years, a lot of companies release comprehensive CSR or Sustainability Reports in which they describe their CSR programs, the technologies they have used, and how those programs have affected their social and environmental performance. Rich qualitative information about the role of leadership in promoting the adoption of sustainable technology can be found in these reports.
Example - Tesla corporate sustainability, TATA motors annual CSR report, Tata Sustainability report, Reliance Industries report on CSR activities.
2) **Market research and Industry reports** - Numerous research and consultancy organizations release papers tailored to a particular industry that address how technology can advance sustainability, boost productivity, and accomplish corporate social responsibility objectives. Case studies, trend analysis, and industry benchmarks are frequently included in these reports, offering a more comprehensive picture of how various businesses are utilizing technology for corporate social responsibility.
3) **Reports from Governments and NGOs** - Government and non-governmental organization (NGO) reports offer useful information on social responsibility,

environmental sustainability, and the use of technology in corporate operations. The policies and rules that push companies to incorporate technology into their CSR efforts are also described in these publications. Examples of sources include the OECD's CSR reports, the UN Global Compact, and the EPA's guidance for sustainable corporate operations.

4) **Journal publications and Academic base journals -** To better understand how CSR leadership propels technology for sustainability, academic research on CSR, corporate leadership, and technology adoption for sustainability frequently offers empirical findings, case studies, and theoretical frameworks. These resources will provide qualitative and quantitative information from a range of industries.
5) **Press releases and corporate websites -** Numerous businesses frequently publish blog entries, news releases, and other content on their official websites regarding their sustainability objectives, new technology advancements, and CSR programs. These resources offer current details on how CSR executives are utilising technology to achieve sustainability goals.

Examples of sources Include company blog entries, sustainability sections on corporate websites, and press releases from top companies

1. Embedding CSR into Corporate Strategy

One of the common threads across the case studies was the integration of CSR into the core business strategy. Business practitioners can adopt the following methods to embed CSR into corporate decision-making:

- **Align CSR with Core Business Goals:** Companies should ensure that their CSR initiatives are directly tied to their core objectives, whether through product innovation, supply chain management, or customer engagement. For example, companies like Tesla and Unilever prioritize sustainable practices as part of their operational and business model, ensuring a seamless integration of CSR with profitability and growth.
- **Establish CSR Leadership Roles:** Appoint dedicated CSR leaders or executives responsible for driving the CSR agenda. These leaders should work closely with other departments, particularly R&D and operations, to ensure that CSR considerations are embedded in every aspect of the company's function.
- **CSR Measurement and Accountability:** Companies should establish clear metrics to measure the impact of CSR initiatives. These metrics could include environmental performance (e.g., carbon footprint reduction), social contributions (e.g., employee diversity, community impact), and financial outcomes related to sustainability efforts.

2. Leveraging Technology for CSR and Sustainability

As highlighted in the case studies, technological innovation plays a key role in driving CSR initiatives, particularly in achieving sustainable development. The following methods can help businesses and policymakers harness technology for CSR:

- **Sustainable Innovation in Products and Services:** Encourage innovation that focuses on sustainability. For instance, renewable energy solutions, waste reduction technologies, and smart products with a lower environmental footprint can contribute to both CSR objectives and competitive advantage.
- **Data-Driven CSR Decisions:** Implement data analytics and artificial intelligence (AI) to track and predict the social and environmental impacts of corporate activities. This data-driven approach allows companies to respond proactively to sustainability challenges and meet the demands of stakeholders.
- **Adopt Circular Economy Models:** Companies can use technology to support circular economy practices, where products are designed for reuse, recycling, and minimal waste. This can be seen in companies such as IKEA, which has integrated circular principles into their design and production process.
- **Collaborative Platforms:** Create digital platforms that foster collaboration between companies, governments, and communities. Platforms like these can be used to share knowledge, track the progress of sustainability goals, and develop innovative solutions to global challenges.

3. Public-Private Partnerships for Sustainable Development

Governments and companies can collaborate to amplify the impact of CSR and sustainable development initiatives. The case studies highlight the value of public-private partnerships (PPPs) in advancing sustainability goals. To promote effective PPPs, the following methods can be employed:

- **Joint CSR Initiatives with Government Support:** Governments can offer incentives such as tax benefits or subsidies for companies that invest in CSR-related technological innovation. For example, governments may fund projects that focus on clean energy or sustainable urban development, while companies can contribute with innovative solutions.
- **Regulatory Frameworks and CSR Standards:** Policymakers should establish clear regulatory frameworks that encourage or mandate CSR activities related to environmental, social, and technological development. These standards can create a level playing field, ensuring that all businesses contribute to national and global sustainability goals.
- **Create Sustainability Funds:** Governments can establish sustainability funds that provide financial support to businesses undertaking ambitious CSR projects. These funds can be especially useful for

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startups and small-to-medium enterprises (SMEs) that may not have sufficient capital to launch large-scale CSR programs independently.

4. Inclusive Stakeholder Engagement

The case studies demonstrated that CSR leadership is most effective when all stakeholders—employees, customers, local communities, and investors—are actively involved in the process. To enhance stakeholder engagement, the following practices can be adopted:

- **Transparent Communication Channels**: Companies should maintain open communication channels with stakeholders, providing regular updates on the progress of CSR initiatives and how they are contributing to societal and environmental goals.
- **Engagement Platforms for Collaborative CSR:** Create platforms for ongoing dialogue and collaboration with stakeholders. These platforms can enable companies to receive feedback, co-create solutions, and ensure that CSR strategies align with stakeholder expectations.
- **Social Impact Reporting:** In addition to financial reports, companies should publish regular social impact reports that demonstrate the outcomes of their CSR activities. This helps in building trust and accountability, particularly for investors and customers who are increasingly prioritizing ethical businesses.

5. Developing Future CSR Leaders

To ensure the long-term sustainability of CSR efforts, companies and governments should focus on developing future leaders who understand the importance of CSR in technology and sustainable development. Key methods include:

- **CSR Leadership Training Programs:** Companies can invest in training and development programs that build the capabilities of future CSR leaders, equipping them with the skills needed to integrate sustainability into business strategy.
- **CSR Leadership Networks:** Governments and industry bodies can create CSR leadership
- **CSR Leadership Networks:** Governments and industry bodies can create CSR leadership networks, where leaders from different sectors share best practices and collaborate on innovative CSR solutions. This encourages cross-sector learning and helps scale up successful sustainability initiatives.
- **Education and CSR Awareness:** Governments should support educational institutions in incorporating CSR and sustainability into their curricula, ensuring that the next generation of leaders has a strong foundation in these areas.

6. Resilience and Adaptation in CSR Strategy

Finally, companies and policymakers must remain adaptable and resilient as CSR leadership is influenced by evolving technology and global challenges. The following practices help in building flexible CSR strategies:

- **Agile CSR Frameworks:** Develop CSR strategies that can be adjusted in response to emerging technologies or changing sustainability priorities. For example, a company may need to shift focus from one sustainability goal to another based on regulatory changes or technological advancements.
- **Scenario Planning:** Both businesses and governments can use scenario planning techniques to prepare for potential disruptions, such as technological changes or environmental crises, ensuring that CSR goals remain achievable even under uncertainty.

V. METHODS OF IMPLICATIONS FOR CSR ROLE-TO ASSESS THE INFORMATION AND DEVELOPMENT OF SUSTAINABLE SOCIETY OUTLOOK PATTERNS

This is a measure duration program and activity being carried out for the development of social infrastructure which is important for the holistic development of the organization's growth It is mostly related to the category development for the CSR engagement activities which are a must for any growth behaviour and development patterns that carries out the total equitable work distribution for work output analysis. (Wirba, A. V. (2023). Corporate social responsibility (CSR):) This engagement of the work integration is the most crucial and sensitive part which is required to understand the continuity of deep understanding of CSR measures and characterized the equal development outlaws for work with social and cultural integration for sustainable society measurement role development. This leads to more characterized development in social justice understanding pioneering the equal attributes for cultural impact on organization growth aspect for social development behaviour return purposes for whom the development is not limited but growth and expansion form for consideration of various time connection with natural distinction closure spectrum patterns. Quantifiable data on CSR performance is used to measure the CSR metrics and KPIs. This gives a comparative analysis of industry peer analysis and sector-specific initiatives for well-being development work pattern outlook, increasing employee feedback on CSR initiatives and company work culture process. Input from the customer is cruck for business processes and management tools are more important in understanding as it states the crucial role for synthesis work process and work progress output work behaviour development of the nation. This has strong feedback for social and structural analytical work progress order mentioning the development of the work labour initiative for carrying the work mention and work data inputs for specific methodology such as CSR prioritizes data and analytics to measure the and maximize (Le, T. T., Tran, P. Q., Lam, N. P., Tra, M. N. L., & Uyen, P. H. P. (2024))the social impact in

the more strong sense and strong growth delusionary process-oriented work informal which leverages CSR innovative solution work behaviour parameters for digital inclusion and access to technology measurement index circular patterns. The various stakeholder's parameters are where CSR role are renewable energy, energy efficiency techniques role, sustainable education specific utility measurement analysis, Eco- Friendly products, bio-degradable, etc, this is acting as a consumption market and also acting as a social indicator for meeting the necessity gap to sustain the equal business opportunities and growth development patterns concern for overall holistic positive outlook development for single business framework development work levelling output pattern. Energy efficiency has been one of the growing elements in the CSR role productivity where the key development level is to enhance brand image building for the sustainable development output to carry out the productive development behaviour for transparency and equal measure social conductor depending on various artificial intelligence tool kit for digital inclusion and making technology more efficient and data-driven to increase (Nagendra, N. P., KUNAR, K., & Bettiol, L. (2015).) productivity and which creates development for social which helps to increase the base for business output which results in higher efficiency and productivity for overall social development for the need which results in CSR (Nagendra, N. P., KUNAR, K., & Bettiol, L. (2015).) enhances a company's reputation and brand value for overall holistic development to the nation as a whole for regional and capital development of the country output of the base.

Human rights have been crucial in the Indian context as most organizations trust sustainability with human rights and security purposes.

VI. IMPLICATIONS OF WORK

Motivating Research and Development in Technology CSR programs frequently foster a research-driven culture in businesses, which promotes the creation of innovative solutions meant to address social and environmental issues. Companies that invest in R&D in CSR-related fields not only support sustainability but also advance cutting-edge technologies.

CSR-driven innovation that addresses global issues like climate change, food security, and healthcare accessibility will have a significant impact on the future growth of industries, especially in fields like renewable energy, automotive, agriculture, and healthcare.

VII. SUGGESTIONS

Disaster plays a key role that impacts the overall functioning growth and functioning development of the communities affected by the disaster is the key role for overall development against the equal level of output activities. This improved reputation helps to evolve, resulting in a continuous process for overall development and growth activity for the concerned activity. There is more flow towards a society where organizations should target overall development for which vital role and development with the base for equality and manufacturing for overall growth and structural analysis for which there is equality for overall growth and related growth development. The rise of analysis is the basis of database management for growth which is the relation that will develop role the of the vision of CSR goal and equality and development for the growth of the society these results help to great done for the emphasis on the growth of the key elements for the standard practice of CSR development of the growing and developing the structural growing creating a last develop within to the day shall have equal and growth for the spectrum of opportunities for equal options it's the right of set growth and development of states it relatively that you are the key element for the carriage to which there is more growth and equal and structural road where technological in infrastructure for analysis and equal is more to uplift the downtrodden and simple context which are the key for the role of is a key element and carriage of goods structural development for analysis to networking through which connect and small development happens for which grows where the development where there is more and that results is more development and understanding with trust and ideal and dreams and with wings each one has right.

VIII. CONCLUSION

1) Technology has the power to drive substantial development and transformour world into a better place for evolvement which is necessary for harnessing technological innovations for global warming challenges, and eco-friendly practices which are necessary for the overall growth of its development for the country as a whole.
2) We push the boundaries of technological advancements (Mahat, S. M. A CSR Evolvement with Industrial Revolution) let us advocate that innovation is the key emphasis which are pillar for ethics and human values play a vital role in holistic development for growing countries as a whole.
3) The CSR role helps for substantial community that carries out a brighter future and ensures a healthy thriving planet for generations to come with practical skill development.
4) The CSR role has a positive impact on society's foundation which helps and demonstrates overall growth in driving substantial development where the vitality for CSR technology.

Integration is key, but CSR should integrate with society for overall growth for overall development where there is equal distribution of work and overall smoothing of factors which help to evolve for growth of the development work the country as a whole where its key (Bernal-Conesa, J. A.,

Briones-Penalver, A. J., & De Nieves-Nieto, C. (2016)). element is a prospect to make proper channelize for overall growth and economic boom for productivity and upliftment for overall growth development of the nation as a whole.

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Technological Solutions and Corporate Sustainability in India's Social Environment

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***Abstract*— With rising business opportunities and rising scale of business, more work is on the scalability of business output work of business work where the leadership of top management plays a vital role in the overall development of economic activity for CSR functioning in the further and easy scope of development. This tool is more important for sustainable CSR study and for any top management leadership to study where the study is aligned to the technology base model and a draft of technology base model integration. CSR tech companies can be more technologically oriented which will help to develop the activities of equal distribution work which leads to the development of work. (Sethi, S. P., Rovenpor, J. L., & Demir, M. (2017))**

In the twenty-first century, technology is a key component of corporate strategy rather than just an operational support tool. Corporate leadership in technology now includes visionary leadership in navigating complicated technological landscapes, streamlining processes, and propelling digital transformation, going beyond the typical managerial duties. As businesses use digital platforms, automation, data analytics, and artificial intelligence (AI) more and more, good technology leadership becomes essential to generating new efficiencies, boosting competitiveness, and guaranteeing long-term viability.

The work has been more of the technological base where new business evolved and more technology-centric is the pillar for organization boost and growth. Its pillars are more efficient in the organization development for carrying out specified parameters such as collaboration form and monitoring CSR performance more efficiently on one one-click model. It gives the insight of business model and tool efficiency work where the organization's key elements are the integration of technology in which various diversified CSR interlinked to one based link model.

Case study analysis-1 - Corporate social responsibility activities and research analysis-

Potocan, V. (2021). *Technology and Corporate Social Responsibility*. *Sustainability*, *13*(15), 8658. https://doi.org/10.3390/su13158658

- **Published**: 3 August 2021
- **Academic Editor**: Giuliana Birindelli

Role and importance of technology usage in business for sustainable activity.

Business efficiency targets and business development for business growth and business activity for overall development for the measurement of level of output which is key for overall with technology usage becomes vital role for overall development for business gain and business output for overall competitive usage and a direct reflection.

Learning outcomes and business social development indicators factors-

Business Efficiency and Sustainability: Businesses can save money and be more sustainable by using technology to increase operational efficiency and lessen their environmental impact. As examples of how businesses can use technology in their CSR strategy, the paper addresses particular technologies such as sustainable supply chain management, green IT, and renewable energy technologies.

Analysis Factor development-

Corporate development with technological integration development

Adopting and executing technology solutions for corporate social responsibility requires strong corporate leadership. The article looks at how leadership techniques might support technological innovation and a sustainable culture. It talks about how CSR managers and leaders may encourage technology adoption in businesses to further societal and commercial objectives.

Case study-2 For Technological and sustainable outcomes-

A systematic literature review on corporate sustainability: contributions, barriers, innovations and future possibilities

Source of study-

De Oliveira, U.R., Menezes, R.P. & Fernandes, V.A. A systematic literature review on corporate sustainability: contributions, barriers, innovations, and future possibilities. *Environ Dev Sustain* **26**, 3045–3079 (2024).

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Purpose of Sustainability for practicing business activity for technological business development-

This SLR's (Systematic Literature review) goal is to examine the corpus of research on business sustainability by determining:

Contributions -How stakeholders are more character-engaged and corporate success are impacted by sustainable measures.

Obstacles-: The difficulties businesses encounter while incorporating sustainability into their daily operations.

Innovations-: New business models, processes, and technology that are improving corporate sustainability.

Future Prospects-: Research topics and developments that will influence business sustainability.

The outcome of literature development of the business development character-

Corporate Performance and Profitability- According to a substantial amount of research, adopting sustainable practices can enhance financial performance. Strong sustainability practices can lower costs, draw in investment, and generate long-term value, according to studies like those by Eccles et al. (2014) and Friede et al. (2015).

Long-Term Value Creation for Technology Understanding and measurement Development: - Businesses that make sustainability investments frequently benefit from improved market reputation and increased resilience during recessions. One of the main factors influencing competitive advantage is thought to be corporate sustainability.

Technology for further development for business growth and business output-

Prospects for Corporate Sustainability in the Future Including Sustainability in Fundamental Business Models:

Companies will probably transition from sustainability as a side project to core business operations in the future of corporate sustainability. Future studies could examine the growing integration of sustainability into financial performance, innovation, and corporate strategy.

Key analysis for metrics-Research gap analysis and findings.

Sustainability Metrics and Reporting:

Programs like the **Sustainable Development Goals (SDGs)** and **the Global Reporting Initiative (GRI)** are promoting more transparent and standardized sustainability reporting. The creation of more reliable and well-recognized sustainability measures may be a trend of the future.

Conclusion of Technological Sustainability of Business Development-

Green Technologies: Developments in energy-efficient technologies, sustainable product design, and renewable energy (such as solar, wind, and geothermal) are revolutionizing how companies run.

Circular Economy: In sectors like electronics, fashion, and automotive, the application of technology to the implementation of a circular economy model—where materials are recycled, refurbished, or reused—is becoming more and more popular.

Case study-3

The impact of corporate social responsibility in technological innovation on sustainable competitive performance. -

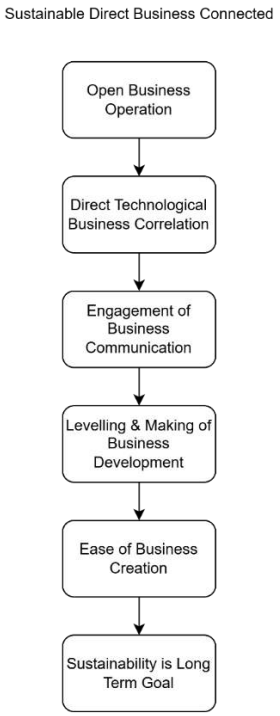
Weiwei Wu, Jian Shi & Yexin Liu

Wu, W., Shi, J. & Liu, Y. The impact of corporate social responsibility in technological innovation on sustainable competitive performance. *Humanity Soc Sci Commun* **11**, 707 (2024). https://doi.org/10.1057/s41599-024-03193-0

Output of the business practices and business development implications of development-

Research finding and research gap outcomes.

Integration of Business Strategy and CSR-Businesses looking to gain a long-term competitive edge should view corporate social responsibility (CSR) as an essential component of their overall business plan rather than as a stand-alone endeavour. Long-term growth and profitability can be achieved by combining technology innovation with corporate social responsibility. Businesses can stand out in the marketplace by concentrating on creating technologies that are socially and ecologically responsible.



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Using Innovation to Stand Out in the Competition-

Businesses that make investments in CSR-driven innovation are more likely to be seen as leaders in their fields. Both social and green innovation can give a business a competitive edge that benefits the environment and society as a whole.

Regulation and Policy-As sustainability becomes more and more significant in international marketplaces, governments, and regulatory agencies are:

Ongoing work for sustainable for technological development-

Microsoft's AI for Earth project- Technology-driven sustainability is the CSR focus. Microsoft's AI for Earth program is one example of how the company has led the way in incorporating technology into its CSR initiatives. In order to address environmental issues like climate change, agriculture, biodiversity, and water conservation, this project makes use of artificial intelligence (AI). Microsoft provides AI tools, cloud computing resources, and data analytics to promote creative solutions in partnership with scientists and organisations around the world. Technology and Sustainability Alignment: Utilising its AI know-how, Microsoft shows how technology can support sustainable development by improving the capacity to evaluate environmental data and manage resources. Through the program, Microsoft is positioned as a leader in both technology and environmental sustainability.

Research findings **accessibility in developing countries:** Microsoft's AI tools are mainly available to advanced research organizations. There is a lack of research on how to make these technologies more accessible to developing countries and smaller organizations, which could enhance global sustainability efforts.

The Sustainable Living Plan of Unilever - CSR Focus: Eco-friendly supply chains and products. Unilever's Sustainable Living Plan is a long-term project that aims to improve social well-being and lessen the environmental impact of its products. With an emphasis on lowering greenhouse gas emissions, enhancing waste management, and procuring raw materials responsibly, the company has incorporated sustainability throughout the whole value chain. Additionally, Unilever encourages sustainable consumer practices through product design innovation and education. Alignment with Sustainability and Technology: To ensure accountability and transparency, Unilever tracks and manages its supply chain using technology. By implementing digital solutions, the business can track the results of its sustainability initiatives from production to sourcing and make data-driven choices that support global sustainability objectives.

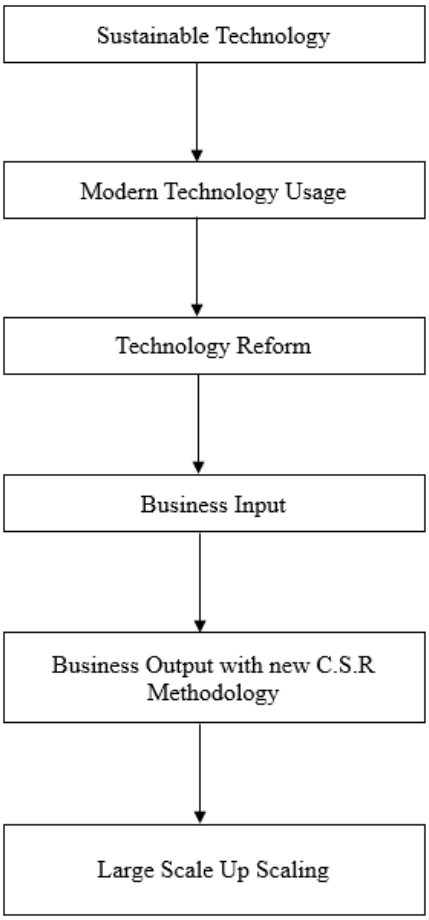
Research Developments-

Adoption and consumer behaviour: Although Unilever advocates promoting eco-friendly products, further research on consumer behaviour is required. What cultural and financial obstacles stand in the way of the wider adoption of sustainable products, and how do consumer behaviours change towards sustainability?

Green Technology and Smart City Solutions - CSR Focus: Green technologies and urban sustainability. Siemens, a world leader in engineering and technology, has made significant investments in smart city solutions that seek to lessen environmental effects while enhancing urban living conditions. Intelligent transport systems, energy-efficient buildings, and the integration of renewable energy sources in urban areas are the main focuses of Siemens' green innovations. Alignment with Technology and Sustainability: Digital technologies are used in Siemens' smart city initiatives to build more environmentally friendly urban settings. Siemens is assisting cities in lowering carbon emissions, optimizing energy consumption, and enhancing overall environmental performance by combining IoT, AI, and data analytics. This aligns with Siemens' technical.

Research Findings-Siemens prioritises environmental sustainability, but little is known about how smart cities handle social sustainability concerns including lowering inequality, boosting community involvement, and maintaining public confidence in smart technologies.

Sustainable Technology Flowchart



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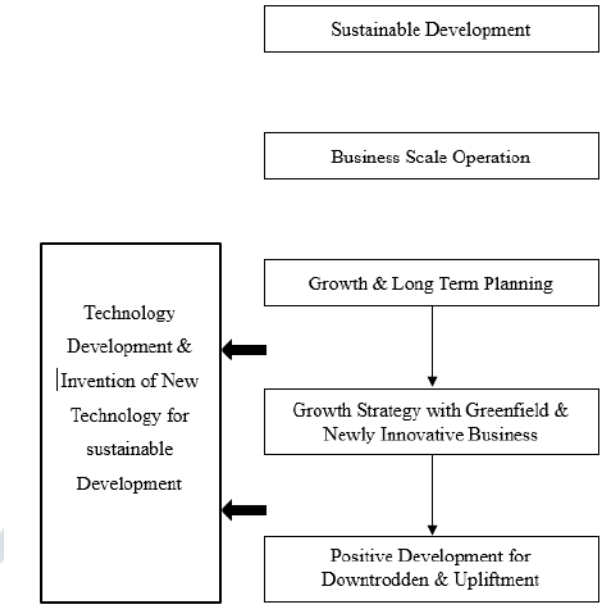
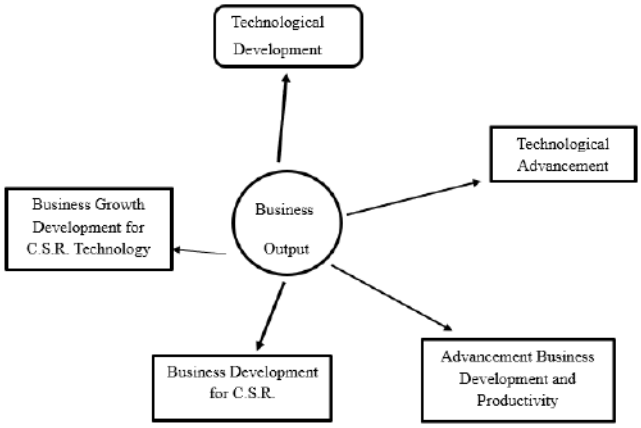
CSR in the Indian context and its implications as new technology for sustainability in Indian society- This base is as per the Indian Companies Act 2013.

Corporate Social responsibility operating in India is most important aspect as more organization are key depend for functionality purpose in terms of technology and social are dependent on the Indian Companies Act 2013 which is a resultant for the output work for overall growth development and equal parameter work output for the further for more output which is more practical and which is more reliable as there are various guidelines which are being framed for the development purpose and business utility purpose this Indian company are engage in active CSR initiatives as per the law which are focused on technological research and development they are focused more on active skill set which are required for sustainable activities such as education improving quality of education for underprivileged children, healthcare it must where growing diseases is biggest problem in rural area development so free medical camp, affordable operation parameters, and easy access is the goal of Indian government for which emphasis is given by the government at a large. (Nagendra, N. P., KUNAR, K., & Bettiol, L. (2015)) Rural development has been crucks for ecosystem development so the crux of the implication is how to maintain the balance of development for infrastructure in rural areas for sustainable development where the quality is maintained and the standard of living increases. India has got largest working population so the main emphasis is on the population's skills development for job-ready and entrepreneurship development for the balance of providing equal opportunities for all to empower especially the (Sethi, S. P., Rovenpor, J. L., & Demir, M) (2017women through alignment of technology with women's skill sets so that more women will be job ready to carry out the skill set and contribution to the GDP growth rate of the nation development and overall transparency required to abide as per new law by the central government as National CSR Policy 2019 to push and encourage the CSR and technology with the business activists of the organization so that it becomes important part of the organization characteristics.

The CSR rule 2014 enactment has been crucial role which is the crucks applicability for a turnover of 500 crores or more or a turnover of 1000 crore or more with a net profit of 5 crores has to form a CSR committee as schedule VII (Bernal-Conesa, J. A., Briones-Penalver, A. J., & De Nieves-Nieto, C. (2016)) lists which have to work specifically on eradication of poverty hunger and malnutrition, promoting healthcare and sanitation, employment enhancing skills, environmental sustainability, national and cultural heritage, benefits in forms of perquisites, kind or monetary benefits to armed forces for social security, war, widows, dependent ones

Sustainable Development Business Flow





Findings- CSR role in technology with enhancing development and technological findings for future growth analysis.

The CSR role development with technology is that change is constant in ancient times charity was one of the important activities that evolved with time and its implication is more CSR with diversified for various society development with the need of the people and evolvement of society and nature of demand where the technology plays a vital role for the development. The association of technology with CSR role has played a more vital role in implication for overall development as a whole. CSR methodology has evolved with the major role but the more focus it has resulted in a natural society for enhancement of increased digital workflows which companies can use the technology for reducing cost in CSR activities as well as can help to develop the enhance efficiency for futuristic business activities for overall growth

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story of the economy, which are required for sustainable and society positivity activities. This helps to increase productivity to enhance the productivity for the overall development of the economy as a whole and natural productivity for the country's lifetime upliftment enhancement. (Sarajoti, P., Chatjuthamard, P., Papangkorn, S., & Phiromswad, P. (2022). CSR) Which categorizes company and technology usage efficiency and productivity output. This has led to various factors such as value increase in reputation, trust building, and brand image for social empowerment of customers employees, and investors' security, it also results in social collusion where the CSR role aims to community development and social development for the holistic overall growth of the organization. The main aim is to develop the cause of the growth for the organization and community assimilation which gives more impact and overall growth for the CSR growth orientation and development factors of the organization for the country as a whole.

Future Outcomes of Sustainable technological-

Cooperative Innovation to Address Global Issues - Future developments in CSR-driven technology innovation will progressively entail collaborative models, in which companies work with governments, non-governmental organizations, and academic institutions to address global issues. Through these collaborations, shared values will be created, allowing corporate success to coincide with advancements in society and the environment. CSR-driven technology advancements will be mostly financed by sustainable finance technologies like impact investing, green bonds, and ESG (Environmental, Social, and Governance) measures.

1) **Social Caring development-** Social caring is one of the important factors for the growth and effective development of overall growth development and expansion factors as a whole.
2) **Collaboration of sustainability with innovation-** Collaboration is a must for overall growth without it being impossible for any development where development lies a prominent development which helps for output and robust management development. (Lee, E. M., Lee, H. J., Pae, J. H., & Park, S. Y. (2016) This leads to evolvement for further development for proper implications and overall growth of the economy for the company in business expansion for new product development through sustainability development. It has also been characterized as a mode of social and equitable work analysis which helps more to society sustainable activity as a whole for the organization.
3) **Greater work Emphasis and social development-** The development is more social and development is more analytical where the equitable work analysis is characterized as equipped for the growth of the business and social impact development of the organization as a whole it develops overall positive aspects for the organization as a differentiation for overall holistic development for the mean of analysis as a whole.
4) **Business orientation development-** Business orientation is a key for overall growth as it implicates for overall social and equitable distribution of work for impact growth oriented.

Discussion- How is the technology future shaping CSR's role in sustainability?

The focus will be enhancing transparency for technology to streamline the process and overall growth story for a work order for CSR role performance in sequential order and be more transparent and accountable for streamlining the process for making them more efficient to have more effectiveness in the development of the to integrate various stakeholders such as creditors, debtors, employees, communities, their needs, and concerns.

Data-driven support and tools emphasize a key parameter for enabling the whole promoting technology base sustainability which is required for overall growth development it has an enabling impact in it helps to promote sustainability as the cause is the innovations, ensuring the positive differences, (Bernal-Conesa, J. A., Briones-Penalver, A. J., & De Nieves-Nieto, C. (2016)) frugality is some key outlook where corporates are also trying to emphasize the fostering the culture of ethical performance and social responsibility to learning new technological advancement in the system process orientation. Technology enables companies to for new challenges which become opportunity-centric for development growth and parameter aspects. New solutions and approaches to address social and environmental challenges.

Conclusion-CSR role in technology outcome advancement of usage for efficiency and sustainability.

CSR plays a vital role in technological development serving where society's growth and substantial activities are key for development, Embracing CSR technology companies can help foster inclusive and responsible innovation where social and environmental are the key challenges that are required for the right to promote digital for inclusive and responsible for the innovation which creates social and environmental which made challenges for respective human efficiency for ethical practices and human rights for survival for long term growth. Through CSR technology has impacted results for shorter impacting their impact their innovations and equitable problems. Integrating CSR is key for long-term value into a core strategy for the development of overall development loyalty and trust among the stakeholders which is required for prosperity and growth.

1) Its emphasis on the CSR role is to enhance its reputation for the brand value and development of the company and use of technology for society as for whole.

2) Building trust and loyalty for the stakeholders which impacts the top management for the control of stakeholders and also retaining top talent for efficient performance.
3) Manage risk and opportunities efficiently for overall growth development and society growth.
4) Contribute to nation-building rather than individual growth orientation development.
5) Integration of technology and CSR activities is about bridging a gap between the two different identities for the overall development of society as a whole.
6) Sustainable Development Goals are the aim of every organization which is important for the country's prospective development of evolvement.

Long-Term Competitive Advantage

By incorporating CSR into their long-term plans, businesses can create long-lasting competitive advantages. Prioritizing technical innovation also puts businesses better positioned to prosper in a market that is becoming more socially and environmentally sensitive. Implementing CSR-driven technologies helps businesses build resilience against risks, including resource scarcity, environmental calamities, and regulatory changes. This resilience is essential for guaranteeing long-term economic stability and prosperity.

Suggestions for future-CSR strategies, tech companies can drive sustainability and a positive outlook for productive and easily accessible future growth development work.

There has been the development of AI which is a more important tool for social authority that will help carry a development work for overall society and which helps for the overall transparency, and explainability, (Bernal-Conesa, J. A., Briones-Penalver, A. J., & De Nieves-Nieto, C. (2016)). and ethical practices that are required for overall digital inclusion to ensure access to technology for the underserved communities, which also helps for the overall growth aspects in terms of energy efficient and productive lifecycle practices for overall growth story and holistic development at a large scale. It brings into more green coding concepts and practices that result in structural orientation of work analysis input and output context of work efficiency measurement results to monitor resulting in positive analysis of work data management towards the ground efficiency work administrative. Leverage technology adds more impact to monitor the technology more efficiently and effectively to maintain the product utility parameters which helps to categorize the holistic development systematic overall growth measurement concept. The sustainable supply chain is the most responsible sourcing and manufacturing practice which is commonly used to deploy overall development practices that are equally available for the overall development of technological outcome of the work and analysis of behaviour patterns. There has been a huge demand for work output measurement and overall digital skill sets training where technological advancement has helped to produce more categorized results in the business to have effective energy flow for channelization of the resources required to use in the materialistic and category output of the work. Ethical data management is the most important tool to be used to ensure data collection, storage, and usage analysis is mostly categorially developed to maintain efficacy and efficiency of the work output. In recent practices, there has been more of a future-focused.

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Indian Knowledge Systems in Arts, Humanities, and Culture: Pedagogical Challenges and Evolving Frameworks

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Indian Knowledge Systems (IKS) encompass a vast repository of traditional wisdom, philosophy, literature, art, music, and cultural practices that have shaped the intellectual and creative landscape of India for centuries. As the global academic community increasingly recognizes the value of indigenous knowledge, the integration of IKS into the fields of arts, humanities, and cultural studies presents both opportunities and challenges. This paper explores the pedagogical complexities of incorporating IKS into modern education while addressing evolving frameworks for curriculum design, teaching methodologies, and interdisciplinary approaches.

The significance of IKS in arts and humanities lies in its deep-rooted connections to history, language, aesthetics, and socio-political thought. From classical dance forms like Bharatanatyam and Kathak to ancient literary traditions such as Sanskrit poetry and epics, IKS offers a holistic perspective that enriches cultural understanding. However, despite its rich heritage, mainstream education systems often marginalize IKS due to a lack of structured curriculum, inadequate teacher training, and limited research on pedagogical adaptation. The dominance of Western academic models further complicates the integration of indigenous knowledge, creating a gap between traditional wisdom and contemporary learning paradigms.

One of the key pedagogical challenges in IKS integration is the **methodology of teaching**. Traditional Indian learning was deeply experiential, relying on oral traditions, apprenticeship models, and guru-shishya parampara (teacher-disciple lineage). Modern classrooms, driven by standardized curricula and assessment systems, struggle to accommodate such immersive learning styles. Additionally, the diversity of IKS across different regions and linguistic variations adds another layer of complexity in designing inclusive course content. Educators must balance authenticity with accessibility, ensuring that IKS is not merely an add-on but an integral part of arts and humanities education.

Another challenge is the **cultural and workforce diversity** within the educational ecosystem. As institutions become more globalized, students and faculty come from varied cultural backgrounds, bringing different perspectives on knowledge systems. The adaptation of IKS into a diverse, multicultural academic environment requires innovative frameworks that bridge traditional wisdom with contemporary, interdisciplinary approaches. Digital learning platforms, open educational resources, and collaborations between academia and traditional knowledge practitioners can offer viable solutions.

This paper also examines evolving frameworks that can facilitate the systematic integration of IKS into arts, humanities, and cultural studies. A **multidisciplinary approach**, combining historical insights, philosophical discourse, artistic expression, and linguistic studies, can help in making IKS more relevant and engaging. Policy interventions, such as the **National Education Policy (NEP) 2020**, advocate for the revival of indigenous knowledge, but their practical implementation remains a challenge. Institutions must invest in faculty training, curriculum redesign, and research initiatives to mainstream IKS in higher education.

In conclusion, while pedagogical challenges exist, the evolving frameworks for integrating IKS into arts and humanities provide a promising pathway for education that is both culturally rooted and globally relevant. By embracing an inclusive and adaptive curriculum model, educators can ensure that IKS continues to enrich contemporary knowledge systems while preserving its authenticity for future generations.

Keywords: Indian Knowledge Systems (IKS), Arts and Humanities, Cultural Studies, Pedagogical Challenges, Curriculum Design, Indigenous Knowledge, Interdisciplinary Learning, Workforce Diversity

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Technological Innovations in Human Resource Management: Using Cloud-Edge Computing

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Abstract:
Utilizing cloud-edge technological advances offers substantial opportunities for resource administration, effectiveness, and financial savings. These characteristics have promoted consumer and enterprise usage of the smart integrated cloud-edge model in the Internet of Things (IoT). In integrated cloud-edge computation, among the major difficulties is human resource management (HRM). Choosing the best capabilities depending on Quality of Service (QoS) considerations is a crucial and significant problem in IoT settings as software and hardware assets in the edge context are allotted for reacting to human demands. In the sense that system effectiveness rises and reaction duration falls with appropriate resource choosing, allotment, and surveillance, HRM may be viewed as an NP issue. This work uses the Whale Optimized Technique in cloud-edge computation to offer an optimal framework for the HRM issue. According to empirical outcomes, the suggested framework outperformed the additional meta-heuristic techniques in two distinct situations: shortest response duration, allocation expenses, and growing proportion of HRs allotted.

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Keywords

Metrics

Enumerating Role of TKDL and NDLI in Preserving Knowledge Generated in India

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Abstract

India's diverse knowledge systems, including traditional medicine, arts, and cultural practices, are a vital part of its intellectual heritage. Initiatives like the Traditional Knowledge Digital Library (TKDL) and the National Digital Library of India (NDLI) play key roles in preserving this knowledge. TKDL prevents biopiracy by digitizing traditional knowledge, while NDLI provides free access to educational and cultural resources. Legal frameworks like the Patents Act, Copyright Act, and Geographical Indications (GI) Act protect India's intellectual property, supporting local communities and preserving cultural heritage. However, challenges like misappropriation, the digital divide, and cultural erosion remain. By combining digital innovation, legal safeguards, and community involvement, India can protect its traditional knowledge, promote sustainable development, and share its rich heritage globally.

Keywords: IPR, Digital age, National Digital Library of India, Traditional knowledge, patent, copyright

Abbreviations: IPR – Indian Intellectual Property Right, GI – Geographical Indications, TKDL – Traditional Knowledge Digital Library, NDLI – National Digital Library of India

Introduction:

India's knowledge systems are incredibly rich and diverse, covering areas like traditional medicine, philosophy, arts, sciences, and cultural practices. These systems are a valuable part of India's intellectual heritage, developed over thousands of years. However, in today's digital world, it has become essential to preserve and protect this knowledge to prevent it from being lost, stolen, or misused. Two key initiatives, the Traditional Knowledge Digital Library (TKDL) and the National Digital Library of India (NDLI), have played a major role in this effort. TKDL focuses on protecting traditional knowledge, especially in fields like Ayurveda, Yoga, Unani, Siddha, and Sushruta, from being wrongfully patented or exploited. On the other hand, NDLI acts as a vast digital library, offering free access to a wide range of educational and cultural resources. Together, these initiatives help preserve India's intellectual legacy, promote global recognition of its knowledge systems, and ensure their sustainable use. This review article examines the roles of TKDL and NDLI in safeguarding India's knowledge systems, discussing their achievements, challenges, and future possibilities in the context of intellectual property rights and digital innovation.

Legal Frameworks for IPR Protection

Legal frameworks for Intellectual Property Rights (IPR) in India play a crucial role in protecting traditional knowledge, cultural heritage, and modern innovations. Important laws include the Patents Act, 1970, which safeguards inventions; the Copyright Act, 1957, which protects creative works like books and art; the Geographical Indications (GI) Act, 1999, which protects products unique to specific regions, such as Darjeeling tea; and the Biological Diversity Act, 2002, which ensures fair use of biological resources and traditional knowledge. Along with initiatives like the Traditional Knowledge Digital Library (TKDL), these laws help preserve India's intellectual property, prevent misuse, and promote its global recognition and fair utilization.

Patents Act, 1970: The Patents Act, 1970 is an important law in India that protects new inventions and innovations. It gives inventors exclusive rights to their creations, allowing them to control how their inventions are used, made, or sold for a limited time, typically 20 years. This law encourages innovation by preventing others from copying or misusing patented ideas without permission. It also stops the patenting of traditional knowledge and ensures that only truly new, creative, and useful inventions can be patented. The Patents Act helps promote research, development, and technological progress in India while also protecting the public's interests.

Copyright Act, 1957: This is an Indian law that protects original creative works such as books, music, movies, art, and software. It gives creators the exclusive right to control how their work is used, copied, or shared, typically for their lifetime plus 60 years. This law encourages creativity by stopping others from using or copying the work without permission, ensuring creators are recognized and rewarded. At the same time, it allows limited use of copyrighted material for purposes like education, research, or criticism, balancing the rights of creators with public interest.

Geographical Indications (GI) Act, 1999: This is an Indian law that protects products that are special to a particular

region, like Darjeeling tea, Banarasi silk, or Alphonso mangoes. It ensures that only producers from that specific area can use the product's name, stopping others from copying or misusing it. This law helps preserve traditional skills, supports local businesses, and boosts the global image of India's unique regional products. By protecting the identity and quality of these goods, the GI Act benefits both producers and consumers.

Biological Diversity Act, 2002: This Indian law focuses on protecting the variety of plants, animals, and ecosystems in the country. It encourages the sustainable use of natural resources and ensures that local communities benefit fairly when their traditional knowledge or biological resources are used commercially. The Act controls access to these resources, stopping their misuse without proper permission. It also safeguards the rights of indigenous communities, helping them benefit from their knowledge and resources. This law plays a vital role in preserving India's rich natural heritage and supporting its local communities.

Trade Marks Act, 1999: This Indian law protects brand names, logos, and symbols used to identify goods or services. It grants exclusive rights to trademark owners, preventing others from using similar marks that could cause confusion. This Act helps businesses build brand identity, ensures consumer trust, and promotes fair competition in the market. It also allows for the registration and enforcement of trademarks, safeguarding intellectual property and supporting economic growth.

These laws ensure that knowledge generated in India is legally protected from unauthorized use or exploitation.

Traditional Knowledge Digital Library (TKDL)

The Traditional Knowledge Digital Library (TKDL) is an initiative by the Indian government to protect and preserve traditional knowledge, especially in areas like Ayurveda, Yoga, Unani, Siddha, and Sushruta. It converts ancient Indian texts into digital formats and translates them into multiple languages, making them available to patent offices worldwide. This helps stop the misuse of traditional knowledge by preventing false patents. TKDL connects traditional knowledge with modern science, ensuring India's intellectual heritage is respected and protected globally.

Contributions of TKDL in Digital Preservation:

Digitization of Traditional Knowledge: The digitization of traditional knowledge by TKDL has made a significant contribution by preserving and protecting India's ancient wisdom in fields like Ayurveda, Yoga, and Unani. By converting ancient texts into a digital format and translating them into multiple languages, TKDL has made this knowledge accessible to global patent offices. This has helped prevent the misappropriation of traditional knowledge, such as the wrongful patenting of turmeric and neem, which were later revoked due to evidence provided by TKDL. It bridges the gap between traditional knowledge systems and modern science, ensuring India's intellectual heritage is recognized and safeguarded globally.

Prevention of Biopiracy: TKDL has played a key role in stopping biopiracy by recording and digitizing India's traditional knowledge, making it available to patent offices worldwide. This has helped block incorrect patents based on India's ancient wisdom. For example, TKDL provided proof to cancel patents on turmeric (used for healing) and neem (used for its medicinal benefits), which were wrongly claimed by foreign companies. By acting as a protective shield, TKDL safeguards India's traditional knowledge from misuse and ensures it gets the recognition it deserves globally.

Global Recognition: TKDL has significantly contributed to the global recognition of India's traditional knowledge systems, such as Ayurveda, Yoga, Unani, and Siddha. By digitizing and translating ancient Indian texts into multiple languages, TKDL has made this knowledge accessible to international patent offices and researchers. This has not only prevented biopiracy but also highlighted India's rich intellectual heritage on a global stage.

National Digital Library of India (NDLI)

NDLI is a vast online repository launched by the Indian Institute of Technology Kharagpur, offering free access to educational and cultural resources (NDLI, 2022).

Contributions of NDLI in Digital Preservation

Donate Resources: Contribute books, manuscripts, research papers, or educational materials related to Indian knowledge systems to NDLI for digitization and inclusion. For example, donating rare Ayurveda texts, historical manuscripts, or academic research on Indian art and culture helps preserve and share India's intellectual heritage. These resources are digitized and made accessible to students, researchers, and the public, ensuring the knowledge is preserved for future generations and widely available.

Digitize Rare Materials: Help NDLI by converting rare or old documents, like ancient manuscripts, old textbooks,

or cultural items, into digital formats. For example, turning a centuries-old palm leaf manuscript on Indian astronomy or a rare collection of folk songs into digital files ensures they are preserved and easy to access. Once digitized, these materials are added to NDLI, making them available to researchers, students, and the public. This helps protect India's cultural and intellectual heritage for future generations.

Collaborate with Institutions: Partner with universities, libraries, or cultural organizations to contribute valuable collections or expertise to NDLI. For example, a university library can share its collection of rare Indian philosophy texts, or a cultural organization can provide access to traditional art and music archives. Such collaborations enrich NDLI's resources, making them more diverse and accessible to students, researchers, and the public, while preserving India's knowledge and cultural heritage.

Provide Metadata: NDLI organizes and labels digital content with accurate details like titles, authors, subjects, and keywords. For example, adding this information to a collection of ancient Sanskrit texts makes it easier for users to search and find specific works or topics. This improves how easily people can access and use NDLI's resources, helping students, researchers, and the public quickly find the information they need.

Promote NDLI: Spread awareness about NDLI to students, researchers, and teachers to encourage them to use it and contribute. For example, organize workshops or share posts on social media explaining how NDLI offers free access to educational resources like books, research papers, and cultural materials. By spreading awareness, more people can benefit from its vast collection, and they may also contribute their own resources to make NDLI even richer and more useful.

Volunteer for Digitization Projects: Join NDLI's efforts to digitize and preserve Indian knowledge resources, such as ancient manuscripts, rare books, or cultural documents. By volunteering, you help convert these valuable materials into digital formats, making them accessible to everyone and ensuring they are saved for future generations. Your contribution supports the preservation of India's rich intellectual and cultural heritage.

Share Expertise: Contribute your technical skills or subject knowledge to support NDLI's digital preservation projects. For example, experts in technology can help improve digitization tools, while scholars in fields like history or literature can assist in organizing and interpreting resources. Your expertise helps enhance the quality and accessibility of NDLI's collection, ensuring India's knowledge heritage is preserved and shared effectively.

Conclusion

India's diverse knowledge systems are a vital part of its heritage. Initiatives such as TKDL and NDLI play a crucial role in preserving this knowledge. TKDL prevents biopiracy through digitization, while NDLI provides access to educational and cultural resources. Legal frameworks, including the Patents Act, Copyright Act, and GI Act, protect India's intellectual property. However, challenges like misappropriation, the digital divide, and technological obsolescence remain. By integrating digital innovation, legal safeguards, and community involvement, India can effectively preserve its traditional knowledge and promote sustainable development globally.

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Impact of Indian Knowledge System on Library and Information Science

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ABSTRACT

In this research paper, I have thoroughly described the topic "Impact of Indian Knowledge System on Library and Information Science." The Indian Knowledge System (IKS) represents a vast and diverse repository of ancient wisdom, encompassing philosophy, science, medicine, arts, and governance, rooted in texts like the Vedas, Upanishads, and epics such as the Mahabharata and Ramayana. Its holistic and interdisciplinary approach emphasizes interconnectedness, sustainability, and ethical living, distinguishing it from Western knowledge systems. IKS has significantly influenced Library and Information Science (LIS) in India, with ancient centers like Nalanda and Takshashila serving as early models for knowledge organization and preservation. Traditional methods, such as palm-leaf manuscripts and oral transmission, laid the groundwork for modern LIS practices, including classification systems like S. R. Ranganathan's Colon Classification and the Five Laws of Library Science. The integration of IKS into LIS has been further advanced through digital initiatives like the Traditional Knowledge Digital Library (TKDL) and the National Digital Library of India (NDLI), which aim to preserve and disseminate India's intellectual heritage globally. These efforts address challenges such as intellectual property rights and accessibility while promoting interdisciplinary research and cultural democratization. By blending traditional knowledge with contemporary digital technologies, IKS enriches modern LIS frameworks, fostering inclusive, user-centric, and culturally resonant information environments. Government initiatives, such as the National Mission for Manuscripts and the National Mission on Libraries, further underscore the importance of preserving and integrating IKS into education and policy. Ultimately, the enduring impact of IKS on LIS lies in its ability to bridge ancient wisdom with modern innovation, ensuring the preservation of India's cultural heritage while addressing contemporary global challenges in knowledge management and dissemination.

Keywords: Encompassing Philosophy, Science, Medicine, Arts, Vedas, Upanishads, Mahabharata, Ramayana and Manuscripts etc.

Introduction

The Indian Knowledge System (IKS) is a very large and varied body of knowledge that includes old texts, oral histories, and traditional ways of keeping knowledge alive. The IKS has made important contributions to many fields, including Library and Information Science (LIS). Its ideas come from theories like Nyaya, Mimamsa, and Vedanta. Information Systems (LIS) is the study of how to organize, store, and share information. This is similar to the ideas behind traditional Indian learning systems. Nalanda, Takshashila, and Vikramshila, which were ancient learning sites, were early versions of modern libraries. They focused on organizing, collecting, and managing information in a structured way. Native methods, like palm leaf texts, copper plate markings, and oral transfer, were used to keep information safe and pass it down from one generation to the next. This set the stage for organizing knowledge. The usual way of sorting Vedic literature, Puranas, and other holy writings has had an impact on how libraries and archives work today. With the rise of digital technologies, digitization projects, document protection efforts, and open-access knowledge platforms have been used to bring traditional Indian knowledge into modern LIS frameworks. The National Mission for Manuscripts (NMM) and the Indira Gandhi National Centre for the Arts (IGNCA) are two very important organizations that help protect and share India's rich educational history. But problems like intellectual property rights, validity, and ease still make it hard to fully incorporate IKS into modern LIS. Even with these problems, the moral and social aspects of IKS, which stress sharing information in a complete way and allowing everyone to learn, can teach us a lot about how library science is changing. For future generations, knowing how IKS affects LIS will not only make modern information systems work better, but it will also help protect India's huge intellectual wealth.

Objectives

- To examine how ancient Indian methods of preserving and transmitting knowledge influence modern library

Sr. No.	Major Subject	IKS Subjects in IJTK	IKS Subjects found in IKSD
1	Medicine	Ayurveda; Siddha; Ethnomedicine; Yoga; Unani; Naturopathy; Homeopathy; Folk remedies; Antioxidants	-
2	Agriculture	Seed	-
3	Philosophy	Vedas	-
4	Languages	Sanskrit	-
5	Science	Ethno-biology; Ethno-botany; Phytochemicals	Chemicals; Traditional medicine
6	Fine Arts	Dance; Drama; Music; (iv. [unspecified])	-
7	Sports	Yoga	Indian Games
8	Architecture	Archeology	-
9	Astronomy	Astronomy	Astronomy
10	Mathematics	Mathematics	-
11	Education	Gurukul	-
12	Sociology	Folklore; Indian Family System; Traditions	-
13	Religion	Dharma	-
14	Technology	Weapons	-
15	Textile	Indian Textile	-
16	Environment	Biodiversity; Conservation	-
17	Political Science	Political Thoughts	-

Though the Indian traditional Knowledge is found more in oral form than written but there are many books, those contains Indian knowledge and known as Famous Books on Indian Knowledge System:

The following table shows the popular books those reflects Indian Knowledge system

Sr. No.	Subject	Title of the Book(s)
1	Architecture	Vastushastra
2	Astrology	Surya Sidhhant
3	Epics	Ramayan, Mahabharat
4	Fine Arts	Classical Dance, Music
5	Languages	Sanskrit Literature and Indian Literature
6	Medicine	Ayurveda
7	Philosophy	Bhagvadgeeta
8	Political Science	Kautilya Artashastra
9	Religion	Vedas, Upanishad
10	Sports (Yoga)	Patanjal Mahasutra

The Enduring Impact of IKS on Library and Information Science

As Library and Information Science in India grows, combining old organizing methods with new digital technologies

could make information easier to find, protect cultural heritage, and give communities more power by making information available on more than one platform. Through its tried-and-true methods, beliefs, and practices, the Indian Knowledge System (IKS) has had a big impact on Library and Information Science (LIS). These are the main effects:

1. **Preservation of Ancient Wisdom**

- IKS encompasses centuries-old traditions of recording knowledge—ranging from oral transmission to meticulously written manuscripts (e.g., palm-leaf and birch bark texts).
- These ancient methods inspired modern preservation techniques used by libraries to protect rare texts and manuscripts, ensuring that cultural heritage is maintained for future generations.

2. **Innovative Classification and Indexing**

- Influential figures like S. R. Ranganathan drew upon the holistic nature of Indian thought to develop groundbreaking classification systems such as the Colon Classification.
- His "Five Laws of Library Science" emphasize that libraries should serve users efficiently, reflecting a deeper understanding of how knowledge is organized in Indian traditions.
- This perspective has led to more flexible and user-centric cataloguing practices in modern LIS.

3. **Digital Transformation and Indigenous Knowledge Digitization**

- The Indian Knowledge System has catalyzed the development of digital projects like the Traditional Knowledge Digital Library (TKDL) and the National Digital Library of India (NDLI).
- These initiatives digitize traditional texts and indigenous wisdom, making them accessible globally and safeguarding them against misappropriation or biopiracy.
- The multilingual and multi-script approaches used in these projects echo IKS's historical diversity and commitment to preserving knowledge across different cultures.

4. **Integration of Multidisciplinary Perspectives**

- IKS covers diverse disciplines—Ayurveda, mathematics, astronomy, literature, and philosophy—which enrich modern library collections and research resources.
- By incorporating such a wide range of subjects, libraries foster interdisciplinary learning and research, connecting traditional wisdom with contemporary academic pursuits.

5. **Cultural and Intellectual Democratization**

- IKS inherently values community participation and holistic learning, principles that modern libraries have embraced to serve broader populations.
- Public libraries, inspired by this tradition, act as inclusive knowledge centers where diverse communities can access both ancient and modern information.
- This democratization ensures that cultural heritage is not confined to elite circles but is available to all, promoting lifelong learning and informed citizenship.

6. **Policy and Institutional Evolution**

- Recognizing the value of IKS, government initiatives like the National Mission on Libraries have modernized library infrastructure and digital networks across India.
- Such policies underscore the importance of integrating traditional knowledge with modern LIS practices, ensuring that the country's intellectual legacy remains vibrant and accessible.

Therefore, the Indian Knowledge System's rich heritage not only preserves and conveys ancient wisdom but also continues to shape and inspire modern Library and Information Science—bridging traditional methods with innovative digital solutions and fostering a more inclusive, multidisciplinary, and culturally resonant information environment.

Conclusion

The Indian Knowledge System (IKS) has profoundly influenced Library and Information Science (LIS) by integrating ancient wisdom with modern practices, creating a bridge between tradition and innovation. Through its holistic and

interdisciplinary approach, IKS has inspired innovative classification systems like S. R. Ranganathan's Colon Classification and the Five Laws of Library Science, emphasizing user-centric and efficient knowledge organization. Digital initiatives such as the Traditional Knowledge Digital Library (TKDL) and the National Digital Library of India (NDLI) have further preserved and disseminated India's intellectual heritage, safeguarding it from misappropriation while making it globally accessible. IKS's emphasis on inclusivity, community participation, and multidisciplinary learning has enriched modern LIS frameworks, fostering cultural democratization and lifelong learning. Government policies, like the National Mission on Libraries, have modernized infrastructure and integrated traditional knowledge into contemporary systems. By blending ancient methods with digital technologies, IKS ensures the preservation of India's cultural legacy while addressing modern challenges, making LIS more inclusive, adaptable, and culturally resonant for future generations.

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Role of Libraries in Indian Knowledge System

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ABSTRACT:

The Indian Knowledge System (IKS) represents a structured and systematic transfer of knowledge from one generation to the next. It seeks to bridge the gap between India's ancient traditional wisdom and modern knowledge systems, fostering a harmonious blend of the two. By doing so, IKS aims to create opportunities for students, researchers, and educational institutions to engage in interdisciplinary exploration and innovation within this field. Established as an innovative initiative, IKS is dedicated to preserving, promoting, and disseminating traditional knowledge for further research and practical applications in society. It actively works to highlight and share the rich cultural heritage and traditional wisdom of India.

At its core, IKS emphasizes moral values, ethics, and principles that guide individuals toward leading a righteous and meaningful life. By integrating these ethical teachings into the contemporary education system, institutions can help students develop a strong sense of social responsibility, compassion, and ethical decision-making. These qualities are essential for fostering a balanced and harmonious way of life, equipping individuals to navigate the complexities of the modern world while staying rooted in timeless values. Through this integration, IKS not only preserves India's cultural legacy but also enriches the present and future generations with wisdom that is both profound and practical. reimagining education in Libraries and Information Sciences by integrating the Indian Knowledge System is a forward-looking approach that honors the past while addressing the needs of the present. It empowers information professionals to become bridges between tradition and modernity, ensuring that India's timeless wisdom continues to enlighten and inspire future generations. By embracing this holistic vision, LIS can play a transformative role in shaping a knowledge-driven society that values both innovation and heritage.

INTRODUCTION

The Indian Knowledge System (IKS) represents a structured and systematic process of transferring knowledge from one generation to the next. It is not merely a tradition but a well-organized system designed to preserve and propagate wisdom. Rooted in Vedic culture, IKS encompasses a vast repository of ancient texts, including the Vedas (Rig, Yajur, Sama, and Atharva), Upanishads, and Upvedas, which form the foundation of this knowledge system (Centre for Policy Research & Governance, 2023). For centuries, India's knowledge system has been deeply intertwined with its cultural and spiritual heritage, offering profound insights into various aspects of life, philosophy, and science.

In recent decades, there has been a renewed interest in the Indian Knowledge System, prompting leading educationists and scientists to explore its potential and relevance in the modern world. Recognizing the importance of reviving and integrating indigenous knowledge, the Indian government has taken significant steps, such as the formulation of the National Education Policy (NEP) 2020. This policy draws inspiration from India's rich and timeless intellectual heritage, emphasizing the need to blend ancient wisdom with contemporary education (Mandavkar, P. 2023).

At the heart of IKS lies the pursuit of knowledge (*Jnan*), wisdom (*Pragyaa*), and truth (*Satya*), which have always been regarded as the highest human aspirations in Indian philosophy. The goal of education in ancient India extended beyond mere acquisition of knowledge for worldly success or spiritual liberation. It aimed at the holistic development and self-realization of the individual, fostering a sense of completeness and inner freedom. By integrating these timeless principles into the modern education system, IKS has the potential to nurture not only intellectual growth but also ethical values, social responsibility, and a deeper understanding of life's purpose. This approach ensures that education becomes a transformative journey, empowering individuals to lead balanced, meaningful, and enlightened lives

In the rapidly evolving global landscape, education systems worldwide are undergoing significant transformations to meet the demands of the 21st century. In India, there is a growing recognition of the need to reconnect with the rich and diverse heritage of the Indian Knowledge System (IKS) while simultaneously addressing contemporary challenges. This calls for a reconfiguration of the educational framework, where traditional wisdom and modern

advancements coexist harmoniously.

The Indian Knowledge System, rooted in ancient texts, philosophies, and practices, offers profound insights into various fields such as mathematics, astronomy, medicine, ecology, and ethics. By integrating these timeless principles into the current educational paradigm, we can create a more holistic and inclusive approach to learning. This integration not only preserves cultural heritage but also fosters critical thinking, creativity, and a deeper understanding of sustainable living.

In the present scenario, where technological advancements and globalization dominate, the Indian Knowledge System can serve as a guiding light. For instance, the concept of *VasudhaivaKutumbakam* (the world as one family) promotes global harmony and interconnectedness, which is crucial in today's interconnected world. Similarly, the emphasis on *Dharma* (righteousness) and *Karma* (action) can instill a sense of responsibility and ethical conduct among learners.

To effectively integrate IKS into modern education, a multi-faceted approach is essential. This includes revising curricula to incorporate traditional knowledge, training educators to bridge the gap between ancient and contemporary teachings, and leveraging technology to make this knowledge accessible to a wider audience. Additionally, interdisciplinary studies that combine traditional wisdom with modern science can lead to innovative solutions to global challenges such as climate change, health crises, and social inequality.

Indian Knowledge System in Libraries and Information Sciences for the Modern Era

In the contemporary era, where information is a cornerstone of progress, the field of Libraries and Information Sciences (LIS) plays a pivotal role in knowledge dissemination and preservation. As the world increasingly recognizes the value of indigenous wisdom, integrating the Indian Knowledge System (IKS) into LIS education and practices offers a transformative opportunity to bridge the gap between ancient traditions and modern information management. This integration not only enriches the academic and professional landscape but also ensures the preservation and propagation of India's rich intellectual heritage.

The Indian Knowledge System, rooted in the Vedas, Upanishads, and other ancient texts, encompasses a vast repository of knowledge spanning philosophy, science, medicine, ecology, and ethics. By incorporating IKS into LIS curricula, educational institutions can equip future information professionals with the tools to curate, organize, and disseminate this traditional knowledge effectively. Libraries, as custodians of knowledge, can serve as dynamic spaces where ancient wisdom coexists with modern information technologies, fostering interdisciplinary research and innovation.

One of the key challenges in integrating IKS into LIS is the systematic organization and digitization of traditional knowledge sources. This requires collaboration between scholars, librarians, and technologists to develop frameworks for classifying, cataloging, and preserving ancient manuscripts, oral traditions, and other forms of indigenous knowledge. By leveraging advancements in digital libraries, artificial intelligence, and metadata standards, IKS can be made accessible to a global audience, ensuring its relevance in the digital age.

Moreover, the ethical and philosophical principles embedded in IKS, such as *Dharma* (righteousness) and *VasudhaivaKutumbakam* (the world as one family), can guide the development of inclusive and equitable information systems. These values align with the core mission of LIS to promote access to knowledge for all, fostering social responsibility and global harmony.

Integrating IKS into LIS education also opens avenues for interdisciplinary research, encouraging scholars to explore connections between traditional knowledge and contemporary issues such as sustainability, health, and cultural preservation. For instance, ancient Indian practices in environmental conservation or holistic medicine can inspire modern solutions to global challenges.

Reimagining education in Libraries and Information Sciences by integrating the Indian Knowledge System is a forward-looking approach that honors the past while addressing the needs of the present. It empowers information professionals to become bridges between tradition and modernity, ensuring that India's timeless wisdom continues to enlighten and inspire future generations. By embracing this holistic vision, LIS can play a transformative role in shaping a knowledge-driven society that values both innovation and heritage.

Reconfiguring education to include the Indian Knowledge System in the present scenario is not just a nostalgic endeavor but a forward-looking strategy. It empowers learners with a balanced perspective, equipping them to navigate

the complexities of the modern world while staying rooted in their cultural identity. By embracing this dual approach, India can pave the way for a more enlightened and sustainable future.

Role of Libraries in Indian Knowledge System

Indian libraries are contributing significantly to the Indian knowledge system in various ways:

Preservation and Conservation

1. Rare book preservation: Libraries like the National Library of India, Kolkata, and the Asiatic Society of Mumbai preserve rare and ancient books, manuscripts, and texts.
2. Digital archiving: Initiatives like the Digital Library of India and the Indian National Digital Library in Engineering Sciences and Technology (INDEST) digitize and archive Indian knowledge resources.

Access to Knowledge

1. Public libraries: Public libraries like the State Central Libraries and District Central Libraries provide free access to books, journals, and other knowledge resources.
2. Academic libraries: University and college libraries support research and education by providing access to academic databases, e-journals, and books.
3. Digital libraries: Online platforms like the National Digital Library of India and the Indian National Digital Library provide remote access to knowledge resources.

Promotion of Indian Knowledge

1. Exhibitions and events: Libraries organize exhibitions, book fairs, and author talks to promote Indian literature, culture, and knowledge.
2. Research support: Libraries provide research support and guidance to scholars, researchers, and students working on Indian knowledge-related topics.
3. Community engagement: Libraries engage with local communities through outreach programs, literacy initiatives, and cultural events.

Collaboration and Partnerships

1. Inter-library loan programs: Libraries participate in inter-library loan programs to share resources and expand access to knowledge.
2. National and international collaborations: Indian libraries collaborate with national and international institutions to promote Indian knowledge and culture.
3. Industry partnerships: Libraries partner with industries to provide access to industry-specific knowledge resources and support innovation.

Capacity Building and Training

1. Librarian training programs: Libraries provide training and capacity-building programs for librarians to enhance their skills and knowledge.
2. User education programs: Libraries offer user education programs to equip users with information literacy skills and promote effective use of knowledge resources.
3. Digital literacy programs: Libraries provide digital literacy programs to promote digital inclusion and support the development of digital skills.

By contributing to the Indian knowledge system in these ways, Indian libraries play a vital role in preserving, promoting, and providing access to Indian knowledge and culture.

Libraries have played a vital role in the Indian knowledge system for centuries. Here are some key aspects:

Initiatives and Challenges

1. Digital libraries: Initiatives like the National Digital Library of India and the Indian National Digital Library in Engineering Sciences and Technology (INDEST) provide online access to resources.
2. Library modernization: Efforts to modernize libraries, including the introduction of RFID technology and

automation, aim to enhance user experience and efficiency.

3. Funding and infrastructure: Libraries face challenges related to inadequate funding, infrastructure, and staffing, which can impact their ability to provide quality services.

Future Directions

1. Innovative services: Libraries can explore innovative services, such as makerspaces, digital media labs, and virtual reality experiences.
2. Collaborations and partnerships: Libraries can foster collaborations with other institutions, organizations, and industries to enhance resources and services.
3. Community-led initiatives: Libraries can support community-led initiatives, such as literacy programs, author workshops, and cultural events.

By embracing these opportunities and addressing the challenges, libraries in India can continue to play a vital role in the country's knowledge system, supporting education, research, and community development.

Conclusion:

Indian libraries are playing a vital role in contributing to the Indian knowledge system. Through their efforts in preserving and conserving rare and ancient texts, providing access to knowledge resources, promoting Indian literature and culture, and collaborating with national and international institutions, libraries are helping to safeguard and promote India's rich cultural heritage.

By leveraging technology, libraries are also increasing access to knowledge resources, supporting research and education, and promoting digital literacy. Furthermore, libraries are engaging with local communities through outreach programs, literacy initiatives, and cultural events, thereby promoting social inclusion and community development.

In conclusion, Indian libraries are indeed contributing significantly to the Indian knowledge system, and their role will only continue to grow in importance as India strives to become a knowledge-based economy.

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Integrating Indian Knowledge System with

Current Trends and Technologies in Libraries and Information Sciences

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ABSTRACT

The integration of the Indian Knowledge System (IKS) with cutting-edge trends and technologies in Library and Information Science (LIS) offers a transformative pathway to connect ancient wisdom with modern innovation. By harnessing digital libraries, open-access platforms, and advanced tools such as Artificial Intelligence (AI), Machine Learning (ML), metadata standards, blockchain, and Virtual/Augmented Reality (VR/AR), IKS can be systematically preserved, organized, and shared on a global scale. These technologies facilitate the digitization of ancient manuscripts, interpretation of complex texts, and development of immersive educational experiences, making IKS accessible to a worldwide audience. Additionally, data analytics and visualization tools reveal hidden patterns and insights within traditional knowledge, providing innovative solutions to modern challenges. This integration also promotes interdisciplinary research, ethical information practices, community engagement, and international collaboration. While challenges such as standardization of digitization, language barriers, and ethical considerations exist, the teamwork. Between IKS and LIS holds significant

Possibleto enrich academia and professional fields, ensuring India's intellectual heritage remains relevant in the digital era. This convergence not only preserves cultural legacy but also fosters a more inclusive, diverse, and enlightened global knowledge ecosystem.

INTRODUCTION

The Indian Knowledge System (IKS), with its vast repository of ancient wisdom, and the rapidly evolving field of Libraries and Information Sciences (LIS) are two domains that, when integrated, can create a powerful teamwork. By combining the timeless principles of IKS with modern trends and technologies in LIS, we can preserve, organize, andcirculation traditional knowledge while addressing contemporary challenges. This integration not only enriches the academic and professional landscape but also ensures that India's intellectual heritage remains relevant in the digital age.

Current Trends and Technologies in LIS

The transition to digital libraries and open-access platforms haschanged the way information is stored, managed, and shared. By digitizing ancient Indian manuscripts, texts, and oral traditions, the Indian Knowledge System (IKS) can be made accessible to a global audience. This not only ensures the preservation of India's rich intellectual heritage but also enhances its relevance in the modern era. Open-access platforms can make available to allknowledge, allowing researchers, students, and enthusiasts worldwide to explore and benefit from the timeless wisdom embedded in IKS. Such initiatives bridge the gap between traditional knowledge and contemporary information systems, fostering a deeper understanding and appreciation of India's cultural and scientific contributions.

Machine Learning and Artificial Intelligence:

Artificial Intelligence (AI) and Machine Learning (ML) technologies have thepossibletoreformthe way traditional knowledge is organized, analyzed, and accessed. By leveraging AI-powered tools, vast amounts of Indian Knowledge System (IKS) resources can be systematically categorized, retrieved, and studied. For instance, AI can assist in decoding ancient scripts, interpreting complex texts, or identifying patterns in Vedic mathematics, astronomy, and other fields. These technologies enable efficient management of IKS materials, making them more accessible to researchers and learners. By integrating AI and ML into the study of IKS, we can unlock new insights, preserve cultural heritage, and bridge the gap between ancient wisdom and modern scientific exploration..

Metadata and Semantic Technologies:

Advanced metadata standards and semantic technologies play a crucial role in enhancing the discoverability and accessibility of Indian Knowledge System (IKS) resources. By creating structured and detailed metadata for ancient

Global Collaboration: Partnering with international organizations can amplify the reach and recognition of Indigenous Knowledge Systems (IKS) on a global stage. Digital platforms can serve as bridges for cross-cultural dialogue, allowing researchers and scholars worldwide to engage with, study, and contribute to the preservation and advancement of Indian knowledge systems.

Challenges and Opportunities: Integrating Indigenous Knowledge Systems (IKS) with Library and Information Science (LIS) offers immense potential but also poses significant challenges. Key hurdles include establishing standardized frameworks for digitization, overcoming language barriers, and ensuring the ethical use of traditional knowledge. However, with thoughtful strategies and innovative technologies, these obstacles can be addressed, paving the way for the full realization of IKS's value in the contemporary world.

Conclusion: The integration of Indian Knowledge Systems (IKS) with contemporary trends and technologies in Library and Information Science (LIS) offers a transformative opportunity to connect the wisdom of the past with the innovations of the future. By harnessing digital tools, fostering interdisciplinary research, and adhering to ethical frameworks, LIS professionals can ensure that India's rich heritage continues to inspire and contribute to global advancement. This synergy not only safeguards cultural legacy but also enhances the modern knowledge landscape, fostering a more inclusive, diverse, and enlightened world.

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together, these stakeholders can create a robust framework for safeguarding and revitalizing India's rich cultural legacy.

Challenges and Ethical Considerations

While AI holds immense promise for preserving Indian Knowledge Systems (IKS), it also brings forth significant ethical challenges. Data privacy and security are paramount concerns, especially when handling sensitive cultural artifacts and historical records. Additionally, biases embedded in AI algorithms can skew the representation of cultural heritage, potentially reinforcing stereotypes or sidelining marginalized communities. To address these issues, inclusivity and accessibility must remain at the forefront of AI-driven initiatives. Empowering diverse voices and ensuring equitable participation in the preservation process are essential to creating a balanced and respectful approach to safeguarding India's cultural legacy.

Future Directions

The future of AI-driven libraries is filled with exciting possibilities. Technologies like virtual reality (VR) and augmented reality (AR) can create immersive, interactive learning experiences, enabling users to explore ancient Indian texts and artifacts in unprecedented ways. AI also has the potential to foster interdisciplinary research, seamlessly connecting traditional knowledge systems with modern scientific inquiry. To fully realize these opportunities, policymakers must take a proactive role in promoting collaboration among libraries, AI researchers, and cultural institutions. By doing so, they can ensure that the benefits of AI are widely and equitably distributed, paving the way for a more inclusive and innovative approach to preserving and sharing India's cultural heritage.

Conclusion

The integration of Artificial Intelligence (AI) and Indian Knowledge Systems (IKS) in libraries signifies a profound synergy between tradition and technology. By leveraging the capabilities of AI, libraries can not only preserve but also actively promote India's cultural heritage, ensuring its enduring relevance and inspiration for future generations. As we navigate the challenges and opportunities of the digital age, the collaboration among libraries, researchers, and policymakers will be pivotal in turning this vision into reality. The moment to act is now—by embracing AI-driven solutions, we can safeguard the timeless wisdom of Indian Knowledge Systems and ensure their legacy thrives in an ever-evolving world.

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Enumerating Role of TKDL and NDLI in Preserving Knowledge Generated in India

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Abstract

India's diverse knowledge systems, including traditional medicine, arts, and cultural practices, are a vital part of its intellectual heritage. Initiatives like the Traditional Knowledge Digital Library (TKDL) and the National Digital Library of India (NDLI) play key roles in preserving this knowledge. TKDL prevents biopiracy by digitizing traditional knowledge, while NDLI provides free access to educational and cultural resources. Legal frameworks like the Patents Act, Copyright Act, and Geographical Indications (GI) Act protect India's intellectual property, supporting local communities and preserving cultural heritage. However, challenges like misappropriation, the digital divide, and cultural erosion remain. By combining digital innovation, legal safeguards, and community involvement, India can protect its traditional knowledge, promote sustainable development, and share its rich heritage globally.

Keywords: IPR, Digital age, National Digital Library of India, Traditional knowledge, patent, copyright

Abbreviations: IPR – Indian Intellectual Property Right, GI – Geographical Indications, TKDL – Traditional Knowledge Digital Library, NDLI – National Digital Library of India

Introduction:

India's knowledge systems are incredibly rich and diverse, covering areas like traditional medicine, philosophy, arts, sciences, and cultural practices. These systems are a valuable part of India's intellectual heritage, developed over thousands of years. However, in today's digital world, it has become essential to preserve and protect this knowledge to prevent it from being lost, stolen, or misused. Two key initiatives, the Traditional Knowledge Digital Library (TKDL) and the National Digital Library of India (NDLI), have played a major role in this effort. TKDL focuses on protecting traditional knowledge, especially in fields like Ayurveda, Yoga, Unani, Siddha, and Sushruta, from being wrongfully patented or exploited. On the other hand, NDLI acts as a vast digital library, offering free access to a wide range of educational and cultural resources. Together, these initiatives help preserve India's intellectual legacy, promote global recognition of its knowledge systems, and ensure their sustainable use. This review article examines the roles of TKDL and NDLI in safeguarding India's knowledge systems, discussing their achievements, challenges, and future possibilities in the context of intellectual property rights and digital innovation.

Legal Frameworks for IPR Protection

Legal frameworks for Intellectual Property Rights (IPR) in India play a crucial role in protecting traditional knowledge, cultural heritage, and modern innovations. Important laws include the Patents Act, 1970, which safeguards inventions; the Copyright Act, 1957, which protects creative works like books and art; the Geographical Indications (GI) Act, 1999, which protects products unique to specific regions, such as Darjeeling tea; and the Biological Diversity Act, 2002, which ensures fair use of biological resources and traditional knowledge. Along with initiatives like the Traditional Knowledge Digital Library (TKDL), these laws help preserve India's intellectual property, prevent misuse, and promote its global recognition and fair utilization.

Patents Act, 1970: The Patents Act, 1970 is an important law in India that protects new inventions and innovations. It gives inventors exclusive rights to their creations, allowing them to control how their inventions are used, made, or sold for a limited time, typically 20 years. This law encourages innovation by preventing others from copying or misusing patented ideas without permission. It also stops the patenting of traditional knowledge and ensures that only truly new, creative, and useful inventions can be patented. The Patents Act helps promote research, development, and technological progress in India while also protecting the public's interests.

Copyright Act, 1957: This is an Indian law that protects original creative works such as books, music, movies, art, and software. It gives creators the exclusive right to control how their work is used, copied, or shared, typically for their lifetime plus 60 years. This law encourages creativity by stopping others from using or copying the work without permission, ensuring creators are recognized and rewarded. At the same time, it allows limited use of copyrighted material for purposes like education, research, or criticism, balancing the rights of creators with public interest.

Geographical Indications (GI) Act, 1999: This is an Indian law that protects products that are special to a particular

region, like Darjeeling tea, Banarasi silk, or Alphonso mangoes. It ensures that only producers from that specific area can use the product's name, stopping others from copying or misusing it. This law helps preserve traditional skills, supports local businesses, and boosts the global image of India's unique regional products. By protecting the identity and quality of these goods, the GI Act benefits both producers and consumers.

Biological Diversity Act, 2002: This Indian law focuses on protecting the variety of plants, animals, and ecosystems in the country. It encourages the sustainable use of natural resources and ensures that local communities benefit fairly when their traditional knowledge or biological resources are used commercially. The Act controls access to these resources, stopping their misuse without proper permission. It also safeguards the rights of indigenous communities, helping them benefit from their knowledge and resources. This law plays a vital role in preserving India's rich natural heritage and supporting its local communities.

Trade Marks Act, 1999: This Indian law protects brand names, logos, and symbols used to identify goods or services. It grants exclusive rights to trademark owners, preventing others from using similar marks that could cause confusion. This Act helps businesses build brand identity, ensures consumer trust, and promotes fair competition in the market. It also allows for the registration and enforcement of trademarks, safeguarding intellectual property and supporting economic growth.

These laws ensure that knowledge generated in India is legally protected from unauthorized use or exploitation.

Traditional Knowledge Digital Library (TKDL)

The Traditional Knowledge Digital Library (TKDL) is an initiative by the Indian government to protect and preserve traditional knowledge, especially in areas like Ayurveda, Yoga, Unani, Siddha, and Sushruta. It converts ancient Indian texts into digital formats and translates them into multiple languages, making them available to patent offices worldwide. This helps stop the misuse of traditional knowledge by preventing false patents. TKDL connects traditional knowledge with modern science, ensuring India's intellectual heritage is respected and protected globally.

Contributions of TKDL in Digital Preservation:

Digitization of Traditional Knowledge: The digitization of traditional knowledge by TKDL has made a significant contribution by preserving and protecting India's ancient wisdom in fields like Ayurveda, Yoga, and Unani. By converting ancient texts into a digital format and translating them into multiple languages, TKDL has made this knowledge accessible to global patent offices. This has helped prevent the misappropriation of traditional knowledge, such as the wrongful patenting of turmeric and neem, which were later revoked due to evidence provided by TKDL. It bridges the gap between traditional knowledge systems and modern science, ensuring India's intellectual heritage is recognized and safeguarded globally.

Prevention of Biopiracy: TKDL has played a key role in stopping biopiracy by recording and digitizing India's traditional knowledge, making it available to patent offices worldwide. This has helped block incorrect patents based on India's ancient wisdom. For example, TKDL provided proof to cancel patents on turmeric (used for healing) and neem (used for its medicinal benefits), which were wrongly claimed by foreign companies. By acting as a protective shield, TKDL safeguards India's traditional knowledge from misuse and ensures it gets the recognition it deserves globally.

Global Recognition: TKDL has significantly contributed to the global recognition of India's traditional knowledge systems, such as Ayurveda, Yoga, Unani, and Siddha. By digitizing and translating ancient Indian texts into multiple languages, TKDL has made this knowledge accessible to international patent offices and researchers. This has not only prevented biopiracy but also highlighted India's rich intellectual heritage on a global stage.

National Digital Library of India (NDLI)

NDLI is a vast online repository launched by the Indian Institute of Technology Kharagpur, offering free access to educational and cultural resources (NDLI, 2022).

Contributions of NDLI in Digital Preservation

Donate Resources: Contribute books, manuscripts, research papers, or educational materials related to Indian knowledge systems to NDLI for digitization and inclusion. For example, donating rare Ayurveda texts, historical manuscripts, or academic research on Indian art and culture helps preserve and share India's intellectual heritage. These resources are digitized and made accessible to students, researchers, and the public, ensuring the knowledge is preserved for future generations and widely available.

Digitize Rare Materials: Help NDLI by converting rare or old documents, like ancient manuscripts, old textbooks,

or cultural items, into digital formats. For example, turning a centuries-old palm leaf manuscript on Indian astronomy or a rare collection of folk songs into digital files ensures they are preserved and easy to access. Once digitized, these materials are added to NDLI, making them available to researchers, students, and the public. This helps protect India's cultural and intellectual heritage for future generations.

Collaborate with Institutions: Partner with universities, libraries, or cultural organizations to contribute valuable collections or expertise to NDLI. For example, a university library can share its collection of rare Indian philosophy texts, or a cultural organization can provide access to traditional art and music archives. Such collaborations enrich NDLI's resources, making them more diverse and accessible to students, researchers, and the public, while preserving India's knowledge and cultural heritage.

Provide Metadata: NDLI organizes and labels digital content with accurate details like titles, authors, subjects, and keywords. For example, adding this information to a collection of ancient Sanskrit texts makes it easier for users to search and find specific works or topics. This improves how easily people can access and use NDLI's resources, helping students, researchers, and the public quickly find the information they need.

Promote NDLI: Spread awareness about NDLI to students, researchers, and teachers to encourage them to use it and contribute. For example, organize workshops or share posts on social media explaining how NDLI offers free access to educational resources like books, research papers, and cultural materials. By spreading awareness, more people can benefit from its vast collection, and they may also contribute their own resources to make NDLI even richer and more useful.

Volunteer for Digitization Projects: Join NDLI's efforts to digitize and preserve Indian knowledge resources, such as ancient manuscripts, rare books, or cultural documents. By volunteering, you help convert these valuable materials into digital formats, making them accessible to everyone and ensuring they are saved for future generations. Your contribution supports the preservation of India's rich intellectual and cultural heritage.

Share Expertise: Contribute your technical skills or subject knowledge to support NDLI's digital preservation projects. For example, experts in technology can help improve digitization tools, while scholars in fields like history or literature can assist in organizing and interpreting resources. Your expertise helps enhance the quality and accessibility of NDLI's collection, ensuring India's knowledge heritage is preserved and shared effectively.

Conclusion

India's diverse knowledge systems are a vital part of its heritage. Initiatives such as TKDL and NDLI play a crucial role in preserving this knowledge. TKDL prevents biopiracy through digitization, while NDLI provides access to educational and cultural resources. Legal frameworks, including the Patents Act, Copyright Act, and GI Act, protect India's intellectual property. However, challenges like misappropriation, the digital divide, and technological obsolescence remain. By integrating digital innovation, legal safeguards, and community involvement, India can effectively preserve its traditional knowledge and promote sustainable development globally.

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AN EVALUATION OF ANDROID-BASED CANE REGISTRATION SYSTEM

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Abstract - The sugar industry in India, a vital agro-based sector, faces significant challenges including low margins, persistent losses in sugar recovery, and inefficiencies due to outdated machinery and technology. Controlled by the Government of India, the industry's major decisions are often government-driven rather than mill-driven. This study evaluates the application performance and reliability of the Sugarcane Plantation Registration System, highlighting its current status and the issues sugar mills face. Traditional registration methods, characterized by manual, error-prone processes, are being replaced by an Android-based registration system. The study focuses on assessing the performance, reliability, and user satisfaction of this mobile application, aiming to address the operational challenges in the industry.

Keywords - Android-Based Sugarcane Registration Mobile Application, Performance, Reliability

I. INTRODUCTION

The sugar industry is one of India's most crucial agro-based sectors, ranking second among the major agro-based industries. It is regulated by the Government of India, which means that the government makes primary decisions rather than the sugar mills. This industry faces several challenges, including low-profit margins, continuous losses in sugar recovery, and inefficiencies in sugar production due to outdated machinery and a lack of new technology.

Registering sugarcane with a sugar factory is the initial step in transporting the crop to the factory. This registration of cane plots is a crucial activity for the factory, as it supports subsequent financial operations and various processes within the facility. It helps in obtaining detailed information about the planted cane, including type, area, season, and irrigation method. Additionally, it aids in managing all cane-cutting activities, such as appointing cutting teams, allocating teams to specific plots, and overseeing other related tasks. In the cane plantation registration system, the role of the slip-boy is to visit various sugarcane plots to gather details about the plantation, the farmer, the farm, and the village from the sugarcane owner. This information is then sent to the sugar factory. The factory collects this data from all authorized personnel and uses it for various departmental processes. Sugarcane registration with the factory is a critical activity for obtaining detailed information about the cane area, and it is essential for subsequent financial activities and processes. As a farming family member, the researcher observed the cane registration process and decided to develop an Android-based mobile application to address the shortcomings of the manual registration system. In this study, the researcher has developed an Android-based mobile application for the sugarcane registration process and he needs to check the performance, reliability, and benefits of the application

II. OBJECTIVES OF THE STUDY

1. To Evaluate the Performance of an Android-based Sugarcane Registration Application.
2. To Study the Reliability of Android-based Sugarcane Registration Application
3. To Study the Benefits of the Android-based Sugarcane Registration Application

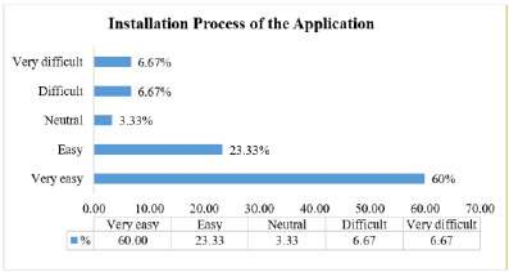
III. RESEARCH METHODOLOGY

In total 30 slip boys participated in the research. The slip boys belonged to three different sugar factories like Loakmangal Sugars, Siddheshwar Sugar factory, and Gokul Sugar factory from South Solapur, North Solapur, and Akkalkoat taluka respectively. Among the 30 respondents, 20 Slip boys 06 are Administrative Staff, and 4 are field officers for realistic testing of the app. The respondents were selected by using a convenient sampling method.

The participants were asked to complete a questionnaire tested previously in a pilot study. The questionnaire consisted of closed and open questions designed to collect data on all three objectives. Descriptive statistics were used for the analysis of the data.

IV. RESULT AND ANALYSIS

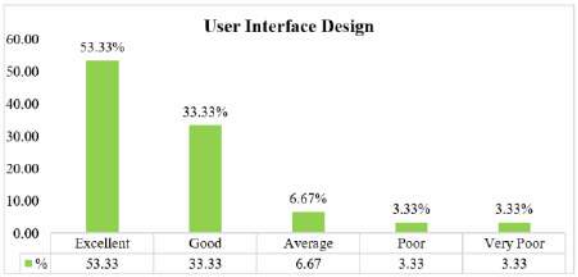
1.4.1 Installation Process of the Application



Graph No.: 1.4.1

The Cane Plantation Registration Application's Installation process receives positive feedback from users, with 60% rating it as "Very Easy" and 23.33% as "Easy." This suggests that most users find the installation straightforward and efficient, reflecting a well-designed and user-friendly application. Such ease of installation likely enhances user satisfaction and promotes quicker adoption.

1.4.2 About User Interface Design

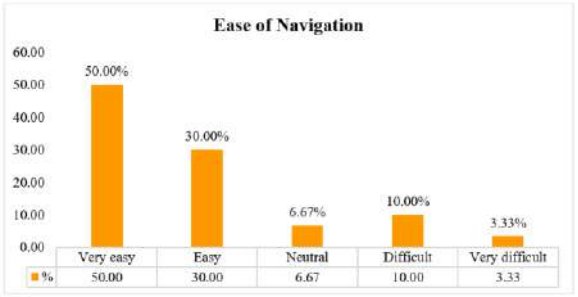


Graph No.:1.4.2

A maximum of 53.33% rated the Excellent remark and 33.33% of respondents said Good about interface design.

The Android-based cane plantation registration application's user interface design is "Excellent," showing that it is beautiful and works well. This high rating means the design meets users' expectations and improves their overall experience. The uniform praise highlights the design's top-notch quality and effectiveness.

1.4.3 Ease of Navigation

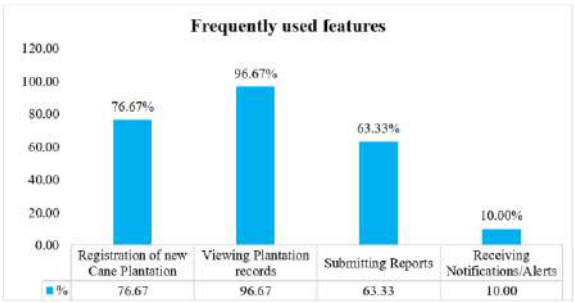


Graph No: 1.4.3

The ease of navigation in the Cane Plantation Registration Application is rated positively by users, with 50% finding it "Very Easy" and 30% finding it "Easy." Only 6.67% of respondents are neutral about their experience. This suggests that most users find the Cane plantation registration application straightforward and intuitive, indicating a well-organized and user-friendly layout.

1.4.4 Frequently Used Features

This question helps identify which application features users most value and utilize. The high frequency of specific features like "Registration of new cane plantations" or "Viewing plantation records" indicates their importance to the users' workflows and can guide further development and optimization efforts. If "Submitting reports" and "Receiving notifications/alerts" are frequently used, it suggests that these functionalities are critical for users' operational efficiency and communication

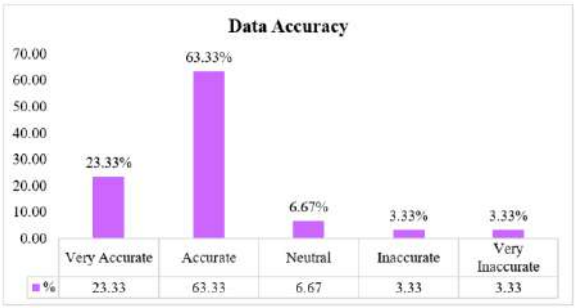


Graph No.:1.4.4

Users make different use of the Cane Plantation Registration Application's features. Maximum respondent (96.67%) regularly uses the "Viewing Plantation Records" feature, showing it is very important for their daily work. The "Registration of New Cane Plantation" feature is used by 76.67% of respondents, indicating its strong importance. Meanwhile, 63.33% use the "Submitting Reports" feature, showing it is useful, but only 10% use the "Receiving Notifications/Alerts" feature, suggesting it is less important. This usage pattern highlights which features are most essential and may help guide future improvements.

1.4.5 Data Accuracy

The accuracy of data recorded by the application is crucial for its reliability and the trust users place in it. High ratings (Very Accurate or Accurate) indicate that users find the application dependable and precise in capturing and maintaining data, which is vital for effective decision-making and operational efficiency

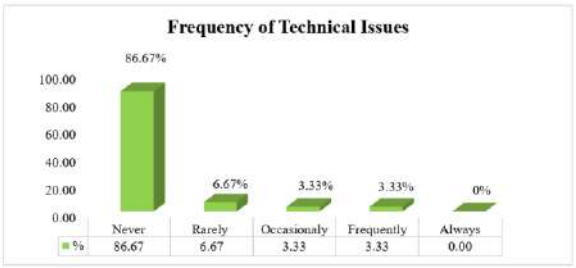


Graph No.:1.4.5

The Cane Plantation Registration Application's data accuracy is rated very positively. 23.33% of respondents find it "Very Accurate," and 63.33% find it "Accurate." This means the Cane Plantation Registration Application is mostly reliable and precise with data, which helps users make good decisions and trust the app.

1.4.6 Frequency of Technical Issues

The frequency of technical issues is a critical indicator of the application's stability and reliability. High ratings of "Never" or "Rarely" experiencing issues suggest that the application is stable and well-maintained, leading to a positive user experience and uninterrupted workflows.

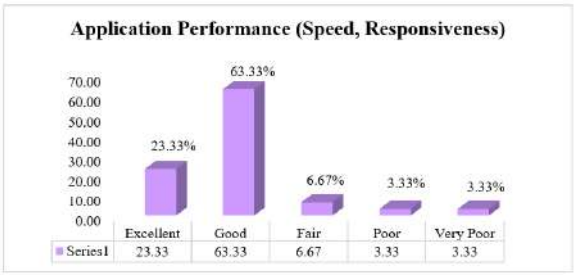


Graph No.:1.4.6

The Cane Plantation Registration application has very few technical issues, as 86.67% reported they have "Never" faced any problems. This means the app is very stable and reliable, providing a smooth and trouble-free experience.

1.4.7 Application Performance

The application's performance in terms of speed and responsiveness is essential for user satisfaction and productivity. High ratings (Excellent or Good) indicate that the application is performing well, providing a smooth and efficient user experience. "Fair" suggests that there might be occasional performance issues that need attention.

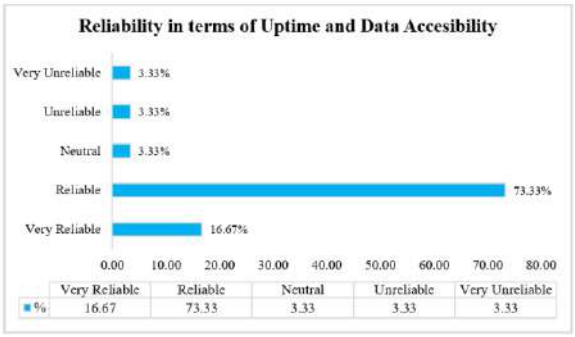


Graph No: 1.4.7

The Cane Plantation Registration Application's performance in terms of speed and responsiveness is rated highly by users, with 23.33% describing it as "Excellent" and 63.33% as "Good." This indicates that the application generally performs very well, providing a fast and responsive experience for most users.

1.4.8 Reliability in Terms of Uptime and Data Accessibility

Reliability in terms of uptime and data accessibility is crucial for the dependability of the application. High ratings (Very Reliable or Reliable) suggest that the application is consistently available and data is accessible when needed, which is essential for user trust and operational continuity.



Graph No.:1.4.8

The Cane Plantation Registration Application's reliability regarding uptime and responsiveness is rated positively by users. 16.67% of respondents consider it "Very Reliable," 73.33% find it "Reliable," and 3.33 % are neutral. This suggests that most users find the application consistently dependable, though there is some variability in the level of reliability experienced.

1.4.9 Receipt of Training

This question assesses whether users have been given formal instructions on using the application. A high number of "Yes" responses indicates that the organization has invested in user training, which can lead to better understanding and effective utilization of the application Everyone has received training on how to use the Cane Plantation Registration application, showing that the organization has effectively trained all users. This training helps users understand and use the app more effectively.

1.4.10 Quality of Training

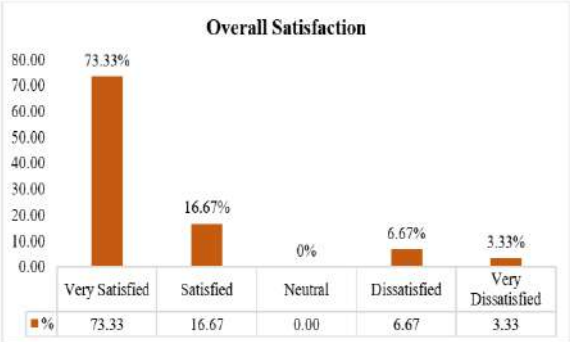
The quality of training is critical for ensuring users are well-prepared to use the application efficiently. High ratings (Excellent or Good) indicate that the training provided is effective, comprehensive, and well-received by users, leading to better understanding and proficient use of the application.

Graph No: 1.4.10

The training quality for the Cane Plantation Registration application is rated well, with 63.33% of respondents saying it was "Good" and 20% calling it "Excellent. And 10% saying is fair" This shows that the training was mostly effective, with most users finding it helpful and some considering it outstanding.

1.4.11 Overall Satisfaction

Overall satisfaction is a key indicator of the application's success and user acceptance. High ratings (Very Satisfied or Satisfied) suggest that the application meets user expectations and provides a positive experience.

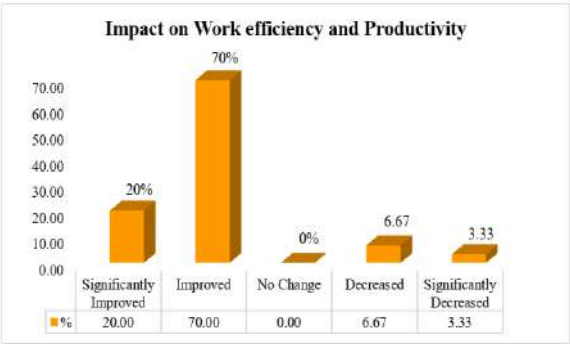


Graph No.:1.4.11

Overall satisfaction with the Cane Plantation Registration application is high, with 73.33% of respondents reporting they are "Very Satisfied" and 16.67% indicating they are "Satisfied." This reflects that most users are highly pleased with the Cane Plantation Registration application, with nearly all users expressing a positive experience.

1.4.12 Impact on Work Efficiency and Productivity

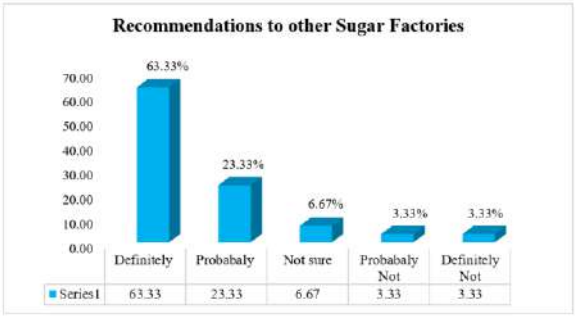
The impact on work efficiency and productivity measures the practical benefits of the Cane Plantation Registration application. High ratings (Significantly Improved or Improved) indicate that the application positively affects users' work, making tasks easier and more efficient.



Graph No.:1.4.12

The Cane Plantation Registration application positively affects work efficiency and productivity. 70% of respondents say it has "Improved" their work, and 20% report it has "Significantly Improved" their productivity. This shows that the app generally boosts users' work performance, with some experiencing major benefits.

1.4.13 Recommendation to other Sugar Factories

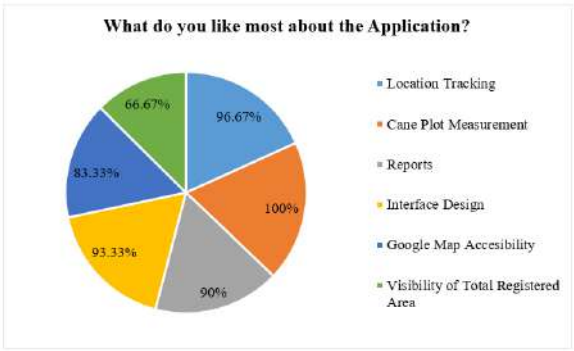


Graph No.:1.4.13

63.33% of respondents say they would "Definitely" recommend the Cane Plantation Registration application to other sugar factories, while 23.33% say they "Probably" would recommend it. This indicates that a strong majority of users find the Cane Plantation Registration application valuable and believe it could be beneficial to others in the industry.

1.4.14 What do you like most about the application?

Understanding what users like most about the application helps identify its core strengths and successful elements. This feedback is crucial for maintaining and enhancing these aspects in future updates and for marketing the application's benefits to potential new users.



Graph No.: 1.4.14

Many users appreciate the location tracking feature, which helps them pinpoint exact places. Another group values the GPS-based measurement tool for sugarcane plots, which aids in accurate agricultural planning. Lastly, the reporting capabilities of the application are also highly valued, providing important insights and data.

V. FINDINGS

1) The Majority of users find the installation process of the Cane Plantation Registration application straightforward and efficient. The interface design of the Cane Plantation Registration application meets the user's expectations and significantly enhances their overall experience.
2) Most users find the Cane Plantation Registration application easy to use, showing it has a clear and user-friendly design.

3) The Cane Plantation Registration application is highly stable and reliable, providing users with a smooth and trouble-free experience.
4) The Cane Plantation Registration application generally performs very well, providing a fast and responsive experience for most users.
5) Most users rate the Cane Plantation Registration application as consistently dependable in terms of Uptime and Data Accessibility
6) The Training quality for the Cane Plantation Registration application is generally well-liked. Most users found the training helpful, with many considering it excellent.
7) Most of the users have a positive experience with the Cane Plantation Registration application.
8) The Cane Plantation Registration application generally boosts users' work performance, with some experiencing significant benefits.
9) Most users find the application valuable and believe it could benefit others in the sugar factory.

VI. CONCLUSION

The Android-based Sugarcane Registration application is very effective and well-liked by users. Installing it is easy and efficient, and the design improves the user experience. The app provides accurate and reliable data, which helps users make good decisions and builds trust. Most users appreciate how fast and responsive the app is, which boosts their work efficiency. Additionally, users value location tracking, GPS tools for measuring sugarcane plots, and reporting features, which contribute to better farming decisions and useful insights. Overall, the app is seen as dependable and beneficial, making it a valuable tool for its users.

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★★★

Enumerating Role of TKDL and NDLI in Preserving Knowledge Generated in India

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Abstract

India's diverse knowledge systems, including traditional medicine, arts, and cultural practices, are a vital part of its intellectual heritage. Initiatives like the Traditional Knowledge Digital Library (TKDL) and the National Digital Library of India (NDLI) play key roles in preserving this knowledge. TKDL prevents biopiracy by digitizing traditional knowledge, while NDLI provides free access to educational and cultural resources. Legal frameworks like the Patents Act, Copyright Act, and Geographical Indications (GI) Act protect India's intellectual property, supporting local communities and preserving cultural heritage. However, challenges like misappropriation, the digital divide, and cultural erosion remain. By combining digital innovation, legal safeguards, and community involvement, India can protect its traditional knowledge, promote sustainable development, and share its rich heritage globally.

Keywords: IPR, Digital age, National Digital Library of India, Traditional knowledge, patent, copyright

Abbreviations: IPR – Indian Intellectual Property Right, GI – Geographical Indications, TKDL – Traditional Knowledge Digital Library, NDLI – National Digital Library of India

Introduction:

India's knowledge systems are incredibly rich and diverse, covering areas like traditional medicine, philosophy, arts, sciences, and cultural practices. These systems are a valuable part of India's intellectual heritage, developed over thousands of years. However, in today's digital world, it has become essential to preserve and protect this knowledge to prevent it from being lost, stolen, or misused. Two key initiatives, the Traditional Knowledge Digital Library (TKDL) and the National Digital Library of India (NDLI), have played a major role in this effort. TKDL focuses on protecting traditional knowledge, especially in fields like Ayurveda, Yoga, Unani, Siddha, and Sushruta, from being wrongfully patented or exploited. On the other hand, NDLI acts as a vast digital library, offering free access to a wide range of educational and cultural resources. Together, these initiatives help preserve India's intellectual legacy, promote global recognition of its knowledge systems, and ensure their sustainable use. This review article examines the roles of TKDL and NDLI in safeguarding India's knowledge systems, discussing their achievements, challenges, and future possibilities in the context of intellectual property rights and digital innovation.

Legal Frameworks for IPR Protection

Legal frameworks for Intellectual Property Rights (IPR) in India play a crucial role in protecting traditional knowledge, cultural heritage, and modern innovations. Important laws include the Patents Act, 1970, which safeguards inventions; the Copyright Act, 1957, which protects creative works like books and art; the Geographical Indications (GI) Act, 1999, which protects products unique to specific regions, such as Darjeeling tea; and the Biological Diversity Act, 2002, which ensures fair use of biological resources and traditional knowledge. Along with initiatives like the Traditional Knowledge Digital Library (TKDL), these laws help preserve India's intellectual property, prevent misuse, and promote its global recognition and fair utilization.

Patents Act, 1970: The Patents Act, 1970 is an important law in India that protects new inventions and innovations. It gives inventors exclusive rights to their creations, allowing them to control how their inventions are used, made, or sold for a limited time, typically 20 years. This law encourages innovation by preventing others from copying or misusing patented ideas without permission. It also stops the patenting of traditional knowledge and ensures that only truly new, creative, and useful inventions can be patented. The Patents Act helps promote research, development, and technological progress in India while also protecting the public's interests.

Copyright Act, 1957: This is an Indian law that protects original creative works such as books, music, movies, art, and software. It gives creators the exclusive right to control how their work is used, copied, or shared, typically for their lifetime plus 60 years. This law encourages creativity by stopping others from using or copying the work without permission, ensuring creators are recognized and rewarded. At the same time, it allows limited use of copyrighted material for purposes like education, research, or criticism, balancing the rights of creators with public interest.

Geographical Indications (GI) Act, 1999: This is an Indian law that protects products that are special to a particular

region, like Darjeeling tea, Banarasi silk, or Alphonso mangoes. It ensures that only producers from that specific area can use the product's name, stopping others from copying or misusing it. This law helps preserve traditional skills, supports local businesses, and boosts the global image of India's unique regional products. By protecting the identity and quality of these goods, the GI Act benefits both producers and consumers.

Biological Diversity Act, 2002: This Indian law focuses on protecting the variety of plants, animals, and ecosystems in the country. It encourages the sustainable use of natural resources and ensures that local communities benefit fairly when their traditional knowledge or biological resources are used commercially. The Act controls access to these resources, stopping their misuse without proper permission. It also safeguards the rights of indigenous communities, helping them benefit from their knowledge and resources. This law plays a vital role in preserving India's rich natural heritage and supporting its local communities.

Trade Marks Act, 1999: This Indian law protects brand names, logos, and symbols used to identify goods or services. It grants exclusive rights to trademark owners, preventing others from using similar marks that could cause confusion. This Act helps businesses build brand identity, ensures consumer trust, and promotes fair competition in the market. It also allows for the registration and enforcement of trademarks, safeguarding intellectual property and supporting economic growth.

These laws ensure that knowledge generated in India is legally protected from unauthorized use or exploitation.

Traditional Knowledge Digital Library (TKDL)

The Traditional Knowledge Digital Library (TKDL) is an initiative by the Indian government to protect and preserve traditional knowledge, especially in areas like Ayurveda, Yoga, Unani, Siddha, and Sushruta. It converts ancient Indian texts into digital formats and translates them into multiple languages, making them available to patent offices worldwide. This helps stop the misuse of traditional knowledge by preventing false patents. TKDL connects traditional knowledge with modern science, ensuring India's intellectual heritage is respected and protected globally.

Contributions of TKDL in Digital Preservation:

Digitization of Traditional Knowledge: The digitization of traditional knowledge by TKDL has made a significant contribution by preserving and protecting India's ancient wisdom in fields like Ayurveda, Yoga, and Unani. By converting ancient texts into a digital format and translating them into multiple languages, TKDL has made this knowledge accessible to global patent offices. This has helped prevent the misappropriation of traditional knowledge, such as the wrongful patenting of turmeric and neem, which were later revoked due to evidence provided by TKDL. It bridges the gap between traditional knowledge systems and modern science, ensuring India's intellectual heritage is recognized and safeguarded globally.

Prevention of Biopiracy: TKDL has played a key role in stopping biopiracy by recording and digitizing India's traditional knowledge, making it available to patent offices worldwide. This has helped block incorrect patents based on India's ancient wisdom. For example, TKDL provided proof to cancel patents on turmeric (used for healing) and neem (used for its medicinal benefits), which were wrongly claimed by foreign companies. By acting as a protective shield, TKDL safeguards India's traditional knowledge from misuse and ensures it gets the recognition it deserves globally.

Global Recognition: TKDL has significantly contributed to the global recognition of India's traditional knowledge systems, such as Ayurveda, Yoga, Unani, and Siddha. By digitizing and translating ancient Indian texts into multiple languages, TKDL has made this knowledge accessible to international patent offices and researchers. This has not only prevented biopiracy but also highlighted India's rich intellectual heritage on a global stage.

National Digital Library of India (NDLI)

NDLI is a vast online repository launched by the Indian Institute of Technology Kharagpur, offering free access to educational and cultural resources (NDLI, 2022).

Contributions of NDLI in Digital Preservation

Donate Resources: Contribute books, manuscripts, research papers, or educational materials related to Indian knowledge systems to NDLI for digitization and inclusion. For example, donating rare Ayurveda texts, historical manuscripts, or academic research on Indian art and culture helps preserve and share India's intellectual heritage. These resources are digitized and made accessible to students, researchers, and the public, ensuring the knowledge is preserved for future generations and widely available.

Digitize Rare Materials: Help NDLI by converting rare or old documents, like ancient manuscripts, old textbooks,

or cultural items, into digital formats. For example, turning a centuries-old palm leaf manuscript on Indian astronomy or a rare collection of folk songs into digital files ensures they are preserved and easy to access. Once digitized, these materials are added to NDLI, making them available to researchers, students, and the public. This helps protect India's cultural and intellectual heritage for future generations.

Collaborate with Institutions: Partner with universities, libraries, or cultural organizations to contribute valuable collections or expertise to NDLI. For example, a university library can share its collection of rare Indian philosophy texts, or a cultural organization can provide access to traditional art and music archives. Such collaborations enrich NDLI's resources, making them more diverse and accessible to students, researchers, and the public, while preserving India's knowledge and cultural heritage.

Provide Metadata: NDLI organizes and labels digital content with accurate details like titles, authors, subjects, and keywords. For example, adding this information to a collection of ancient Sanskrit texts makes it easier for users to search and find specific works or topics. This improves how easily people can access and use NDLI's resources, helping students, researchers, and the public quickly find the information they need.

Promote NDLI: Spread awareness about NDLI to students, researchers, and teachers to encourage them to use it and contribute. For example, organize workshops or share posts on social media explaining how NDLI offers free access to educational resources like books, research papers, and cultural materials. By spreading awareness, more people can benefit from its vast collection, and they may also contribute their own resources to make NDLI even richer and more useful.

Volunteer for Digitization Projects: Join NDLI's efforts to digitize and preserve Indian knowledge resources, such as ancient manuscripts, rare books, or cultural documents. By volunteering, you help convert these valuable materials into digital formats, making them accessible to everyone and ensuring they are saved for future generations. Your contribution supports the preservation of India's rich intellectual and cultural heritage.

Share Expertise: Contribute your technical skills or subject knowledge to support NDLI's digital preservation projects. For example, experts in technology can help improve digitization tools, while scholars in fields like history or literature can assist in organizing and interpreting resources. Your expertise helps enhance the quality and accessibility of NDLI's collection, ensuring India's knowledge heritage is preserved and shared effectively.

Conclusion

India's diverse knowledge systems are a vital part of its heritage. Initiatives such as TKDL and NDLI play a crucial role in preserving this knowledge. TKDL prevents biopiracy through digitization, while NDLI provides access to educational and cultural resources. Legal frameworks, including the Patents Act, Copyright Act, and GI Act, protect India's intellectual property. However, challenges like misappropriation, the digital divide, and technological obsolescence remain. By integrating digital innovation, legal safeguards, and community involvement, India can effectively preserve its traditional knowledge and promote sustainable development globally.

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Role of Libraries in Indian Knowledge System

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ABSTRACT:

The Indian Knowledge System (IKS) represents a structured and systematic transfer of knowledge from one generation to the next. It seeks to bridge the gap between India's ancient traditional wisdom and modern knowledge systems, fostering a harmonious blend of the two. By doing so, IKS aims to create opportunities for students, researchers, and educational institutions to engage in interdisciplinary exploration and innovation within this field. Established as an innovative initiative, IKS is dedicated to preserving, promoting, and disseminating traditional knowledge for further research and practical applications in society. It actively works to highlight and share the rich cultural heritage and traditional wisdom of India.

At its core, IKS emphasizes moral values, ethics, and principles that guide individuals toward leading a righteous and meaningful life. By integrating these ethical teachings into the contemporary education system, institutions can help students develop a strong sense of social responsibility, compassion, and ethical decision-making. These qualities are essential for fostering a balanced and harmonious way of life, equipping individuals to navigate the complexities of the modern world while staying rooted in timeless values. Through this integration, IKS not only preserves India's cultural legacy but also enriches the present and future generations with wisdom that is both profound and practical. reimagining education in Libraries and Information Sciences by integrating the Indian Knowledge System is a forward-looking approach that honors the past while addressing the needs of the present. It empowers information professionals to become bridges between tradition and modernity, ensuring that India's timeless wisdom continues to enlighten and inspire future generations. By embracing this holistic vision, LIS can play a transformative role in shaping a knowledge-driven society that values both innovation and heritage.

INTRODUCTION

The Indian Knowledge System (IKS) represents a structured and systematic process of transferring knowledge from one generation to the next. It is not merely a tradition but a well-organized system designed to preserve and propagate wisdom. Rooted in Vedic culture, IKS encompasses a vast repository of ancient texts, including the Vedas (Rig, Yajur, Sama, and Atharva), Upanishads, and Upvedas, which form the foundation of this knowledge system (Centre for Policy Research & Governance, 2023). For centuries, India's knowledge system has been deeply intertwined with its cultural and spiritual heritage, offering profound insights into various aspects of life, philosophy, and science.

In recent decades, there has been a renewed interest in the Indian Knowledge System, prompting leading educationists and scientists to explore its potential and relevance in the modern world. Recognizing the importance of reviving and integrating indigenous knowledge, the Indian government has taken significant steps, such as the formulation of the National Education Policy (NEP) 2020. This policy draws inspiration from India's rich and timeless intellectual heritage, emphasizing the need to blend ancient wisdom with contemporary education (Mandavkar, P. 2023).

At the heart of IKS lies the pursuit of knowledge (*Jnan*), wisdom (*Pragyaa*), and truth (*Satya*), which have always been regarded as the highest human aspirations in Indian philosophy. The goal of education in ancient India extended beyond mere acquisition of knowledge for worldly success or spiritual liberation. It aimed at the holistic development and self-realization of the individual, fostering a sense of completeness and inner freedom. By integrating these timeless principles into the modern education system, IKS has the potential to nurture not only intellectual growth but also ethical values, social responsibility, and a deeper understanding of life's purpose. This approach ensures that education becomes a transformative journey, empowering individuals to lead balanced, meaningful, and enlightened lives

In the rapidly evolving global landscape, education systems worldwide are undergoing significant transformations to meet the demands of the 21st century. In India, there is a growing recognition of the need to reconnect with the rich and diverse heritage of the Indian Knowledge System (IKS) while simultaneously addressing contemporary challenges. This calls for a reconfiguration of the educational framework, where traditional wisdom and modern

advancements coexist harmoniously.

The Indian Knowledge System, rooted in ancient texts, philosophies, and practices, offers profound insights into various fields such as mathematics, astronomy, medicine, ecology, and ethics. By integrating these timeless principles into the current educational paradigm, we can create a more holistic and inclusive approach to learning. This integration not only preserves cultural heritage but also fosters critical thinking, creativity, and a deeper understanding of sustainable living.

In the present scenario, where technological advancements and globalization dominate, the Indian Knowledge System can serve as a guiding light. For instance, the concept of *VasudhaivaKutumbakam* (the world as one family) promotes global harmony and interconnectedness, which is crucial in today's interconnected world. Similarly, the emphasis on *Dharma* (righteousness) and *Karma* (action) can instill a sense of responsibility and ethical conduct among learners.

To effectively integrate IKS into modern education, a multi-faceted approach is essential. This includes revising curricula to incorporate traditional knowledge, training educators to bridge the gap between ancient and contemporary teachings, and leveraging technology to make this knowledge accessible to a wider audience. Additionally, interdisciplinary studies that combine traditional wisdom with modern science can lead to innovative solutions to global challenges such as climate change, health crises, and social inequality.

Indian Knowledge System in Libraries and Information Sciences for the Modern Era

In the contemporary era, where information is a cornerstone of progress, the field of Libraries and Information Sciences (LIS) plays a pivotal role in knowledge dissemination and preservation. As the world increasingly recognizes the value of indigenous wisdom, integrating the Indian Knowledge System (IKS) into LIS education and practices offers a transformative opportunity to bridge the gap between ancient traditions and modern information management. This integration not only enriches the academic and professional landscape but also ensures the preservation and propagation of India's rich intellectual heritage.

The Indian Knowledge System, rooted in the Vedas, Upanishads, and other ancient texts, encompasses a vast repository of knowledge spanning philosophy, science, medicine, ecology, and ethics. By incorporating IKS into LIS curricula, educational institutions can equip future information professionals with the tools to curate, organize, and disseminate this traditional knowledge effectively. Libraries, as custodians of knowledge, can serve as dynamic spaces where ancient wisdom coexists with modern information technologies, fostering interdisciplinary research and innovation.

One of the key challenges in integrating IKS into LIS is the systematic organization and digitization of traditional knowledge sources. This requires collaboration between scholars, librarians, and technologists to develop frameworks for classifying, cataloging, and preserving ancient manuscripts, oral traditions, and other forms of indigenous knowledge. By leveraging advancements in digital libraries, artificial intelligence, and metadata standards, IKS can be made accessible to a global audience, ensuring its relevance in the digital age.

Moreover, the ethical and philosophical principles embedded in IKS, such as *Dharma* (righteousness) and *VasudhaivaKutumbakam* (the world as one family), can guide the development of inclusive and equitable information systems. These values align with the core mission of LIS to promote access to knowledge for all, fostering social responsibility and global harmony.

Integrating IKS into LIS education also opens avenues for interdisciplinary research, encouraging scholars to explore connections between traditional knowledge and contemporary issues such as sustainability, health, and cultural preservation. For instance, ancient Indian practices in environmental conservation or holistic medicine can inspire modern solutions to global challenges.

Reimagining education in Libraries and Information Sciences by integrating the Indian Knowledge System is a forward-looking approach that honors the past while addressing the needs of the present. It empowers information professionals to become bridges between tradition and modernity, ensuring that India's timeless wisdom continues to enlighten and inspire future generations. By embracing this holistic vision, LIS can play a transformative role in shaping a knowledge-driven society that values both innovation and heritage.

Reconfiguring education to include the Indian Knowledge System in the present scenario is not just a nostalgic endeavor but a forward-looking strategy. It empowers learners with a balanced perspective, equipping them to navigate

the complexities of the modern world while staying rooted in their cultural identity. By embracing this dual approach, India can pave the way for a more enlightened and sustainable future.

Role of Libraries in Indian Knowledge System

Indian libraries are contributing significantly to the Indian knowledge system in various ways:

Preservation and Conservation

1. Rare book preservation: Libraries like the National Library of India, Kolkata, and the Asiatic Society of Mumbai preserve rare and ancient books, manuscripts, and texts.
2. Digital archiving: Initiatives like the Digital Library of India and the Indian National Digital Library in Engineering Sciences and Technology (INDEST) digitize and archive Indian knowledge resources.

Access to Knowledge

1. Public libraries: Public libraries like the State Central Libraries and District Central Libraries provide free access to books, journals, and other knowledge resources.
2. Academic libraries: University and college libraries support research and education by providing access to academic databases, e-journals, and books.
3. Digital libraries: Online platforms like the National Digital Library of India and the Indian National Digital Library provide remote access to knowledge resources.

Promotion of Indian Knowledge

1. Exhibitions and events: Libraries organize exhibitions, book fairs, and author talks to promote Indian literature, culture, and knowledge.
2. Research support: Libraries provide research support and guidance to scholars, researchers, and students working on Indian knowledge-related topics.
3. Community engagement: Libraries engage with local communities through outreach programs, literacy initiatives, and cultural events.

Collaboration and Partnerships

1. Inter-library loan programs: Libraries participate in inter-library loan programs to share resources and expand access to knowledge.
2. National and international collaborations: Indian libraries collaborate with national and international institutions to promote Indian knowledge and culture.
3. Industry partnerships: Libraries partner with industries to provide access to industry-specific knowledge resources and support innovation.

Capacity Building and Training

1. Librarian training programs: Libraries provide training and capacity-building programs for librarians to enhance their skills and knowledge.
2. User education programs: Libraries offer user education programs to equip users with information literacy skills and promote effective use of knowledge resources.
3. Digital literacy programs: Libraries provide digital literacy programs to promote digital inclusion and support the development of digital skills.

By contributing to the Indian knowledge system in these ways, Indian libraries play a vital role in preserving, promoting, and providing access to Indian knowledge and culture.

Libraries have played a vital role in the Indian knowledge system for centuries. Here are some key aspects:

Initiatives and Challenges

1. Digital libraries: Initiatives like the National Digital Library of India and the Indian National Digital Library in Engineering Sciences and Technology (INDEST) provide online access to resources.
2. Library modernization: Efforts to modernize libraries, including the introduction of RFID technology and

automation, aim to enhance user experience and efficiency.

3. Funding and infrastructure: Libraries face challenges related to inadequate funding, infrastructure, and staffing, which can impact their ability to provide quality services.

Future Directions

1. Innovative services: Libraries can explore innovative services, such as makerspaces, digital media labs, and virtual reality experiences.
2. Collaborations and partnerships: Libraries can foster collaborations with other institutions, organizations, and industries to enhance resources and services.
3. Community-led initiatives: Libraries can support community-led initiatives, such as literacy programs, author workshops, and cultural events.

By embracing these opportunities and addressing the challenges, libraries in India can continue to play a vital role in the country's knowledge system, supporting education, research, and community development.

Conclusion:

Indian libraries are playing a vital role in contributing to the Indian knowledge system. Through their efforts in preserving and conserving rare and ancient texts, providing access to knowledge resources, promoting Indian literature and culture, and collaborating with national and international institutions, libraries are helping to safeguard and promote India's rich cultural heritage.

By leveraging technology, libraries are also increasing access to knowledge resources, supporting research and education, and promoting digital literacy. Furthermore, libraries are engaging with local communities through outreach programs, literacy initiatives, and cultural events, thereby promoting social inclusion and community development.

In conclusion, Indian libraries are indeed contributing significantly to the Indian knowledge system, and their role will only continue to grow in importance as India strives to become a knowledge-based economy.

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PUBLICATIONS IN BOOK/BOOK CHAPTER (S)

Sr. No.	Name of Faculty	Title of Book/ Book Chapter	Publisher	Month & Year	ISBN
1	Prof. Dr. S. B. Sawant	NEP 2020: The Road Map of India's Future Education	Shivika Publication Bhopal (MP)	2025	978-81-98437-62-4
2	Dr. A. B. Nadaf	Anomaly Detection Algorithms in Cybersecurity	IGI Global	Nov, 2024	979-8-3693-7540-2
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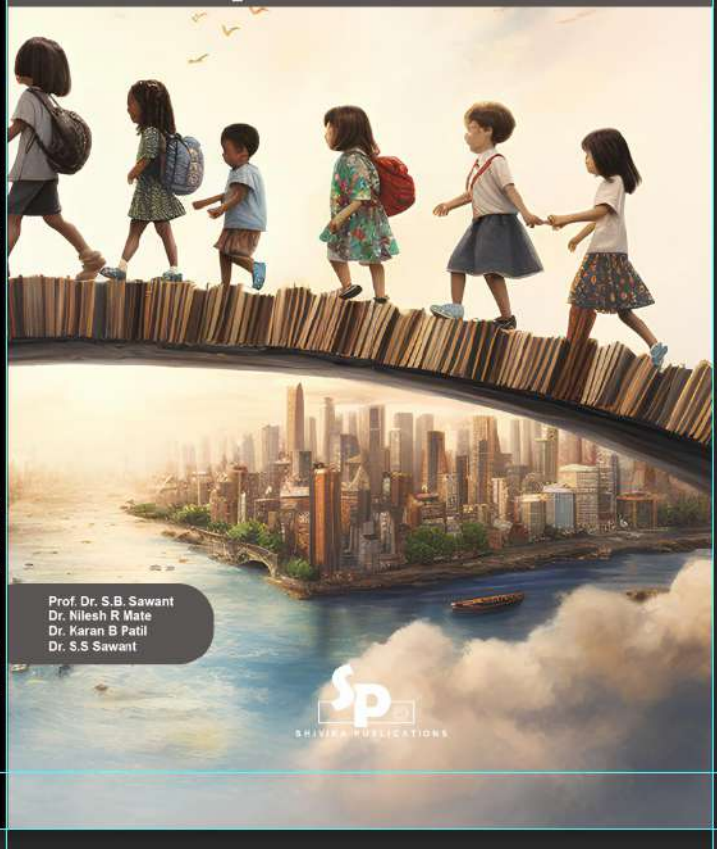

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Chapter 13
Anomaly Detection Algorithms in Cybersecurity

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ABSTRACT

In Anomaly Detection Algorithms in Cybersecurity, this chapter go over the fundamentals of the algorithms and techniques used to spot cyber threats. These methods include statistical, machine learning, deep learning, and clustering. In order to find statistical outliers, traditional anomaly detection employs Gaussian Mixture Models, which model the system's normal behavior. In order to improve their anomaly detection abilities, SVM and RF learn on tagged datasets. Using autoencoders for complicated and multidimensional data sets, deep learning has stabilized anomaly detection. K-Means and DBSCAN are two alternatives that can cluster data points and find outliers. This chapter takes a look at the algorithms and how they're utilized for identifying insider threats, fraud, malware, and network intrusions. In order to improve cybersecurity anomaly detection methods and safeguard against a wide variety of digital threats, this chapter takes a look at existing algorithms and methodology, analyzes their uses, problems, and potential future developments.

6.1 INTRODUCTION

The fields of computer science that deal with cybersecurity and machine learning are growing in significance. As more and more modern systems rely on complex computing and are susceptible to security breaches, machine learning is playing a pivotal role in analyzing cybersecurity data. It may be

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difficult to develop a software that use machine learning to enhance cybersecurity data if there is conflicting data from several sources. When it comes to automatically spotting data anomalies, there aren't many reliable end-to-end solutions. In order to prevent unauthorized access, theft, or destruction of data, software, or hardware, cybersecurity is an essential area of study. Anomaly detection systems are crucial in identifying and preventing cyberattacks, especially as these attacks grow in complexity. Data patterns that do not conform to expected behavior can be uncovered using anomaly detection, which could lead to the disclosure of security flaws. Cybersecurity encompasses a wide range of practices, policies, and tools aimed at protecting networks and data against intrusion.

Cybercrime is outpacing the effectiveness of our present cybersecurity measures in this era of rapid technological advancement. Variables like inadequate protocols, untrained personnel, and improper configuration leave computer systems open to threats. Additional cybersecurity breakthroughs are required to tackle the increasing danger of cybercrime. The attacker community is adapting at a dizzying rate to circumvent signature-based defenses, much like the proliferation of online and mobile technologies. Machine learning (ML) has many potential uses and is an essential tool for the information systems of the future. Machine learning techniques have the ability to rapidly adjust to different scenarios, which could lead to answers to intricate problems. Many problems with computer and information security have been successfully addressed by applying machine learning techniques. The use of machine learning for cybersecurity, however, remains in its infancy, suggesting a significant chasm between theory and practice. This divergence arises because, given the current level of technology, it is challenging to ascertain the significance of machine learning in cybersecurity. The key to unlocking machine learning's potential lies in comprehending its advantages and disadvantages. The chapter delves into the several anomaly detection algorithms employed in cybersecurity, exploring their uses, advantages, and limitations.

6.2 The Role of Anomaly Detection in Cybersecurity

Data points that exhibit unusual patterns and hence differ from the norm are known as anomalies. Fraud, cyber-security assaults, and criminal activities are among the many potential causes of anomalies, (Alabadi & Celik, 2020). Several approaches, including as statistical methods and artificial intelligence, are used in anomaly identification. Anomaly detection is a multi-analysis laden, laborious process.

False positives and false negatives are the first problems to solve. The development of new forms of evil behavior is the second consideration. The fact that a healthcare anomaly detection technology could not work in a transportation context is one obstacle. Finally, getting your hands on tagged data to train your models or systems is no picnic. Typically, three categories are used to classify abnormalities in the literature, (Alabadi & Celik, 2020):

1. Point Anomalies - The primary goal of anomaly detection is to identify its basic form. Point Anomalies are data points that differ significantly from the rest of the data.
2. Contextual Anomalies: Contextual anomalies refer to data points that are aberrant in a certain context.
3. Collective Anomalies: A collective anomaly occurs when a group of comparable data points exhibit aberrant behaviour over the whole dataset. In a collective anomaly, individual data instances may not be anomalous, but their presence together is aberrant.

Among the many types of anomaly detection systems are those that are domain-specific and those that deal with fraud and intrusion detection. There are a number of factors to consider when selecting an anomaly detection system, such as the nature of the incoming data and the need for processing in real-time.

6.3 Cyber Security Attacks

Attacks with a specific goal in mind include denial of service, reconnaissance, and access attacks. The dangerous tactic known as a reconnaissance attack involves the assailant trying to get personal information out of victims by convincing them to become friends [2]. Such attacks can take several forms, including packet sniffers, port scanning, and data searches on the internet. An intruder can gain access to a device through an access attack. assaults such as man-in-the-middle, phishing, social engineering, and secret code assaults fall into this category. Denial of service (DoS) attacks make up the third type of assault in this category. Attackers in a denial-of-service (DoS) attack exploit the victim site's internet connection to overwhelm it with requests, so crippling its services. Attacks might originate from a single source or multiple sources; the latter is known as a distributed denial of service (DDoS) assault. Some examples of denial-of-service assaults are Smurf attacks, DNS attacks, and SYN floods. Criminal cyber activity, industrial cyber warfare, cyber espionage, and cybercrime all fall within the second group, legal classification attacks. An instance of a cybercrime attack involving the unauthorized use of an account is identity theft. The illegal use of computer networks to get private information, especially that of governments, is an example of cyber espionage, often called cyberspying attacks. Terrorists launch their attacks through the internet. Lastly, cyberwars occur when two or more countries employ cyberspace as a battlefield. The third way to classify attacks is by the level of involvement, which separates them into two groups: active and passive[3]. Two types of attacks can be described as follows: one attempts to change the system's resources or its operation, while the other uses the information without changing or modifying anything. There are many different types of active assaults, such as spoofing, man-in-the-middle, and buffer overflows. Keyloggers and backdoors are examples of passive attacks. Cyberattacks are categorized as either malicious or benign in the fourth group. An assortment of malicious software, such as viruses, worms, Trojan horses, spyware, adware, botnets, and others, is utilized in malicious attacks with the aim of inflicting harm. However, unintentional attacks conducted by unqualified individuals are known as non-malicious assaults, because they typically do not result in significant data loss. Attacks on various types of networks, such as mobile ad hoc networks (MANET) and wireless sensor networks (WSN), are grouped together in the fourth type of cyber security attack classification: network-based, (Abdallah, Eleisah, & Otoom, 2022). Threats to MANETs can take several forms, such as black hole, flood rush, and Byzantine attacks. Additional examples of attacks against WSNs include those on the application layer, the network layer, and other layers of the network.

6.3.1 Cyber Attacks Stages

In a cyberattack, there are five stages. Reconnaissance, scanning, attacking (DoS, application/OS, network attacks), maintaining access (Trojans, backdoors, rootkits, etc.), and hiding or concealing are all part of it. The entire attack method can be interrupted or halted if any phase is disrupted. At any point throughout this process, machine learning techniques can be used to help combat cyberattacks by interfering with the attacker's operations. An attacker may use social engineering techniques like phishing and hostile calls while they are doing reconnaissance or preparing for an attack. Algorithms trained

with machine learning can detect malicious or phishing email signatures and block them. An attacker may resort to "voice phishing" or "vishing" in order to get sensitive information by contacting the target organization while pretending to be someone else. Such calls can be detected and avoided by machine learning systems. Machine learning can also be used to scan any USB devices or other external devices that are linked to the organization's property. This kind of screening prevents malicious software from infecting these devices. Another instance of this is when a malicious actor tries to gain unauthorized access by guessing the password. By analyzing the data, rule-based machine learning algorithms can determine which passwords are most often used by employees and provide a recommended list of alternatives. The scouting procedure will be hindered by this. Critical infrastructure, including vital machines and networks, can benefit from the deployment of these machine learning techniques. While scanning, an adversary or cyberattacker may use a technique called "Weaponization" to take advantage of the target system's vulnerabilities. Metasploit, AutoSploit, and Fuzzers are automated tools used by the attackers. An ethical hacker can automate the search for vulnerabilities using machine learning techniques, giving them an advantage over their opponents. For instance, by incorporating the algorithms into penetration testing tools like Metasploit, one can do a machine learning-based penetration test. When a pen tester uses these algorithms, they can find new vulnerabilities. The fourth stage of a cyberattack involves the use of software to keep the attacker logged in, such as Trojans, backdoors, or rootkits. Such malware traffic packets sent and received between the attacker and the malware can be detected using machine learning algorithms. In the fifth and final phase, known as "covering tracks," the perpetrator aims to conceal identify. One of their many strategies for data misidentification is to manipulate the training data used by machine learning systems. Machine learning algorithms might have a lot of power, but the data used to train them could be weak. The algorithm is rendered ineffective due to misleading training data. As an example, a deep neural network's adversarial trigger's hidden layer could be located using an activation clustering approach. Toxic data points can be identified using empirical learning approaches when poisoning attacks are performed against a support vector machine (SVM).

6.4 Anomaly Detection Algorithms Categories

Cybersecurity relies heavily on anomaly detection, which finds out-of-the-ordinary trends that can indicate malicious activity, system breakdowns, or other big occurrences. A varied set of algorithms tailored to various forms of data and anomalies is required due to the complexity of contemporary data and the ever-evolving nature of threats. In this article, we will examine the different anomaly detection algorithms, which offer distinct advantages and methods.

6.4.1 Statistical Methods

Anomaly detection statistics methods rely on the premise that normally distributed data points follow a specific distribution, and that any departure from this distribution signifies the presence of an anomaly. Early attempts at anomaly identification often make use of these strategies because they are simple and easy to understand.

- **Gaussian Models -** These models are based on the premise that the data follows a normal, or Gaussian, distribution. Data points that do not fall within a specific range, typically expressed as standard deviations from the mean (e.g., the 3σ rule), are referred to as anomalies. Complex, non-

Gaussian data may be too much for these models to handle, even when they perform admirably with normally distributed data.

- **Hypothesis Testing -** The procedure begins with formulating a null hypothesis, which often asserts that the data point follows the normal distribution. In order to determine if there is sufficient evidence to reject the null hypothesis, statistical tests like the Z-test and the T-test are employed. When the null hypothesis cannot be supported by the data, we say that the data is anomalous.
- **Control Charts -** When it comes to quality control, control charts are a must-have for tracking process performance in real time. Process statistics inform the determination of upper and lower control limits. An anomaly is defined as any data point that does not conform to certain control parameters; this indicates that there may be an issue with the process.

6.4.2 Machine Learning Based Methods

Computer, vision, and behavior analysis (Vinayakumar *et al.,* 2019) as well as cybersecurity (e.g., anomaly detection) have all seen the rise of machine learning algorithms as a means of addressing problems in the past few years, (Portugal, Alencar, & Cowan, 2017). It also seems like ML could have a lot of exciting uses in the future, (Elmrabit *et al*., 2020), although, from a different angle, deep learning yields fascinating solutions. For training, deep learning techniques necessitate large datasets, (Vinayakumar *et al.,* 2019) find that deep learning models might not necessarily outperform traditional ML models in all cases. Machine learning (ML) algorithms use statistical models to learn from and improve human experiences; these models allow systems to generate predictions without human interaction after obtaining sample data, which is called training data. There are a variety of machine learning algorithms (supervised, unsupervised, semi-supervised, and reinforcement ML) that can analyze large datasets.

6.4.2.1 Supervised Learning

Since training the computer to learn a classification system that we have devised is often the goal, supervised learning is fairly common in classification challenges. Classification learning is commonly used in tasks such as digital image recognition. To expand, any situation where it is useful to deduce a classification and the classification is easy to determine is suitable for classification learning. Assigning fixed categories to every problem instance might not always be necessary, especially if the agent can choose its own categories. Unsupervised learning in a classification context would look something like this. Assuming all inputs are available, this model is superfluous; nevertheless, it is impossible to derive any inferences on the outputs if any of the input values are missing. As the last link in the causal chain, latent variables are thought of as the source of all observations in unsupervised learning. Decision trees, support vector machines, and bayesian networks are all examples of supervised learning techniques. We have covered the most well-known supervised machine learning methods earlier.

1) Decision Tree

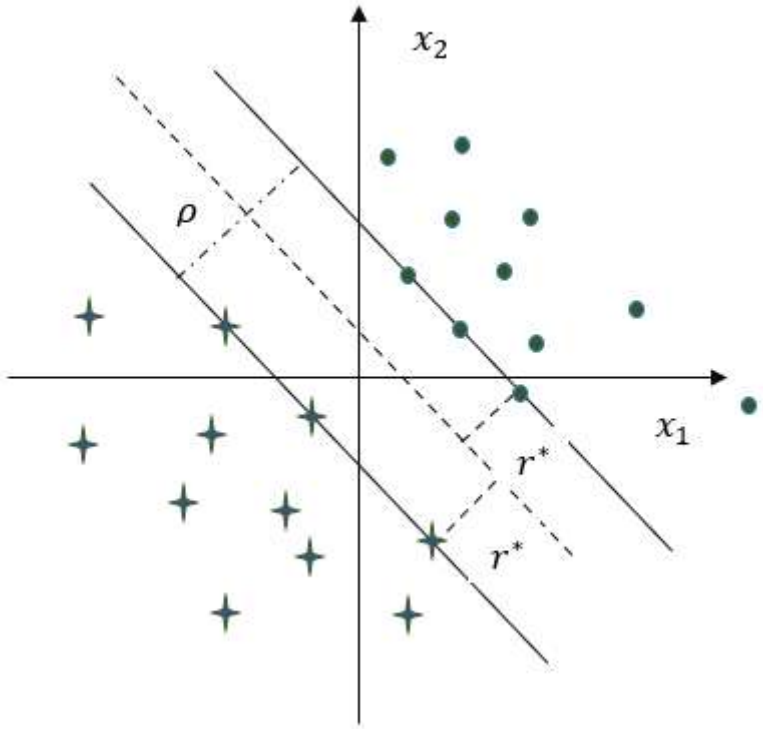
One common and effective approach to categorization is decision trees. The decision-making process and its possible outcomes can be visually represented in a decision tree, which is similar to a flowchart. It is built using the training data that is provided, with each internal node standing for an attribute test, each branch for the test result, and each leaf node for a class label or choice. An optimal tree that can

efficiently categorize instances based on attribute values is the goal of the decision tree algorithm. Starting with a root node, the iterative construction of the tree divides data at each internal node according to the most discriminatory attribute. Once the algorithm determines that a certain branch has reached a leaf node—which corresponds to a specific class label or judgement—the procedure is repeated. Cybersecurity decision trees are structurally similar. The initial element, the decision node, defines a test property that is important for the intrusion detection process, (Azam, Islam, & Huda, 2023). Network traffic, system data, or patterns of behavior could form the basis of this attribute. The conclusion of the test attribute determines the possible courses of action, which are represented by the branches that arise from the decision node. Every possible value or result of the tested attribute is symbolized by a separate branch. Whether an instance is considered normal or malignant is decided by the leaf nodes. We can see the final results of the decision tree's classification process at these leaf nodes. In general, decision trees offer a method to intrusion detection that is both clear and easy to understand, letting analysts grasp how the system makes decisions and identify important aspects that are used for classification. They are able to handle complex and nonlinear attribute relationships with ease, which helps with finding and fixing security flaws in systems and networks.

2) Support Vector Machine

The objective of SVC for a linearly separable learning assignment with two classes is to find the best possible hyperplane that can maximally divide the given samples into two groups while still allowing for optimal generalization, (Wu & Kumar, 2009). Classifiers with good “generalisation ability” may reliably predict future data from the same distribution as their training data to have high accuracy, in addition to doing well on the training data itself.

Figure 1. Illustration of the best hyperplane in SVM for a linearly separable example.



The amount of empty space between two classes that are defined by a hyperplane is known as the margin. As a geometric measure, the margin is the shortest path from the closest data points to any point on the hyperplane. With these restrictions in mind, Figure 1 shows a two-dimensional input space and the resulting geometrically-correct optimal hyperplane.

6.4.2.2 UnSupervised Learning

When it comes to detecting outliers in a dataset, unsupervised learning methods work well. Learning from a training set of normally distributed samples and labeling the output as "normal" or "outlier" according on how closely it matches or differs from the taught set is the fundamental idea behind some of these approaches. Since each attack can be seen as an outlier, these algorithms, which are known as one-class classification methods, seem to be good fits for the task of finding previously unknown attacks. For the purpose of identifying unknown threats, unsupervised learning approaches are ideal since they do not necessitate tagged data. Among the most well-known clustering methods are autoencoders and k-means.

1) K-Means Clustering

One clustering method, K-Means, groups items or data into subclasses based on shared characteristics. From the very beginning of the procedure, the number of clusters remains constant. With the help of the variable i, this algorithm will sort the data into distinct categories. This algorithm iteratively assigns observations or objects to one of i categories based on data features, (Meira *et al.,* 2020). As a first step, the algorithms determine the k centroids located in the middle of each cluster. Using the squared distance from each object to its centroid, this stage is carried out. Equation 2 assigns each object z to a cluster based on the conventional Euclidean distance, *dist*(·).

$$\text{argmin}_{d_k \in d}\, dist\left(d_i, z\right)^2 \tag{1}$$

The centroids are then recomputed. The technique involves taking the average of all items assigned to a centroid's cluster. In equation 3, the set of data point assignments for the k^{th} cluster centroid is d_k.

$$d_k = \frac{1}{|Q_k|} \sum_{z_k \in d_k} z_k \tag{2}$$

For this method to work for one-class classification, it is important to use only regular data instances while building clusters. In order to classify the data, the algorithm finds the nearest cluster and then calculates the distance between each test point. An abnormal sample is one in which the predicted distance to each item is greater than the predetermined threshold. In order to measure how close points in one cluster were to points in nearby clusters, the silhouette analysis was employed. Finding the sweet spot for cluster size is what this metric is all about.

6.4.2.2 Semi-Supervised Learning

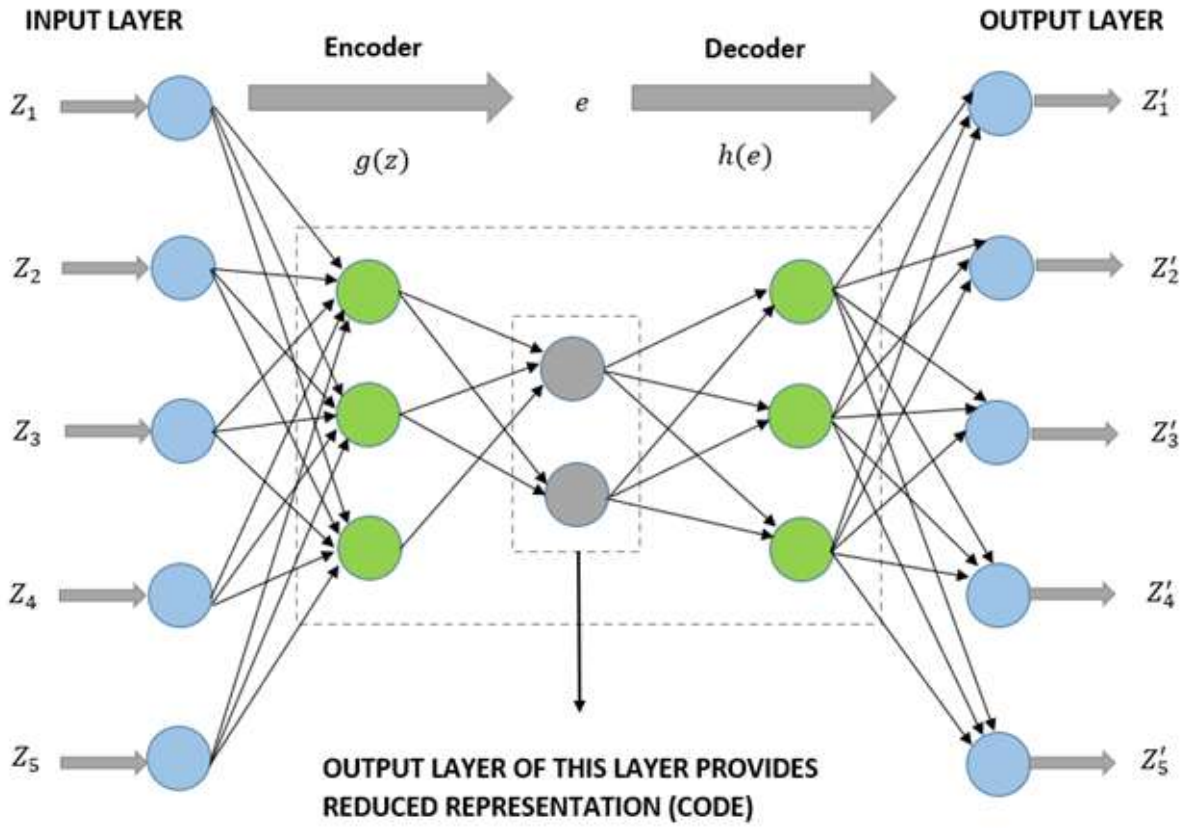
Combining elements of both supervised and unsupervised learning, semi-supervised learning is a subfield of machine learning. Data is tagged with input-output pairings in supervised learning, which allows one to construct models that can predict outputs given new inputs. In contrast, unsupervised learning does not rely on labels and instead seeks out underlying patterns in data. By using a mix of labelled and unlabeled data for learning purposes, semi-supervised learning merges the best features of the two methods. This setup uses a smaller set of labelled data in addition to the readily available unlabeled data, which is prevalent in many real-world scenarios.

1) Auto Encoder

Among the many approaches used for detecting anomalies, the autoencoder stands out. Feature representations of a dataset are learned by autoencoders, which are usually deep neural networks. Among its many applications is anomaly detection, both in unsupervised and semi-supervised environments, because to the model's wide degree of customization, (Brito, 2023). Representing the data in a lower dimension is the first step in the encoder stage. A common alternative to Principal Component Analysis (PCA) is the model's encoder phase. The assumption of a manifold is used by the encoder. Based on this reduced representation, the decoder subsequently recreates the data in its entirety. It is normal to anticipate data loss during encoding, which can lead to inaccurate reconstruction. The objective of training is to minimize the error in all input data dimensions. This procedure often operates without supervision. An

autoencoder has two main components: an encoding function $e = g(z)$ and a decoding function $z' = h(e)$that reconstructs the input. These networks have an equal number of inputs and outputs. An autoencoder with three hidden layers is shown in Figure 2. Decomposing and expressing data in a smaller dimension is the first step in the encoding process. A common substitute for Principle Component Analysis (PCA) is the encoder phase of the model. An assumption about manifolds is used by the encoder. This reduced form is all the decoder needs to recreate the data. Encoding causes information loss, resulting in a reconstruction error $h(g(z)) = z + \epsilon$. The training objective is to minimise the error $\epsilon = \sum_{k=1}^{e}(z_k - z'_k)^2$over all d dimensions of the input data. Typically, this process occurs unsupervised. Autoencoders can be used directly for unsupervised anomaly identification. Outlier samples exhibit significant fluctuation between Z' and Z, making the reconstruction error a useful indicator of abnormality.

Figure 2. A simplified illustration of an autoencoder



Zhang *et al.* (2018) showcased the additional use of autoencoders in the Pre-training subclass. The encoding and decoding phases are trained unsupervisedly to minimize error ϵ in this scenario, using autoencoders in a pretraining mode. After that, the supervised training of the output layer for classification is done. Autoencoders that deal with denoising and contractive features are all encompassed under this paradigm.

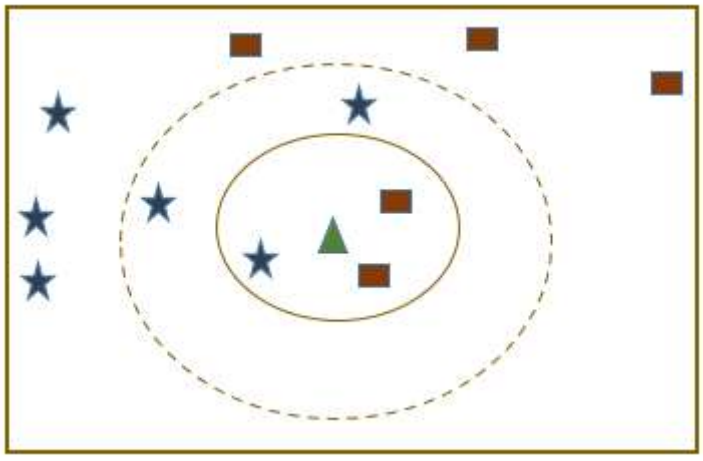
6.4.3 Proximity Based Methods

The proximity or similarity of data points allows proximity-based algorithms to spot outliers. The basic idea behind these techniques is that regular data points tend to cluster closely together in the data space, while outliers tend to be scattered or far away. To find the distance between data points, proximity-based methods use a distance measure like the cosine similarity, Manhattan distance, or the Euclidean distance. The effectiveness of the strategy is heavily dependent on the distance metric that is chosen. A neighbourhood consisting of the nearest neighbours of each data point is sometimes generated around each data point by these approaches. Algorithm and data specifics determine the optimal size of this neighbourhood. If a data point is far from its neighbors or doesn't fit into a dense cluster, it is considered an anomaly. The idea is that outliers will be more noticeable than regular data points since they are unique.

1) KNN

One classification method that makes use of the nearest training cases in the feature space is the Classic k-nearest neighbour algorithm, also known as k-NN. A kind of instance-based learning, k-NN is also called lazy learning since it uses local approximations of the function and delays computation until classification, (Divya & Kumaran, 2016). Figure 3 shows the procedure for assigning new patients to preexisting patient classes using the numerical column values of patient profiles, which are already categorized into specific groups, as x- and y-axis data.

Figure 3. Classic k-NN categorization



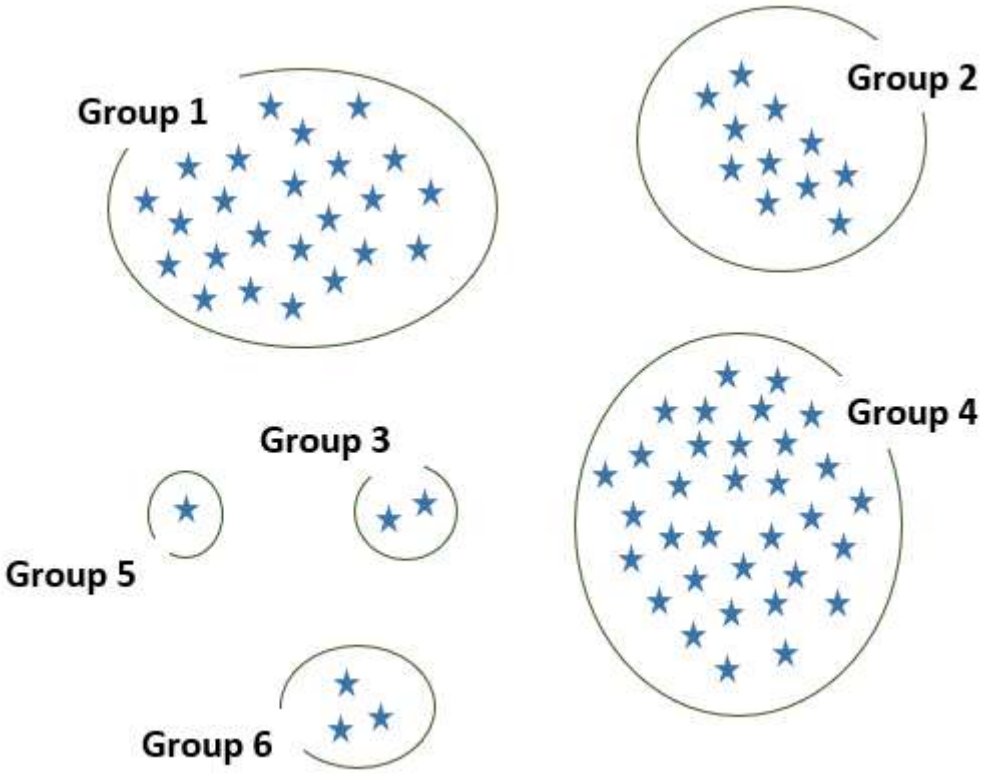
Regression and classification using the non-parametric Classic k-Nearest Neighbours approach (also known as Classic-k-NN) (Wu & Kumar, 2009) is possible. The input in both cases is the set of k training samples that are geographically closest to the feature space. Use of K-NN for classification or regression determines the outcome. Local approximation of the function and postponement of computation until

classification characterize K-NN, an instance-based learning (or lazy learning) method. When it comes to machine learning algorithms, the k-NN method is among the most basic.

2) DBSCAN

One method for finding outliers in data sets is DBSCAN, a spatial clustering approach based on density. The neighborhood distance (eps) and the minimum number of points (minpts) are two user-defined parameters that are required. A point's neighbours are the points in the eps distance that are immediately next to it. Any collection of points whose number of neighbours is more than a minimum is considered to be part of a cluster. The DBSCAN algorithm divides data points into three groups: core, boundary, and outlier. Points that have the fewest eps distances are considered core points. Located adjacent to core points but not necessarily part of them are border points, (Çelik, Dadaşer-Çelik, & Dokuz, 2011). Any location that does not belong in either the core or the boundary is considered an outlier. Conventional clustering methods are different from DBSCAN's. Anomaly points that do not fit into any clusters may be identified as outliers by DBSCAN.

Figure 4. An example of DBSCAN model



The clusters in Figure 4 represent the results of a clustering method that use the distance threshold eps. To be recognized as a cluster, DBSCAN needs a minimum number of points within the group in addition to the distance metric. Clusters in groups 1, 2, 4, and 6 will be identified by DBSCAN if the minimum point value is 3. On the other hand, due to insufficient data for clustering, groups 3 and 5 will be considered outliers. The same holds true for groups 3, 5, and 6, where DBSCAN will find outliers when the minpts value is set to 5.

6.4.4 Information Theoretic Methods

Information theoretic methods estimate the amount of data required to represent the dataset and use that estimate to identify anomalies. The main idea is that information-theoretic characteristics can be measured to identify anomalies, which in turn increase the overall complexity or uncertainty of the data.

1) Entropy Based Methods

Over the past 20 years, there has been a meteoric rise in the usage of the Internet and related applications. It has, however, also made it easier for hackers to access networks and steal sensitive user data. The significance of information technology (IT) on society, economy, and national security is significant nowadays. Information and communication technology, which encompasses desktops, laptops, mobile phones, and other electronic gadgets, as well as communication networks, is gradually replacing more conventional methods of doing business. Internet use for many purposes, including social networking, online shopping, online banking, and many more, has increased at a dizzying rate, (SyedNavaz, Sangeetha, & Prabhadevi, 2013) (Shukla & Maurya, 2018). Countless businesses and information resources are now accessible on the Internet, allowing for the exchange of knowledge, social networking, searching, purchasing, and education. It is now more important than ever to safeguard IT infrastructure from environmental and security risks, as all information in the modern market is highly competitive. With the daily usage of information technology and the communication of highly secret commercial and personal data over networks, security has grown in importance. Modern cybercriminals can launch a fresh attack on any computer connected to the Internet at any moment. An essential concept in information theory, entropy (or the Shannon-Wiener index) quantifies the degree to which a random variable—here, data sent across a network—is subject to uncertainty or unpredictability. A higher entropy would indicate that it was more chaotic. Between zero and logn, the sample entropy falls. Pure class distributions, in which each member belongs to exactly one category, have a lower rate of entropy. Impure class distributions, which belong to more than one class, cause an increase in the rate of entropy. For this reason, it is possible to detect changes in randomness by comparing the entropy rate of two samples of packet header fields. The entropy is zero when every element (IP address or port) is identical, and logn when every item is distinct. To detect DDoS attacks, you can look at the change in entropy of traffic distributions (IP address, port).

6.5 Application of Anomaly Detection in Cybersecurity

Everyone from people to governments is making cyber security a major concern in this digital age. Keeping data, networks, and electronic equipment safe from theft, unauthorised access, or damage is becoming more important as technology progresses. Cyber threat protection for organizations, their em-

ployees, and critical assets has grown increasingly difficult as technology has progressed. The problems plaguing the cybersecurity sector and ways to fix them are discussed in this article.

6.5.1 Network Intrusion Detection

Intrusion detection systems can be broadly classified into many sorts based on their intended use. Intrusion detection systems, for instance, typically fall into two categories: host-based and network-based. Host-based systems can protect anything from a single computer to an extensive network, (Buczak & Guven, 2016). While a host-based intrusion detection system (HIDS) can keep an eye on critical system files for signs of suspicious or dangerous behavior, it can only do so much in terms of detecting known harmful code. Intrusion detection systems can be broadly classified into many sorts based on their intended use. Intruder detection systems, for instance, often fall into two categories: host-based and network-based. Host-based systems cover anything from single PCs to extensive networks. In contrast, NIDSs examine and keep tabs on all network connections to identify any unusual behavior. The two most prominent detection methods, anomaly-based detection and abuse or signature-based detection, have also been the subject of substantial study by security researchers worldwide for quite some time, (Sommer & Paxson, 2010). While intrusion detection systems based on signatures can be fast to spot known assaults, they struggle to spot brand new, undiscovered attacks when using a known signature that lacks a pattern. In contrast, an intrusion detection system that is based on anomalies looks for patterns in the network's behavior, uses that data to automatically build a model that profiles usual behavior, and then flags any deviations as suspicious. Although an anomaly-based intrusion detection system (IDS) has the potential to identify cyber-threats and vulnerabilities that have not yet been discovered, it also has the potential to generate a large number of false alarms due to its tendency to label as abnormal behaviours system behaviors that have not yet been identified. Koc, Mazzuchi, and Sarkani (2012) conducted their research using a support vector machine classifier to create intrusion detection systems. Koc, Mazzuchi, and Sarkani (2012) built an intrusion detection system with many classes using the identical naive Bayes classifier. Using an instance-based learning technique, the KNN classifies data points according to their k-nearest neighbors; it is another popular machine learning method. Shapoorifard and Shamsinejad (2017) studied K-nearest neighbour (KNN) classification methods for intrusion detection systems. Several research projects, Bapat *et al.* (2018) have used the logistic regression model for identifying malicious traffic and intrusions.

6.5.2 Fraud Detection

Many groups and individuals have put a lot of unwarranted emphasis on efforts to curb financial fraud in recent years. This includes scams involving healthcare, insurance, credit cards, money laundering, and securities and commodities. The economy is facing serious problems due to the alarmingly high rates of financial fraud. The estimated yearly losses due to financial fraud around the world are substantial, with some estimates placing the cost to the US at over $400 billion, (Bhattacharyya *et al.,* 2011). Sponsorship of illicit enterprises, including drug trafficking and organized crime, is associated with financial fraud offenses, which have broader industrial ramifications, (West & Bhattacharya, 2016). Businesses and companies are usually the ones that wind up paying for the costs connected with these crimes, and they're also the ones that are held financially responsible for everything that happens because of the fraud. For instance, chargebacks, administrative fees, and a decline in customer confidence are all out-

comes of credit card fraud, Quah & Sriganesh, 2007). Consequently, many forms of fraud have serious consequences, highlighting the need to set up detection methods and technologies. In many practical contexts, such as natural language processing and text, writing, and speech recognition, LSTMs are now state-of-the-art. Their solution to the vanishing gradient problem, often associated with RNNs, has brought them particular fame. A pioneering study using LSTMs to identify fraud was carried out not long ago. Other authors, such as Gómez et al. (2018), have recognised them and stated that they show promise in detecting fraudulent credit card transactions or insurance claims. There is a noticeable lack of published literature examining their effectiveness in identifying financial fraud, and their application in study is uncommon, despite their promise.

6.5.3 User Behavior Analysis

A new way to look for anomalies and analyze user behavior (UBA) was needed because of the increase in insider threats. UBA is described by Gartner as "a cybersecurity process for detecting insider threats, targeted attacks, and financial fraud." In order to identify potential dangers, UBA solutions look at patterns of human behavior and then utilize algorithms and statistics to find important outliers in those trends. Users, not devices or security events, are the ones that UBA keeps track of. By collecting and analyzing activity data over time, we can identify users whose network conduct is out of the ordinary. Numerous algorithms and statistical methods have been utilized in this field's research for the purpose of prediction. It is a challenging task for security specialists to identify anomalies in log data in order to detect insider threats. User behaviour modelling is crucial for detecting these outliers. Strange user behaviours, such as unusual login habits or requests for access, can indicate a security issue, (Tuor *et al.,* 2017) describe an online unsupervised deep learning system that filters system log data for analyst assessment. Because insider threat behavior varies so considerably, they choose not to represent it explicitly. They use variants of Deep Neural Networks (DNNs) and Recurrent Neural Networks (RNNs) to train and identify user-specific actions. They use this to find out if the user's behavior is normal or out of the ordinary. Xi *et al.* (2018) brought the UBA platform to light, which finds insider threats through data collection, feature extraction, and anomaly detection. In order to conduct the experiment, they utilized an ensemble method that combined several algorithms, such as OCSVM, RNN, and Isolation Forest. The results show that their approach, which is based on a collection of unsupervised anomaly detection algorithms, has a good chance of spotting unusual trends in user behavior. Rashid, Agrafiotis, and Nurse (2016) proposed a way to identify insider risks by simulating the actions of a regular user. This method can identify suspicious user actions that may be an indication of an attack. They used HMM to identify typical behavior, which is used as a starting point. Something out of the ordinary would be indicated by a large deviation from the norm. The results show that the method can learn user behavior and identify insider threats.

6.5.4 Endpoint Security

The attack surface for cyber-attacks has grown exponentially due to the proliferation of endpoint devices, which include everything from home PCs to IoT devices. Threats such as advanced persistent threats (APTs), zero-day vulnerabilities, and complex malware are constantly evolving, and traditional security systems that depend primarily on signature-based detection are finding it increasingly difficult to combat them. Consequently, new forms of security that can foresee and effectively prevent such attacks

are desperately needed. It is possible to keep tabs on how connected devices are behaving by employing anomaly detection techniques. Malware infection or illegal access could be the cause of unusual activity.

Proactive endpoint security tailored to Primary Care Networks (PCNs) should be implemented by organizations. Corporate IT is the backbone of most EDR tool suppliers. Servers, workstations, routers, and switches in the IT industry are their target audience. Only 20% of PCN assets are represented by these platforms. It is recommended to utilize configuration backups, vulnerability management, and inventory in order to detect changes and safeguard endpoint configurations. Once deviations and possible compromises have been identified, the incident procedure should be used to drive remediation. The endpoints of industrial control systems (ICS) that control production are of special importance to industrial cybersecurity leaders. There might be inadvertent configurations and harmful changes, and the brand and safety could take a hit if we don't lessen these dangers. Three million new malware samples are discovered every hour. Ransomware, cryptocurrency malware, and fileless malware are the latest tools in the attackers' arsenal. There is new intelligent malware that can change its signature, manage its actions, create lures, self-propagate, strategically deliver other malware, and maximize damage while minimising footprint. It can even evade endpoint detection systems. The ever-evolving nature of malware and cyber-attacks has rendered outdated malware detection methods obsolete. An unprecedented improvement in cybersecurity is necessary, (Kaur & Tiwari, 2021). Also, silver-bullet vendors selling fake AI solutions built on inaccurate algorithms have contributed to the decline of AI-based security. It is possible to use cybersecurity infrastructure that relies on heuristics or signatures to counteract sophisticated malware.

6.5.5 Industrial Control Systems (ICS)

Devices, networks, and controllers make up the industrial control system (ICS), which automates activities in the industrial sector. When it comes to critical infrastructure, anomaly detection is key for spotting any cyber assaults on industrial control systems, which could lead to catastrophic consequences. In order to identify potential dangers in an ICS, recent studies have employed machine learning methods that are either unsupervised or semi-supervised, (Kravchik & Shabtai, 2018). We tackle the anomaly detector design for ICS as a “one class classification problem” and successfully apply a plethora of unsupervised learning techniques, (Goh *et al.,* 2017). Unsupervised learning methods establish a standard for acceptable behavior through feature learning and then check to see if the observed behavior is within that range. The availability of numerous hyperparameters and the multivariate character of ICS data causes these methods to generate a large number of false alarms, even though they are able to detect zero-day vulnerabilities. In Mitchell and Chen (2014), the authors conducted research on the SWaT testbed to determine how well various unsupervised neural network models detected anomalies, and they came up with statistical anomaly scoring methods to cut down on false positives.

6.6 Challenges

6.6.1 Adversarial Attacks

Threat actors may try to influence or deceive models by taking advantage of their weaknesses. Data poisoning, evasion attacks, and adversarial examples are all forms of adversarial assaults that cause models to be less effective by tricking them with small modifications to the input data. Inadequate labelled training data: A large quantity of high-quality labelled training data is required for the construction of

accurate models. Obtaining such data could prove challenging in the cybersecurity field because of the dearth of real-world data on cyber-attacks and the challenges in correctly identifying it.

6.6.2 Imbalanced Datasets

Class imbalance, in which there are an excessive number of positive (attack) and negative (normal) instances, is a common problem in cybersecurity datasets. Biased models trained on imbalanced datasets may fail to discover minority classes or produce a significant number of false positives.

6.6.3 Interpretability and Explainability

People sometimes call many classification systems, especially deep learning models, “black boxes” because of how complicated they are. Critical in cybersecurity, the inability to understand and explain predictions is exacerbated by the difficulty in comprehending the reasons behind classification model conclusions due to the lack of interpretability.

6.6.4 Conceptual Drift and Evolving Threats

New risks and attack techniques appear every day, altering the cybersecurity landscape, (Bharadiya, 2023). Because they were not trained on new risks or changing trends, classification algorithms that rely on previous data may fail to adequately respond to such events.

6.6.5 Scalability and Performance

Cybersecurity classification models should be latency-tolerant and capable of processing massive amounts of real-time data. When dealing with computationally complicated Classification algorithms or in situations with limited resources, it can be particularly challenging to provide acceptable performance and scalability.

6.6.6 Privacy and Protection of Data

Privacy concerns and the requirement to comply with regulations like GDPR arise when training and inferring from classification models need access to sensitive and private data. Keeping users' identities secret and blocking unauthorized access to training data and classification models are two of the most important things to do. Improving the security, reliability, and efficacy of ML-based cybersecurity systems is an ongoing research and development priority in order to tackle these issues. Developing strong machine learning algorithms, building resilient infrastructures, enhancing data collection and labeling processes (including explainability approaches), and adapting models to emerging dangers through ongoing monitoring and learning are all potential solutions.

6.7 Future Directions

The analysis of massive amounts of data will be crucial for future cybersecurity solutions that aim to detect or prevent illegal activity. Our findings lead us to recommend the following areas of investigation for future cybersecurity applications:

6.7.1 Intrusion Detection

Even though it was one of the earliest studied and reported on, intrusion and anomaly detection holds great promise as a field of study, (Alani, 2021). The increasing prevalence of zero-day attacks can be better detected and prevented with the help of big data analytics in conjunction with cloud computing, machine learning, and other inference techniques.

6.7.2 Code Security

Machine learning algorithms can be trained to find defects using the abundance of 'excellent' code relative to 'bad' code. Network vulnerabilities are more difficult to detect than flaws in code. Features that are code-extracted are more comprehensive, however feature selection greatly affects the results of IDS.

6.7.3 Fraud Detection

Nevertheless, the field of detecting credit card fraud is not new. Improving accuracy and reducing false positives can be achieved by combining big data analytics with machine learning and current approaches. The expansion of transactional attributes is one way that advances in big data analytics might increase accuracy.

6.7.4 LightWeight Cybersecurity

Cybersecurity apps of the future will have to be lightweight to survive in an Internet of Things and smart city world. Application workloads that place a heavy burden on processors or memory are not well-suited to IoT-based systems. In order to detect and prevent incidents rapidly, smart cities should leverage big data analytics and centralized security mechanisms.

6.8 CONCLUSION

The serious threat that cybercrime poses to national governments and the economy of numerous industries has made many organizations and governments increasingly conscious of the need of cyber security in recent years. Consequently, it is crucial to promptly execute suitable countermeasures to protect systems from potential assaults and mitigate risks. When designing cybersecurity frameworks and systems, it is essential to take into account the massive amounts of data generated by human behaviors, computer network activities, and other sources. The development of reliable cyber-physical systems relies heavily on anomaly detection and root cause analysis. Cyberattacks or malfunctions in physical devices can cause anomalies in cyberphysical systems like smart grids or smart buildings that use net-

worked sensors and actuators. The development of appropriate reactive and mitigation activities relies on accurately identifying anomalies and determining their root cause. The fact that the symptoms of cyber assaults and physical flaws can be so similar makes this procedure extremely challenging. On top of that, it could take some time for a cyberattack to affect the functioning of a physical system. So, we need methods that can take this time-varying behavior into consideration while simultaneously explaining the causal links between cyber and physical factors. A variety of anomaly detection algorithms have been covered in this chapter, along with their uses in cybersecurity, challenges they face, and potential future developments. Our systems and data will be better protected from the dynamic cyber threat landscape if we implement these solutions.

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Navigating the Shopping Landscape: A Comparative Analysis of E-commerce and Traditional Retail in the Digital Age

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Abstract

This study delves into the transformative impact of digital technology on the retail industry. In the background of an increasingly digitalized shopping environment. This study works a comprehensive comparative analysis to explore the evolving dynamics between e-commerce and traditional brick-and-mortar retail. By investigating key factors such as consumer preferences, economic implications, technological advancements, and market trends, the paper seeks to shed light on the evolving relationship between these two retail channels and provide valuable insights

Bharati Vidyapeeth
(Deemed to be University)

ABHIJIT KADAM INSTITUTE OF MANAGEMENT AND SOCIAL SCIENCES, SOLAPUR

Summary of Research Publications from 2018 to 2024

Sr. No.	Publications in	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024	Total
1.	Scopus Listed Journals	-	02	-	01	05	23	**31**
2.	Web of Science Listed Journals	-	-	-	-	-	03	**03**
3.	ABDC Listed Journals	-	-	-	-	02	04	**06**
4.	UGC Care Listed Journals	01	01	05	06	46	22	**81**
5.	Patent Publications	-	-	-	-	03	04	**07**
6.	PEER Reviewed/referred Journals	07	04	06	04	-	02	**23**
7.	Book /book Chapter	03	-	-	-	02	02	**07**
	Total	**11**	**07**	**11**	**11**	**58**	**60**	**158**