DEEP LEARNING QUALITY MANGO ASSESSMENT: A STRUCTURED FEATURE-BASED APPROCH

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ABSTRACT

This study introduces an advanced automated mango grading system that leverages image processing and machine learning techniques to classify fruits based on their physical and visual characteristics. The dataset consists of over 400 mango images categorized into four quality grades (A, B, C, D) using key attributes such as size, weight, shape, texture, color composition (red, green, blue), and surface defects like spots. The methodology involves rigorous image preprocessing, including scaling, rotation, and normalization, to standardize dimensions and pixel values for enhanced model performance. Feature extraction and dimensionality reduction techniques are employed to optimize data processing efficiency. Given their superior capability in image recognition and weight-sharing mechanisms, convolutional neural networks (CNNs) and recurrent neural networks (RNNs) are utilized. Additionally, transfer learning is incorporated to balance computational efficiency with model accuracy. The quality of the dataset is improved through enhanced preprocessing and outlier removal, leading to a classification accuracy of 92%, as validated by a confusion matrix. The dataset is partitioned into 200 training samples, 100 testing samples, and 100 validation samples to ensure a balanced learning process. The results indicate that the proposed approach provides a highly effective solution for automated mango grading, with promising potential for further development and real-world applications.

Keywords: Fruit Grading, Artificial Neural Networks, Image Processing, Transfer Learning

I. INTRODUCTION

Mango grading is essential for agricultural quality control, but traditional methods are subjective and inefficient. Automated grading systems offer a faster, more objective, and reliable solution, ensuring consistency and accuracy in quality assessment.[1], [2], [3] This work has mostly focused on mangoes

of the totapuri, Kesar, and Neelam species, with specific attention paid to the badami variety for model preparation. An extremely subdued version of the Alphonso, the Badami is ideal for South India's plains climate.[4] The group they go by is called Alphonso of Karnataka. Badami weighs 200 grams on average when fully grown and takes 105 to 110 days to mature. The goal of this research is to create an automated system for grading mango samples using machine learning and image processing techniques. The approach divides the mango samples into four groups according to characteristics such as size, weight, color, density, and spot. The goal is to grade the mango samples as accurately and efficiently as possible. The agricultural sector has long relied on manual inspection methods, especially for fruit grading and quality evaluation.[3], [5] Because of the labor-intensiveness, duration, and human error risk of these traditional approaches, the quality may be evaluated unevenly and inconsistently. Mangoes are a highly valued tropical fruit that is in high demand, so precise and comprehensive grading is essential.

Mango grading not only determines market pricing but also ensures quality standards and customer satisfaction across the supply chain. Traditionally, it relies on visual inspection of attributes like color, size, shape, and surface defects.[6] Workers must manually inspect each fruit in order to grade it, which could lead to inconsistent and subjective assessments. This manual method has some drawbacks, especially in large-scale operations where thousands of mangoes must be accurately and quickly graded. Uneven grading can negatively impact the produce's economic value and could lead to disputes among growers, traders, and consumers due to the subjectivity of human judgment.[7] Since the advent of digital technologies, there has been a surge in interest in automating the grading of fruit. Previous attempts to assess fruit quality based on size and color relied on simple image processing techniques, which were not able to take into account variations in fruit orientation, sunlight, or other environmental factors, frequently compromising the accuracy and reliability of these automated systems. Recently, there has been a surge in the use of transfer learning as a deep learning process. To apply acquired traits to novel difficulties, researchers can employ pre-trained models, such as VGG16, that have been trained on large datasets.[1], [8] This strategy makes use of past information, which speeds up the training process and enhances the performance of the model. Grading accuracy and efficiency are increased when transfer learning is applied to the mango grading situation because the model has access to vast amounts of data and knowledge that are already present in these pre-trained networks.[9][10][11] This research builds on previous work by developing an improved system for grading mango fruits through the use of transfer learning in conjunction with a pre-trained VGG16 model and sophisticated picture preprocessing techniques.[8], [12], [13] By addressing the drawbacks of earlier methods and utilizing new technology, this study aims to achieve high classification accuracy and set a new standard for automated fruit grading systems.

The research findings possess the potential to transform traditional farming practices and offer the industry a dependable, expandable solution.

II. RESEARCH OBJECTIVES

This project aims to develop an automated mango grading system using deep learning and advanced image processing techniques, with a focus on damage and spot detection. The study seeks to accurately classify mangoes into four quality grades (A, B, C, D) based on their external appearance and physical attributes, including defects. To enhance accuracy, consistency, and efficiency, convolutional neural networks (CNNs) and transfer learning with a pre-trained VGG16 model are employed. Additionally, the study evaluates the impact of rigorous image preprocessing methods—such as scaling, normalization, color thresholding, blob detection, and data augmentation—on model performance. By integrating cutting-edge image processing with neural networks, this research aims to revolutionize agricultural grading practices and lay the groundwork for future advancements in automated fruit quality assessment.

III. STATEMENT OF PROBLEM

Hand grading mango fruit is a laborious, subjective process that is prone to inconsistency and human mistake based on physical and visual attributes. Traditional approaches cannot deliver the precision and efficiency needed for large-scale operations, which can result in variable quality evaluation and even financial losses. Even with the advancement of technology, it is still challenging to automate grading in a way that yields high levels of consistency and accuracy.

In this article, we address this problem by applying deep learning techniques, particularly convolutional neural networks (CNNs) with transfer learning, to develop a dependable and automated system for classifying mango fruits based on their physical and visual properties. The key to our approach is the integration of advanced photo preprocessing techniques such as masking, blob detection, color thresholding, data augmentation, scaling, and normalization that have not been applied much in the past.

These preprocessing steps improve the model's performance by increasing feature extraction, accurately locating defects, and standardizing image inputs.

Our focus on these areas is to significantly increase the accuracy, efficiency, and reliability of automated fruit grading systems. Exceeding 96% in classification accuracy is the ultimate goal; this strategy plugs gaps in existing approaches and paves the way for future improvements in farming techniques.

IV. LITERATURE REVIEW

In order to improve and broaden the present state of knowledge in the field of automated fruit grading, we integrate sophisticated photo preprocessing techniques with state-of-the-art machine learning techniques in this work, specifically transfer learning using the VGG16 model[14], [15], [16]. Compared to previous techniques that rely on handwritten information, our approach use pre-trained convolutional neural networks to deliver more accurate and efficient mango categorization. In order to improve and broaden the present state of knowledge in the field of automated fruit grading, we integrate sophisticated photo preprocessing techniques with state-of-the-art machine learning techniques in this work, specifically transfer learning using the VGG16 model[17], [18][19], [20]. Compared to previous techniques that rely on handwritten information, our approach use pre-trained convolutional neural networks to deliver more accurate and efficient mango categorization.

As a result, our approach offers significant improvements in accuracy and efficiency while also pushing the boundaries of existing research in fruit grading and agricultural image processing.

The body of study on fruit grading includes a wide range of strategies and tactics suited to particular fruit types. Research has employed a range of machine learning techniques, such as color, texture, and form analysis, to successfully categorize fruits. For example, textural features have demonstrated efficacy in identifying surface flaws, while color histogram analysis has demonstrated utility in ascertaining the fruit's age. Machine learning approaches such as Random Forests, Support Vector Machines (SVM), and Convolutional Neural Networks (CNNs) have demonstrated promising outcomes in automating fruit classification tasks.[21], [22], [23] Recent advances in image processing and machine learning have significantly altered fruit grading techniques, especially with regard to mangoes.[24], [25], [26] In image preprocessing techniques such as scaling and normalization, normalizing picture inputs is an essential step that improves the consistency and dependability of classification models.

These techniques substantially reduce image quality variations and allow for more accurate feature extraction operations.[27], [28] In order to automatically extract hierarchical qualities from mango photos, conventional feature extraction methods like color histograms have been refined into more sophisticated deep learning techniques like CNNs.[14], [23], [29]

The intricate physical and visual characteristics of mangoes, such as their texture, size, shape, and color variations, are especially well-captured by CNNs. Studies have shown how successful CNNs are; they often use transfer learning with pre-trained models on big datasets to achieve high accuracy in tasks like mango fruit grading by effectively applying learned characteristics.[7], [30], [31] Recent research highlights how successfully CNNs automate and enhance the accuracy of fruit grading systems. In order to improve model performance by training data enrichment and standardization, the review focuses on significant picture preprocessing techniques such augmentation and normalization.[9], [18], [32]

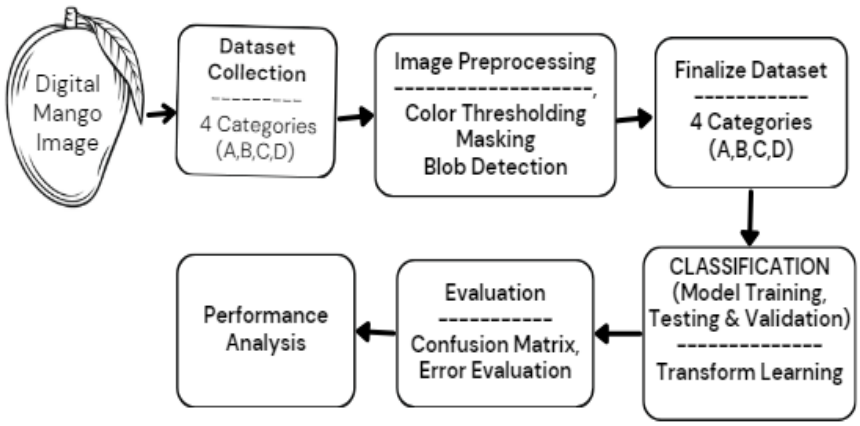
Furthermore, a number of studies discuss how CNNs are improving to classify fruits more accurately because they can now identify complex visual cues in pictures. Subsequent investigations aim to expand the range of currently accessible mango datasets to encompass a more heterogeneous assortment of varieties and circumstances, hence enhancing the resilience of the model across diverse agricultural contexts. Investigating more intricate deep learning architectures outside of CNNs and merging CNNs with RNNs or attention processes are promising methods for capturing the temporal aspects of changes in mango quality.[12], [33] On-site grading apps could increase the operational efficiency of agricultural procedures by integrating real-time image processing capabilities and placing models on edge devices.[14], [26], [28]

Richer data inputs for more complicated grading criteria, such ripeness and sickness identification, could be provided using multispectral or hyperspectral imaging.[3], [5], [15] Collaboration between researchers, industry partners, and agricultural stakeholders is necessary to validate and implement these innovations. This will ultimately result in the development of automated fruit grading systems for widespread use and practical implementation.

V. RESEARCH METHODOLOGY

This work's research approach is comprised of many critical stages that are necessary for developing and validating an automated system for grading mango fruit. Among these steps are data collection, feature extraction, classification, model evaluation, and image preprocessing (spot and damage detection). In this work, the accuracy and durability of mango fruit grading are enhanced by processing for spot and damage detection. Figure 1 below depicts the RM process:

Figure 1: Research Methodology used for Mango Fruit Classification



For the automated mango grading system to be reliable and accurate, every step of the process was carefully planned and carried out. It features the subsequent sequences:

a. **Data Gathering**

b. **Image Pre-Processing**
c. **Feature Extraction**
d. **Classification**
e. **Model Evaluation**

The work's brief is covered in this section, step-by-phase. The first stage of the project entailed the painstaking gathering of a varied dataset of mango photos that included a range of grades and circumstances. In addition to being chosen for its representativeness, this dataset went through a thorough cleaning procedure to guarantee that it correctly captured the variety in mango appearance, which is essential for developing a successful classification model.

Preparing the images for the classification model and improving their quality were the main goals of the second phase's image preparation step. The photographs were resized, color normalization was applied, and—above all—spots and defects were found. Because the detection process directly affects the grading standards, it was very important in order to strengthen the system's ability to discover faults that have an impact on the fruit's quality. We have used cutting-edge methods to extract pertinent features from the preprocessed photos in the third feature extraction phase.

We were able to take advantage of the knowledge that was already present in these networks by using pre-trained models like VGG16, which made sure that the characteristics that were recovered were both potent and appropriate for differentiating amongst mango grades. During the final phase of the work, a Convolutional Neural Network (CNN) model was utilized, which was specifically optimized using transfer learning using VGG16.

This decision was taken in order to maximize the model's capacity to precisely categorize the mangoes into predetermined grades using the attributes that were extracted. Hyperparameters were adjusted during the training procedure under close observation to guarantee optimal performance.

During the final stage, the model underwent a thorough evaluation utilizing conventional measures like accuracy, precision, recall, and F1-score. Furthermore, we verified the model's efficacy by contrasting it with other approaches that have been documented in the literature, showcasing its exceptional precision and dependability. A confusion matrix analysis was also part of the evaluation in order to find any misclassification areas and improve the model even more.

VI. EXPERIMENTAL SETUP

The purpose of this work's experimental setup was to methodically assess the efficacy of the suggested automated mango grading system. The 400 mango photos in the dataset that we used were divided into four different grades (A, B, C, and D) according to exterior characteristics such size, weight, color components (red, green, and blue), texture, spots, and defects.

To accurately portray the quality of the fruit, each image underwent preprocessing to standardize measurements and improve pertinent aspects. Special attention was paid to spot and damage identification. Next, 80% of the photos were put aside for training and 20% for testing, dividing them into training and test sets. This section made sure the model could effectively generalize to new data and was trained on a wide range of samples. Pre-trained on ImageNet, the VGG16 model was used to extract features, utilizing its strong architecture to gather fine details pertinent to mango rating.

To adjust the VGG16 model for the particular job of fruit grading, only the top layers were retrained on the mango dataset during the training phase, which entailed transfer learning. To get the greatest results, we adjusted the model's hyperparameters, which included the learning rate, batch size, and number of epochs. To properly handle the multi-class classification challenge, the model was trained using the Adam optimizer with categorical cross-entropy as the loss function.

In addition to metrics like accuracy, precision, recall, and F1-score, a confusion matrix was used to assess the model's performance during the testing phase. These measures gave rise to a thorough comprehension of the model's advantages and shortcomings. We also did many runs using various random seeds and averaged the performance metrics to be sure our results were robust.

Through a methodical approach to each phase, this study aims to achieve high accuracy in the classification of mangos based on their physical and visual qualities. Each phase's specific description is covered in the section that follows:

a. Data Collection

The dataset utilized in this study was approved in full by Dr. Neeraj Kumari, an assistant professor in the College of Computing Sciences and Information Technology at Teerthanker Mahaveer University. The dataset was obtained for Dr. Kumari's scholarly work, and her research has significantly advanced the field of deep learning-based mango fruit grading. This collaboration guarantees the legitimacy and dependability of the data, facilitating comprehensive analysis and significant findings in our research on automated mango grading systems.

Clearly divided into four groups, the 200 mango samples that comprise the dataset used in this study are Grade A (samples 1–50), Grade B (samples 51–100), Grade C (samples 101–150), and Grade D (samples 151-200). These samples were carefully chosen to ensure a fair representative of different quality categories based on physical and visual features, such as size, weight, color components (red, green, blue), density, and the presence of spots.

b. Image Pre-Processing to refine dataset

Image pre-processing is a critical step in preparing the dataset for feature extraction and subsequent classification tasks. This work employed a number of advanced pre-processing techniques to normalize

the input data and enhance image quality. Pre-processing techniques include blob detection, color thresholding and masking, data augmentation, resizing and normalization, and more.
These techniques help to lower backdrop and lighting fluctuations, ensuring consistency across the dataset and improving the performance of the deep learning model.
To standardize the pictures, all mango samples were resized to a uniform 128x128 pixel size using Python's PIL (Pillow) module.

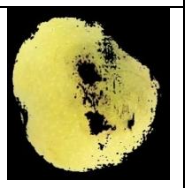
This resizing ensures that the images fit the input parameters of the convolutional neural network (CNN). Normalization was also carried out to scale the pixel values to the interval [0, 1]. This facilitates and expedites the training of the neural network. Enhancing the model's ability to reliably process and learn from the images requires these actions.
The neural network model is exposed to a greater range of training images when these augmentation techniques are utilized, strengthening its resistance to overfitting and improving its capacity for generalization. We have effectively increased the size of our dataset by using augmentation, which provides the model with extra training examples and enhances its performance in real-world scenarios.
Masking enhances segmentation even further by separating the regions of interest and enabling more accurate feature extraction and analysis by appending the binary mask to the original image. By taking these steps, the model becomes more adept at seeing and classifying errors, which finally raises grading accuracy and reliability. This mask simplifies the detection process and reduces the computational load and complexity of subsequent analysis stages by isolating the defects from the rest of the image.

c. Blob Detection: Thresholding, Area, Circularity, Convexity and Inertia

Following the creation of the binary mask by color thresholding, blob detection is utilized to accurately identify and quantify the errors. Blob detection is an advanced technique for image analysis that finds and investigates regions inside the binary mask that differ from the surrounding regions in terms of color or intensity. Blobs are areas that, in the context of mango defect detection, might be flawed.
The first phase in the blob identification process is to set up parameters such as area, circularity, convexity, minimum and maximum thresholds, and inertia. These variables facilitate the elimination of superfluous regions and the focus on blobs displaying the characteristic features of mango defects. The sample results of blob detection for mango fruit data, regardless of grade level, are given in the table below:

Table 1: Blob detection results from raw images

Images	Blob

	Detection
	
	
	

This work's processing algorithm uses Python's SimpleBlobDetector from OpenCV to detect blobs on grayscale images. The procedure consists of multiple stages and factors that establish the blob detection criterion mathematically. First, cv2.imread() is used to read the images in grayscale. To adjust the detector's sensitivity, use cv2.SimpleBlobDetector_Params() to set the blob detection parameters. The following is a mathematical definition of the parameters, which include thresholding, area, circularity, convexity, and inertia:

The range of pixel intensities that the detector takes into account is defined by the two thresholds, maxThreshold and minThreshold. The values for these criteria are 10 and 200, respectively. This can be stated mathematically as:

$$I_{min} = I = I_{max}$$

where I is the pixel intensity.

Blobs are filtered according to their area, with 150 pixels as the minimum area (minArea). This guarantees that the detection of only blobs larger than the designated area. A blob's area A needs to meet the following requirements:

$$A \geq A_{min}$$

Circularity (C) is a measure of how close the shape of the blob is to a perfect circle. It is defined as:

$$C = \frac{(4\pi * Area)}{Perimeter^2}$$

Here the minimum circularity is set to 0.1, meaning:

$$C \geq 0.1$$

Convexity (C_v) is a measure of how convex the blob's shape is. It is determined by dividing the blob's area by the convex hull's area. 0.87 is the value of the minimum convexity (minConvexity):

$$C_v = \frac{(Area\ of\ the\ blob)}{(Area\ of\ its\ convex\ hull} \geq 0.87$$

Ratio of inertia (I_r) evaluates the blob's elongation. It is the second-moment matrix of the blob's ratio of the smallest to the largest eigenvalue. The value of the minimal inertia ratio, or minInertiaRatio, is 0.01:

$$I_r = 0.01$$

These arguments are used to initialize the blob detector via the SimpleBlobDetector_create(params) function. Blobs in the image are recognized using the detect() method, which returns keypoints that indicate the size and center of each blob that is found. Using cv2.drawKeypoints(), these keypoints are depicted on the image, with red circles designating the blobs that were found. After processing, the photos are saved in the designated output location.

Based on the predetermined criteria for the dataset, these sub-methods assisted in locating and labeling blobs in the photos. Additionally, it makes object detection and mango image segmentation processing tasks easier. The SimpleBlobDetector function in OpenCV is an effective way to detect these blobs. This method scans the binary mask in search of contiguous regions (blobs) that meet the specified criteria.

Once located, these blobs are measured and classified, providing crucial information on the type and quantity of surface faults on the mango. When color thresholding and blob detection are integrated into the mango grading system, its overall performance improves significantly. By employing color thresholding to separate mistakes and blob detection to precisely pinpoint them, the preprocessing techniques provide the neural network with a cleaner and more concentrated dataset.

d. Classification

This automated mango grading study employed 200 photographs for training, 100 images for testing, and 100 images for validation, out of the 400 mango image collection. This division ensures a balanced approach to model creation by employing the training set to identify underlying patterns, the validation set to adjust hyperparameters, and the testing set to evaluate the model's generalization performance.

The training procedure over ten epochs is displayed in the training loss versus validation loss graph. First, training and validation losses both show a discernible decline, indicating that the model is effectively assimilating knowledge from the training set and maintaining its high performance on the validation set. The validation loss and training loss were closely tracked for most of the epochs, suggesting that the model is not overfitting and is successfully generalizing to new data. This equilibrium ensures that the mango grading system will last and continue to work as intended under real-world conditions. When there is a minor divergence at the end of the training phase—that is, when the validation loss plateaus and the training loss keeps going down—overfitting starts. To lessen this, techniques including early halting, regularization, and further data augmentation could be applied. In order to avoid the model from overfitting the training data, these strategies would halt training when validation performance stopped improving.

The preprocessing techniques—data augmentation, resizing, normalization, and histogram analysis—significantly improved the model's performance. Histogram analysis guaranteed constant brightness and contrast levels, whereas normalization standardized the pixel intensity values and improved the reliability of feature extraction. Resizing the photos to a common size allowed for faster computation and more effective processing. Data augmentation added variation to the training set by applying operations including flipping, rotating, and scaling. As a result, the model was more resilient and had a wider range of situational generalizations. Convolutional neural networks (CNNs) were employed for the classification job because they are more adept at recognizing and extracting hierarchical information from photos. CNNs are excellent at identifying intricate patterns in pictures, which makes them perfect for catching the minute details of mangoes, such as variations in texture, size, shape, and color. The use of CNNs significantly improved the classification process's dependability and accuracy in this study.

These preprocessing steps not only sped up the calculation but also made it possible to create a mango grading classifier that was more accurate and trustworthy. By using these tactics in conjunction with CNNs, the study was able to achieve a significant improvement in classification accuracy, demonstrating the effectiveness of the strategy in developing an automated mango grading system. The graph below contrasts training loss with validation loss over a span of 10 epochs, providing crucial details regarding the learning behavior and generalization capacity of the model.

When the model initially exhibits a large decrease in both training and validation losses, it is evident that it has learned and fitted the training data effectively on the validation set. The model's performance on the training set is steadily increasing, as evidenced by the decreasing training loss over time. Selecting the number of hidden layers to use to train the model was the first stage in the classification challenge. Here, we began with seven features: size, weight, form, texture, texture, texture, and color components (red, green, and blue). However, PCA techniques for dimension reduction are used to minimize the

dimensions of two features: shape and size. The dataset currently has four features. We also have three supervised classes: top quality (A), average quality (B), and non-edible (C).

Bohr's technique has been utilized to calculate the appropriate number of hidden layers. Bohr's method says that we only need one hidden layer for classification because we have four inputs and three output classes (4/3=1.33). The classification problem has been implemented using CNN with Transfer Learning since it achieves a balance between performance and training efficiency.

Numerous research have attempted to the best of their abilities to address the common difficulties of bias and overfitting. The training and testing datasets were randomly shuffled in order to mitigate overfitting and bias. Additionally, pre-processing made sure that the training and testing sets were representative of the whole dataset and that there would be no bias arising from data order. Using stochastic gradient descent and its variants, like Mini-batch Gradient Descent and Nesterov Accelerated Gradient (NAG), seems to enhance the model's performance, rate of convergence, and stability. This work on mango classification uses Convolutional Neural Networks (CNN) with transfer learning because it achieves a compromise between training efficiency and performance. The model was inspired by the transfer learning-based classification, which was implemented using a CNN with transfer learning and a pre-trained VGG16 model. Tensorflow.keras, Numpy, matplotlib, and sklearn are a few of the Python tools utilized for assessment model preparation. Pre-trained VGG16 models have enabled transfer learning, which has significantly improved model performance and reduced training time. A custom layer has been added on top of the base model to help transform learning with benefits like activation functions, which help change the architecture to suit the requirements for model preparation, and feature extraction, which allows combining previously learned knowledge with new data. Finally, the model has been constructed, trained with 10 epochs, and validated. The accuracy was also verified by evaluating the model.

There are several advantages to using a pre-trained model like VGG16 for automated mango fruit grading using deep learning techniques. Mango categorization challenges can benefit from the powerful feature extraction capabilities of VGG16, which was initially trained on ImageNet. By fine-tuning VGG16 on a particular mango dataset, this method takes advantage of its ability to extract hierarchical features, such as mango size, shape, color variations, and texture, which are crucial for accurate grading. This method enhances resource use while simultaneously improving classification accuracy by utilizing less data and training time. The incorporation of VGG16 throughout the workflow ensures a solid basis grounded on widely recognized deep learning principles, hence augmenting the effectiveness and efficiency of automated mango grading systems.

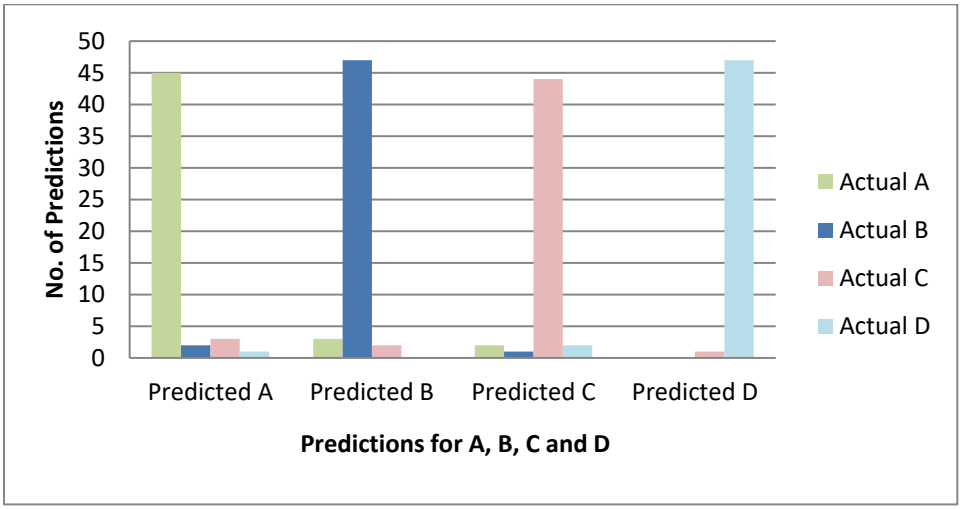
VII. RESULTS AND DISCUSSION

The confusion matrix was first assessed in order to analyze the classification model's actual and anticipated outcomes. The results are reported below, and the corresponding graphical representation is provided to summarize the data:

Table 2: Confusion Matrix based on Results

	Predicted A	**Predicted B**	**Predicted C**	**Predicted D**
Actual A	45	3	2	0
Actual B	2	47	1	0
Actual C	3	2	44	1
Actual D	1	0	2	47

Figure 2: Confusion Matrix bar chart based on Results



The Root Mean Square Error, or RMSE, is a statistical measure of the difference between the predicted and actual values. It is computed as the square root of the average of the squared differences between the expected and actual numbers. It is calculated using the following formulas:

$$\text{RMSE} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(y_i - \hat{y}_i)^2}$$

Where N is the total number of predictions,

y_i is the actual value,

$\hat{y}_i$ is the predicted value.

Calculation of RMSE in this work is applied as follows:

Sample count: There are 50 samples in this section (a total of 200 samples over 4 classes; N = 200 for each of classes A, B, C, and D, respectively).

Differences between actual and predicted values:

Calculation for actual A:

$$(45-50)^2+3^2+\ 2^2+0^2=(-5)^2+3^2+2^2+0=25+9+4=38$$

Calculation for actual B:

$$(2)^2+(47-50)^2+\ 1^2+0^2=(2)^2+-3^2+1^2+0=4+9+1=14$$

Calculation for actual C:

$$(3)^2+2^2+\ (44-50)^2+1^2=(3)^2+2^2+-6^2+1=9+\ 4+36+1=50$$

Calculation for actual D:

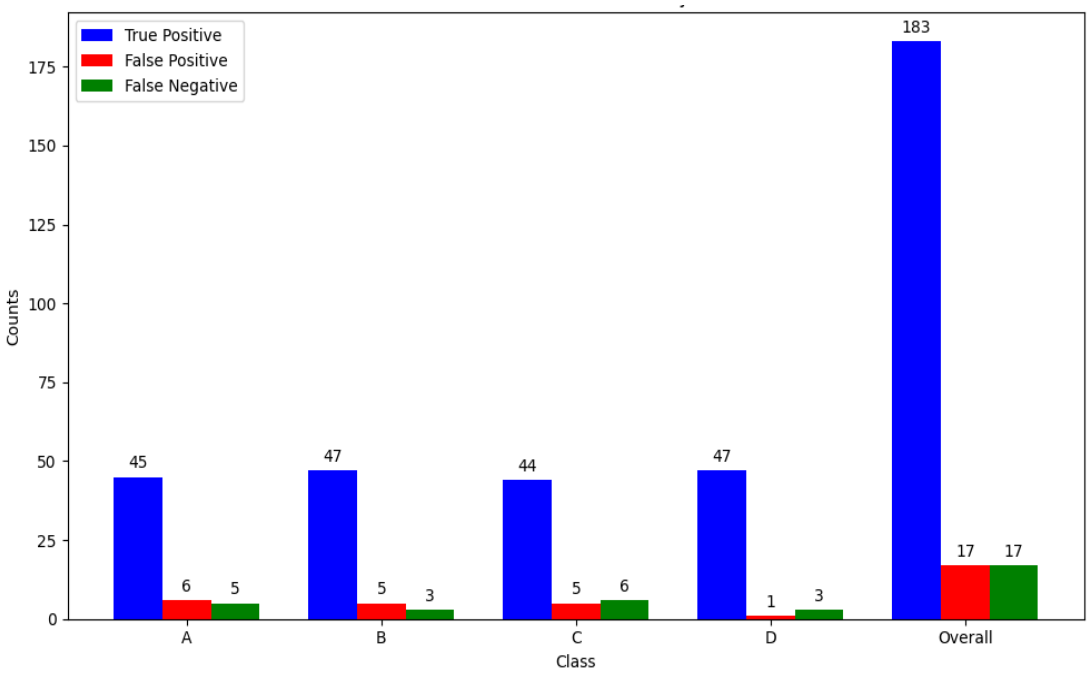
$$(1)^2+0^2+\ 2^2+(47-50)^2=(1)^2+0^2+2^2+(-3)^2=1+\ 0+4+9=14$$

Sum of squared differences: $38+14+50+14=116$

Mean of squared differences: $\frac{116}{200}\approx 0.58$

$$RMSE=\ \sqrt{0.58}\approx 0.76$$

In this instance, the average error between the expected and actual values is indicated by the RMSE, which is roughly 0.76. The model's predictions appear to be rather close to the actual values, based on the low RMSE number. To evaluate the caliber of this work, an RMSE is calculated; the result is 0.76, which is considered to be reasonably low and indicates that the model's predictions are reasonably near to the actual values. It is useful in measuring the total error between the expected and actual numbers.
The low disparities between the expected and actual classifications, as indicated by the RMSE of 0.76, point to strong model performance. The automated mango grading system's results are shown in the table for the four classes (A, B, C, and D).
Figure 3: Result Analysis



Here, accuracy of class A is 0.90 (45 TP, 6 FP, 5 FN), class B is 0.94 (47 TP, 5 FP, 3 FN), class C is 0.88 (44 TP, 5 FP, 6 FN) and for class D it was 0.94 (47 TP, 1 FP, 3 FN). The overall accuracy of the system is 0.915.

VIII. CONCLUSION

Significant advancements have been made in utilizing artificial neural networks and image preprocessing to improve mango grading. This study categorized mangoes into four grades (A, B, C, and D) based on their physical and visual attributes, achieving a high classification accuracy of 92% through convolutional neural networks (CNNs) combined with transfer learning and advanced image processing techniques. The model's accuracy surpasses that of traditional image processing methods, highlighting its effectiveness in automated fruit classification. Key preprocessing techniques, including scaling, normalization, data augmentation, and histogram analysis, played a crucial role in standardizing inputs and enhancing feature extraction. Transfer learning with a pre-trained VGG16 model significantly improved accuracy, reduced training time, and enhanced feature representation. A well-balanced dataset, split into training, testing, and validation sets, ensured robust model evaluation. The system demonstrated high reliability in classifying mangoes into the designated grades, with minimal classification errors. Notably, the model exhibited exceptional precision in distinguishing between grades A and B, reinforcing its accuracy and dependability in automated mango grading.

IX. FUTURE WORK

Future research can expand upon this work in several promising directions. Increasing the dataset size to include a wider variety of mango types and diverse growing conditions will enhance the model's generalization and robustness. Additionally, incorporating multispectral or hyperspectral imaging could provide richer data inputs, enabling the detection of complex features such as disease presence and ripeness levels. Exploring advanced deep learning architectures, such as recurrent neural networks (RNNs), enhanced convolutional neural networks (CNNs), or attention mechanisms, could further improve the system’s ability to capture temporal changes in fruit quality over time.

Real-time image processing capabilities and deployment on embedded systems or edge devices would facilitate on-site grading, significantly improving operational efficiency in agricultural workflows. Collaboration among researchers, industry partners, and agricultural stakeholders will be crucial for validating and implementing these advancements. Ultimately, these efforts will drive automated fruit grading systems closer to widespread real-world adoption, transforming quality assessment in the agricultural sector.

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Digital Marketing needs identification for Uttarakhand tourist zones using BCG matrix: A Strategic Case Approach

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Abstract:

"It is time for the world to visit Uttarakhand and discover that it is simply Heaven" (Excerpt from Uttarakhand's Tourism Policy 2023)

Located in the foothills of the Himalayas, Uttarakhand borders China and Nepal on the international side. Visitors may experience Uttarakhand's pristine nature in all its beauty. A wealth of natural beauty, spanning mountains and forests, has been bestowed upon the state. The fact that dense woodland covers over half of its land area adds to its unique feature. The state is spread out over the majestic Himalayas, which are home to a diverse range of rare plants and animals, a comfortable climate, and a tranquil setting. The numerous glaciers in this region are the source of India's principal rivers, such as the Ganga and the Yamuna. Any description of the beauty of Uttarakhand would be incomplete without mentioning the people call this blessed country home. The helpful and industrious people of Uttarakhand are as varied as the state's myriad natural characteristics. Numerous native tribes live in harmony with one another while preserving their unique cultures. In addition to its distinctive travel experiences, Uttarakhand's natural and cultural diversity makes it a treasure trove for historians, hikers, yoga practitioners, anthropologists, ornithologists, naturalists, linguists, geologists, and more. The state has something to offer in any discipline you can think of. By raising awareness, the general public can also be made aware of the distinctive tourism products. Through tourism, the state is able to create more job prospects thanks to digital marketing. Digital marketing has the potential to increase awareness in a multiplicative way to the state but it has been evident from the data that still the state

need to work on digital marketing mix in many of its tourist zones. The tourists across India and World to be made aware of different categories of tourism available in the state. For exploring and embracing Uttarakhand's rich natural beauty and religious roots as well as its exciting future as a global platform for experiential tourism it is important to emphasize much on the role of digital marketing for creating awareness and generating employment because it is time to share Uttarakhand's many extraordinary, unique, and authentic stories with the world. With the given research article the zones have been placed on BCG Matrix for devising digital promotion mix strategies for the upliftment of tourist destinations and products from every nook and corner of the state.

Keywords: ***Uttarakhand's Tourism, Digital Marketing, Employment Generation, Uttarakhand's Culture, BCG Matrix***

1 Introduction:

Digital marketing can play a significant role in generating revenue for Uttarakhand tourism by helping to:

- Build brand loyalty: Create a brand for the hotel and gain customer trust.
- Engage with customers: Use social media to engage with guests and build a stronger brand.
- Reach target audiences: Use interactive media to reach the target audience at the right time.
- Create meaningful content: Create content for domestic and inbound tourists to connect with guests and increase traffic.
- Communicate with visitors: Use digital marketing to communicate with visitors and customers more effectively.
- Access new markets: Use digital marketing to access new markets.
- Fine-tune messaging: Use digital marketing to fine-tune messaging.

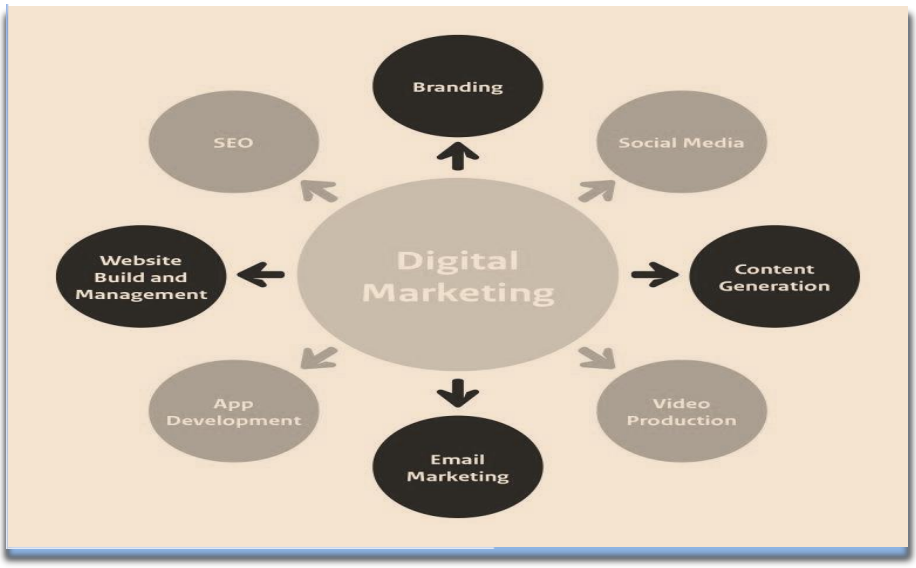

Image 1: Digital Marketing role in Tourism Sector

Digital marketing by means of content generation, website build and management, video production, app development gives a boost to tourism sector.

Digital marketing can be more efficient and effective than traditional marketing methods. However, some hotels may be reluctant to adopt digital marketing due to unfamiliarity with digital tools, investment costs, or a continued reliance on traditional marketing.

2. Objective of the Study:

1) To study the role of digital marketing in generating employment in Uttarakhand.
2) To bring forth the areas to be focused to increase the employment and revenue for the state.

3. Methodology of the Study:

The researcher has explored the Uttarakhand tourism websites, various research journals and articles and blogs to draw important inferences. The data pertaining for identification of the tourism zones have also been gathered from states official sites. State tourism websites have been researched for references.

4. Review of Literature:

Tourism & Hospitality Industry in Uttarakhand:- Uttarakhand is located in the Himalayan belt of northern India and is blessed with snowcapped mountains, lakes, rivers, unique flora and fauna, trekking routes, pilgrimage, and religious sites, wildlife sanctuaries, national parks, and even biodiversity zones. The state is also known for the famous char dham yatra i.e. Kedarnath, Badrinath, Yamunotri, and Gangotri which attracts a huge crowd from every corner of the country. Bansal & Gangotia (2010) argued about how Uttarakhand acquired the title of 'DevBhoomi' where the major purpose of visit for domestic and inbound tourists is holiday/leisure and yoga and health.

According to the PHDCCI Research Bureau report (2013), Uttarakhand is the most preferred destination in India and has huge potential to become the tourism hub of India. Uttarakhand tourism suffered a major setback after post 2013 Kedarnath disaster, but it recovered very fast and according to the Uttarakhand Tourism Board Report 2019, the number of tourists visiting Uttarakhand reached its peak by three times the total arrival of domestic and international tourists. To further give a boost to the Tourism & Hospitality sector of Uttarakhand the government has decided to develop around seven tourism zones across the state. These seven zones will focus on developing the local economy, hotels, and transport facilities, and offering employment to the local community.

Kotler & Armstrong, (2020) argued how digital technologies are bringing radical changes in marketing concepts, trends, processes, and strategies. The continuous development and widespread usage of a global network of information technology in the 21st century has made digital business one of the most significant modes of communication and business activities between hotels and customers. However different innovative marketing concepts like Digital Marketing, E– Commerce, Internet marketing, social marketing, mobile marketing, word of mouth, cross–channel marketing, and big data have been used by most of the star category hotels of Uttarakhand.

Arya,(2011) highlighted that Indian Hospitality Industry is now in the top 10 Indian industries which are actively engaging with their customers on social media, websites, blogs, and YouTube channels. According to the Statist's report 59% of 5-star deluxe hotels, used blogs as their main marketing tools, whereas only 9% used blogs among the 1-star hotels and 72.5% of 5 – star Deluxe hotels used pay- perclick as a marketing tool, and 76.6% hotels and resorts used hotel website for their marketing strategy.

TIMES OF INDIA Report, Nov 9, 2024: According to the tourism department, the state recorded 5.96 crore visitors in 2023, up from 3.68 crore in 2018—a growth of 61.79%.

Philip et al., 2012;Rudnicki and Vagner, 2014: The BCG matrix is used as an analytical tool instrategic management, portfolio management, brand marketing, andproduct management. Moreover, it aids identifying the cash flow requirements, investments, and marketing decisions.

5. Transformative benefits of digital marketing for the state:

Digital marketing provides transformative benefits for businesses in this scenic state, and it helps the state to reach a broader audience, and also fosters growth even in remote areas like,

5.1. Wider Audience Reach:

In Uttarakhand, businesses can benefit greatly from digital marketing as it enables them to expand their reach and connect with a broader audience. While Uttarakhand is primarily known for its tourism and agriculture, there's a growing demand for various industries such as hospitality, education, real estate, and e-commerce. By utilizing digital marketing strategies, businesses can reach and engage with audiences on a local and global scale, transcending geographical limitations

- Local and Global Reach: By leveraging tools like social media, search engines, and websites, businesses can target customers not only from towns like Dehradun, Nainital, and Haridwar but also reach potential clients from across the country and around the globe.
- 24/7 Availability: Digital platforms allow businesses to be accessible at all times, making it easier for potential customers to browse products or services, increasing opportunities for conversions.

5.2. Cost-Effective Marketing:

Traditional marketing methods like print ads, billboards, or television spots can be expensive, especially for small businesses. Digital marketing provides a cost-effective alternative for businesses in Uttarakhand, regardless of their size or budget.

- Affordable Campaigns: Businesses can run low-budget yet effective campaigns on platforms like Google Ads, Facebook, or Instagram and see immediate results. Even with minimal investment, digital marketing can help attract the right customers.
- High Return on Investment (ROI): With precise targeting and analytical tools, businesses can measure the performance of their campaigns in real-time. Adjustments can be made instantly, ensuring that marketing budgets are used efficiently to maximize ROI.

5.3 Targeted Marketing:

In Uttarakhand, businesses range from traditional stores to new-age startups. What makes digital marketing exceptional is its ability to provide targeted marketing. This means businesses can focus on a specific segment of the population based on their behaviour, interests, demographics, or even geographic location.

- Precision Targeting: For instance, a resort in Rishikesh can target tourists interested in spiritual retreats, while an educational institution in Dehradun can focus on parents searching for quality schools for their children.
- Personalization: Personalizing ads, emails, and social media campaigns tailored to the specific needs of customer's increases engagement and helps build a loyal customer base.

5.4 Boosts Local SEO and Visibility:

With more customers turning to Google to find businesses, services, or products, having a robust Search Engine Optimization (SEO) strategy is crucial. For businesses in Uttarakhand, especially in smaller towns or rural areas, optimizing for local search terms ensures higher visibility on search engines.

- Ranking on Google: By using local keywords like "best restaurant in Dehradun" or "affordable hotel in Mussoorie," businesses can ensure they show up when potential customers are searching

- Google My Business: Listing your business on Google My Business ensures your business appears on Google Maps and local search results, giving customers easy access to your contact details, location, and reviews.

Image 2: Digital marketing agencies offering services to boost tourism

5.5 Increases Brand Awareness:

In an era where consumers are spoiled for choice, building a strong brand presence is essential. Establishing and growing their brand identity in Uttarakhand is facilitated by digital marketing through maintaining consistent messaging and providing high-quality content.

- Social Media Influence: By being active on social media platforms like Facebook, Instagram, or Twitter, businesses can engage with their audience and build an emotional connection. Sharing behind-the-scenes content, stories about your journey, or updates about new products will make your brand relatable.
- Content Marketing: Blogs, videos, and infographics not only showcase your expertise but also increase brand visibility and credibility. Engaging and informative content also encourages customers to share, which further enhances your reach.

5.6 Drives Online Sales:

With the rise of e commerce platforms, online sales have become a crucial revenue stream for many businesses. In Uttarakhand, where tourism is a significant contributor to the economy, businesses offering online booking systems for hotels, tours, and activities have a massive advantage.

- E-Commerce Integration: For businesses like handicrafts, organic produce, or boutique hotels, creating an online store or booking system enhances customer convenience and increases sales.

- Influencer Marketing: Partnering with local influencers or travel bloggers in Uttarakhand to promote your products or services is another powerful way to boost online sales.

5.7 Real-Time Results and Analytics:

One of the most significant advantages of digital marketing is the ability to track and analyze the performance of your marketing efforts in real-time. Businesses in Uttarakhand can enhance their marketing strategies continuously by making informed decisions through this data-driven approach.

- Measurable Results: Whether it's the number of website visitors, the engagement on a Facebook post, or the ROI on a Google Ad campaign, digital marketing tools like Google Analytics or Facebook Insights provide detailed data on how well your marketing efforts are performing.
- Adaptability: Based on these insights, businesses can tweak their strategies, adjust campaigns, or reallocate budgets to achieve better results without having to wait for months to see the impact.

5.8 Real-Time Results and Analytics:

Building and maintaining strong customer relationships is key to business success, and digital marketing provides several avenues to engage with customers.

- Customer Feedback: Platforms like social media allow customers to communicate directly with businesses, share their feedback, and ask questions. This two-way interaction shows loyalty and trust.
- Email Marketing: Sending personalized offers, newsletters, or updates through email is an excellent way to keep your customers engaged and informed. It helps build long-term relationships with your audience.

6. Zones identified for the given study

Total seven zones have been identified for the study comprising various dhams, religious tourist destinations, temples, adventure destinations, wellness cum religious spots etc.

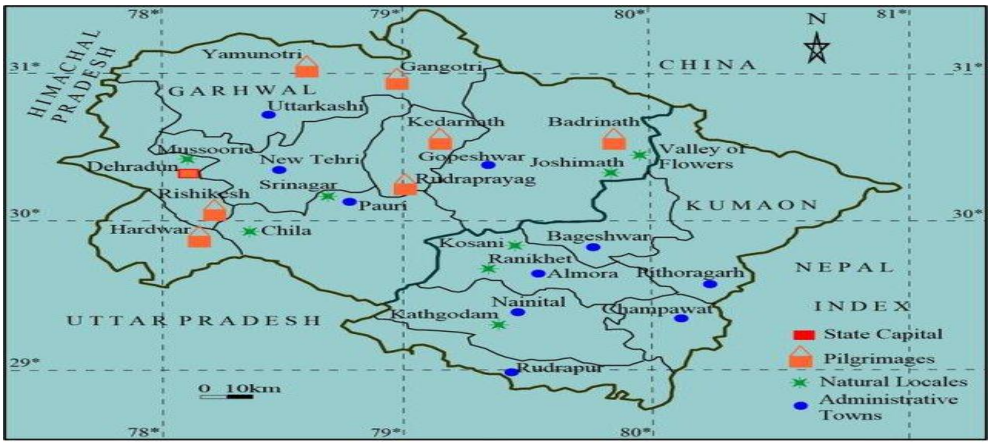

Image 3: Journal of multidisciplinary academic tourism The nature of tourism and tourists/pilgrims' inflow in Uttarakhand Himalaya

○ Zone 1: Dehradun, Musoorie, Haridwar, Rishikesh and Environs,International Gateway at Jolly Grant Airport	○ Zone 4: Uttarkashi, Gangotri, Tehri Lake, Domestic Gateway at Chinyalisaur Airport
○ Zone 2: Nainital Lake District and Environs, International Gateway at Pantnagar Airport	○ Zone 5: Pithoragarh, Thal to Munsiyari (Lower Johar Valley), Almora,Champawat, Domestic Gateway at Naini Saini Airport
○ Zone 3: Corbett National Park West, Landsdowne, Pauri and Environs	○ Zone 6: Badrinath, Kedarnath, Valley of Flowers, Domestic Gateway at Gauchar Airport
	○ Zone 7: Yamunotri, Chakrata and Mori (Tons River)

Table 1: Source- Journal of multidisciplinary academic tourism The nature of tourism and tourists/pilgrims' inflow in Uttarakhand Himalaya

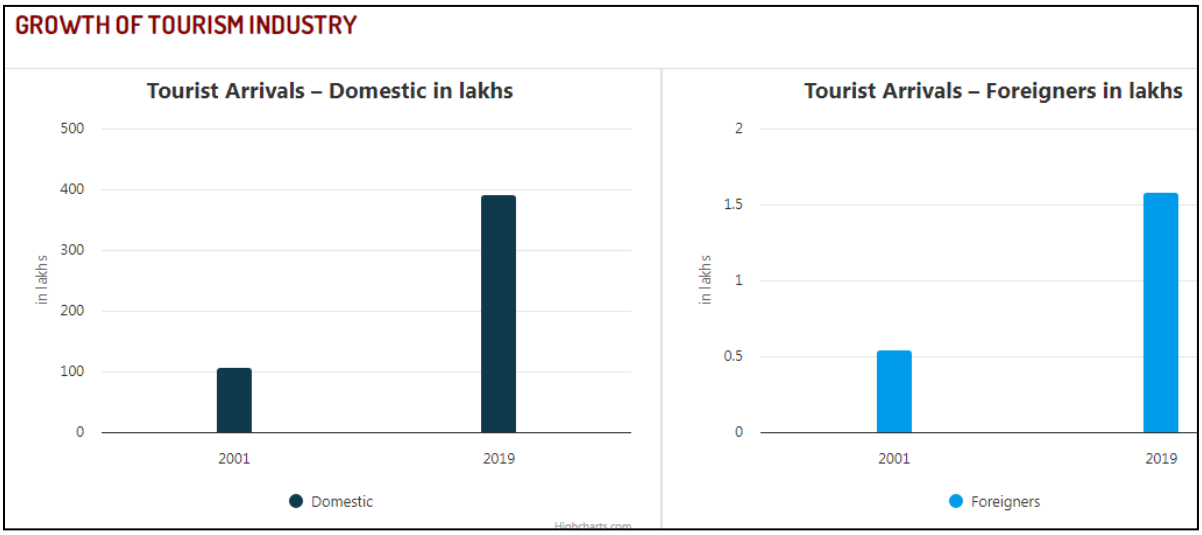

Table 2: Source-https://investuttarakhand.uk.gov.in/uttarakhandtourism/Source:

Sl. No.	Name of Tourist Destination	Year 2021		
		Indian	Foreigner	Total
1	Dehradun	2866107	1675	2867782
2	Rishikesh	291230	1576	292806
3	Mussoorie	1229528	280	1229808
4	Pauri	7350	0	7350
5	Srinagar	209555	0	209555
6	Kotdwar (Swaragasram, Chilla)	108362	638	109000
7	Rudraprayag (without Kedarnath)	46479	36	46515
8	Kedarnath	242985	27	243012
9	Gopeshwar (Nandprayag,Mundoli, Tharali etc.)	10163	53	10216
10	Joshimath (Govindghat, Ghanghariya)	167369	12	167381
11	Badrinath	199406	3	199409
12	Auli	127487	1	127488
13	Hemkund Sahib	19909	0	19909
14	Valley of Flowers	10383	15	10398
15	Tehri	490512	2300	492812
16	Uttarkashi (Harshil, Gangnani etc.)	80593	140	80733
17	Gangotri	33771	0	33771
18	Yamunotri	33311	0	33311
19	Haridwar	12717825	616	12718441
20	Almora	38027	171	38198
21	Ranikheth	54265	0	54265
22	Kausani & Bageshwar	45807	8	45815
23	Pithoragarh	53433	73	53506
24	Champawat	15704	7	15711
25	Nainital	325626	633	326259
26	Kathgodam	107932	177	108109
27	Corbett National Park	287324	6813	294137

Table 3: Uttarakhandtourism.gov.in

The state enjoys footfall of domestic and international tourists in incremental form. But considering the tourism as the unique selling proposition for the state and the major vital source of revenue it is required to analyze the tourist zones wherein much of promotional mix is required to be applied. Based on the figures stated above the identified zones have been placed on BCG Matrix. BCG Matrix has been used as it is an excellent integration of the strategic aspects (growth, investment, and disinvestment) together with the financial aspects (Duica et al., 2014). It provides a base for decision-making for future actions and strategic options, provides information about efficient resource allocation, and identifies the cash flow requirements of the product.

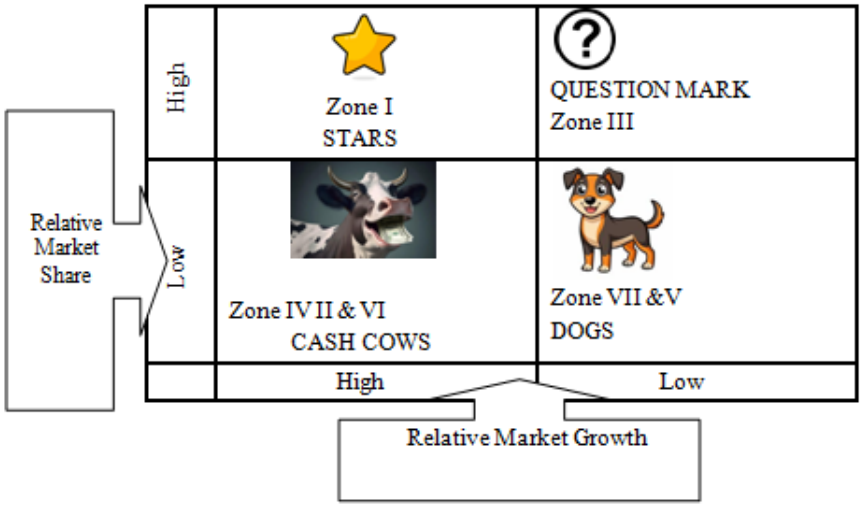

Image 4: BCG for Uttarakhand Tourist Zones

Figure A Blueprint of the BCG based on areas identified to be emphasized by the state

7. Zones in purview of BCG with recommendations and findings:

Zone I: The given zone falls under Star category. It includes the tourist zones with high market share and relatively high market growth. These areas are highly preferred by the tourists at pan India level due to high rate of digital marketing mix. The state yield 38.5% of its total revenue from Mussorie, Dehradun, Rishikesh and tourists arrival at Jolly Grant International Airport. [ACNielsen ORG-MARG Pvt. Ltd. 2022]

Zone III: The given Question Mark zone includes the tourist zones with high market share and relatively low market growth. These areas are preferred on moderate basis by the tourists at pan India level due to high rate of digital marketing mix. But still the digital marketing mix need to be revisited in context of promoting the jungle safari's and the facility/service mix in an effective manner. The state yield 23% of its total revenue from Corbett, Rajaji, Lansdown and Pauri interiorsrt. [ACNielsen ORG-MARG Pvt. Ltd. 2022]

Zone IV, II &VI: The given Cash Cow zone includes the tourist zones with high market share and relatively high market growth. These areas are preferred on higher basis by the tourists at pan India level due to well defined and designed digital marketing mix. But to maintain the same revenue pace or even to enhance the growth and share the digital strategies in context of online digital modes to be revived on regular basis. The state yield 33.3% of its total revenue from Nainital, Pantnagar, Tehri Lake, Char Dham yatra, Gochar airport, International gateway at Pantnatar airport etc. [ACNielsen ORG-MARG Pvt. Ltd. 2022]

Zone VII, II &VI: The given Dog zone includes the tourist zones with high investment and relatively very less revenue earned. In this yamnotri and chakrata are towards high revenue earning tourist sites but comparatively the other destinations needs to be revisited in terms of tourist footfall be it domestic and out of geographical boundaries of india. The positioning to be revised on all the social media platforms in terms of the sub-sites, hill infrastructure and ease of booking tickets and the home stays. The state yield 14.57% of its total revenue from Yamnotri, Pithoragarh, Almora, Champawat, Chakrata and Mori etc. [ACNielsen ORG-MARG Pvt. Ltd. 2022]

7.1 Other areas recommended to be focused upon: *Areas for further improvement to increase tourism*:

a. **Infrastructure development:**

Addressing issues like poor road conditions in remote areas, better accessibility to offbeat destinations, and improved accommodation options in various price ranges.

b. **Sustainable practices:**

Promoting eco-tourism initiatives, managing waste disposal, and educating local communities about responsible tourism to minimize environmental impact.

c. **Diversification of tourism products:**

Beyond pilgrimage and adventure tourism, focus on developing niche segments like wellness tourism, cultural tourism, agro-tourism, and culinary experiences.

d. **Marketing and promotion:**

Targeted marketing campaigns to attract international tourists, utilizing digital platforms to showcase Uttarakhand's unique offerings and promote the state as a safe and welcoming destination.

e. **Community engagement:**

Empowering local communities by involving them in tourism activities, providing training opportunities, and ensuring equitable benefits from tourism revenue.

f. **Safety and security:**

Enhancing emergency response systems, particularly in high-altitude areas, and addressing concerns regarding natural disasters.

8. Conclusion:

In today's world, no business can afford to overlook the power of digital marketing, and this holds true for businesses and tourist zones in Uttarakhand as well. Whether the tourists running a local café in Nainital or managing a tour company in Rishikesh, digital marketing offers cost-effective, measurable, and targeted solutions that can propel your business to new heights. By embracing digital marketing strategies, businesses in Uttarakhand can not only expand their local and global reach but also drive sales, build brand awareness, and foster lasting customer relationships. If you haven't already explored the world of digital marketing, now is the perfect time to start and watch your business thrive amidst the breathtaking landscapes of Uttarakhand. The state with focusing more on digital marketing techniques may improve the employment and also generate revenue for the state. The social media hence will be proved beneficial for the promotion of local tourism, its scenic beauty and adventurous sites and destinations. Overall, Uttarakhand has immense potential to further establish itself as a major tourist destination with strategic planning, focus on sustainability, and promotion of its diverse tourism offerings.

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"Garhwal's Ghost Villages to Host Villages: Homestay Tourism as a Mechanism for Community Reawakening"

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Abstract

In Garhwal region, homestay have emerged as blessing, addressing multi faceted challenges of hillyareas, such as distress migration, unemployment, inadequate infrastructure, culture erosion, gender inequality etc. As a key agent of tourism, Homestay is proving the solution of all these while fostering economic growth. It helps to generate additional income and empower local communities particularly women, by enhancing the status, improving standard of living, providing independence and recognition within the society. Many youths from this region are leaving the villages for the search of better opportunities and they all are leaving behind the gray populations. However, homestays is solution of this type of distress migration. In terms of gender equality, homestays have proven a powerful tool for the women empowerment as the active participation of women in this operation has significantly increased social networking which in turns foster cultural preservation and promotion. The potential of Homestay is a crucial to revitalize "Ghost Village" of Garhwal offering hope for reversing migration trends. This technological advancement is essential in tourism sector for flexible tourism solutions. Online platform contactless booking system generates its demand worldwide. Homestay tourism is best example to combine innovation and tradition to empower the local community. It helps migration prone villages to control the youth crowd which there by enhance the economic growth along with giving new strength to heritage of particular destination.

Keywords:- *Migration, Homestay, Local communities, economic growth.*

Introduction

Uttrakhand a picturesqueHimalayan state whose name is derived from Sanskrit word meaning "Northern region" signifies its location in the Northern part of India. Uttrakhand share its international borders with Nepal and Tibet and national borders with Himachal Pradesh and Uttrakahnd. Uttrakahand is slightly smaller than Himachal Pradesh but shares many similarities geographically and culturally (Khan, M. (2024). Whose primary source of income is particularly agriculture as limited industrial growth seems leads to income inequality and hinders the economic advancement of state (Mamgain, R. P. 2007). The significant challenges like socio- economic, distress migration; unemployment etc. and all of these issues have led to emergence of "Ghost Village" where mass of youth population is migrating in search of better opportunities from hills which is the major threat of local communities in Garhwal (Kumar, S., & Misra, P. 2024). Commercialisation of accommodation is known as the homestay it is a process where owners offer guest a stay in their own house at a reasonable price (Kontogeorgopoulos et al., 2015). Homestay is a unique and appealing form of hospitality that benefits for both host and guest as under

this concept host offers their own residence to visitors for accommodation and provides necessary services within their local environment. From the visitor's perspective, it's a budgeted concept while allowing host to continue with traditional work, cultural activity like agriculture, animal farming and handicraft without disruption. We can say that, Homestay are a part of budgeted accommodation which helps to promote the sustainable tourism and the best part that it also emerged as a solution of many challenges of Garhwal region while fostering economic growth and cultural preservation (Dube, A., & Sharma, R. A. 2018). This makes homestay an excellent way to promote cultural heritage while generating additional income. This empowers local community especially to women, enhance the livelihood, and improve status and fostering economic independence. It also creates an opportunities of cultural exchange among host and guest, making homestay an agent of sustainable tourism (Chand et al., 2024).In hospitality industry Homestay serves as solution of many issues of hilly areas by offering a unique form of accommodation which provides a platform to local families where they can share their homes to visitors at reasonable price and also allow them to experience region's culture, local traditions and lifestyle in limited budget.This model supports sustainable tourism whereby revenues are channeled directly into the local community as a supplement to their thin alternative source of income and tightly linked with the local culture and natural environment. Along such lines, it is asserted that homestay tourism may even economically empower the local community building opportunity as well as capturing their culture within regions where such losses could create problem through lost of traditional customs especially as with places such as Garhwal.

Homestay provides besides economic benefits the greater facilitate of cultural exchange and understanding between the locals and visitors. Hosts and guests experience common actions and communications are undertaken through the engagement with each other's lifestyles; they learn and can build relationships that last a lifetime. This interaction brings them more pride in the local community and makes them feel more identified with it. The opportunity for homestay tourism is a potential enabler of women, especially through economic independence and involvement in the decision-making process that affects the family and the community. Through the participation of women in homestay operations, social change will be ensured, hence turning them into key actors in regional economic development. The homestay model also has great potential in bringing about environmental impacts and sustainable practices in tourism activities. For instance, through the promotion of these eco-friendly activities such as the use of local resources besides efforts to conserve energy, the homestay operator stands in a good chance of minimizing the effect of tourism on the environment. Despite many challenges like limited accessibilities, environmental challenges, Covid-19 pandemic introduce digital transformative. In addition, the fast growth of tourism at this level fuels local government and authorities to improve their infrastructure and services, thus propelling holistic growth of this region.

This research aims to discuss how homestay tourism can be used to reverse the trend of migration in Garhwal and how it will contribute to enhancing community well-being, preserving cultural heritage, and sustainable economic development. The basis of this study is to convert “Ghost Villages” into “Host villages” by identifying how homestay tourism can brings the changes in Garhwal region which is facing distress migration.

Objectives

1. To Analyzing socio-economic impact of Homstay on local communities of the garhwal region.
2. To explore how homestay tourism contributes to local culture in retaining local customs.
3. To investigate the role of homestay in reversing distress migration from the Garhwal region.

Literature Review

Homestay is rapidly developing pattern in the hilly regions of Uttrakhand which helps to local communities to not rely solely on one source of income especially agriculture (Awasthi, I., & Mehta, B. S.,2020). Homestay have gained the recognition for the development of rural areas in Uttarakhand, India by offering not only the accommodation but also the authentic cultural experiences, thereby enhancing the economic opportunities for local communities (Chourasia, B. 2024). Study of (Awasthi, I., & Mehta, B. S. 2020) focuses on socio economic benefits of homestay but lack in depth exploration of the socio cultural dynamics and psychological impacts on both host and guest.Garhwal region have many factors like insufficient job opportunities, non-satisfactory health facilities, unfit social conditions etc. are also responsible for the migration from uttrakhand hilly areas which can be relieve through strengthening local community especially women, encouraging entrepreneurship, uplifting tourism, preserving culture (Bansal, N., & Diwakar, B. (2024).Studies (Nurfadilah et al., 2024) suggested reverse migration; further evidence is needed to understand the factors driving reverse migration.That is why homestay is unique, special concept helps in direct financial advantage as it is providing the option to foster the economic growth without leaving agriculture and other traditional activities like animal farming, pottery, fishery, carving etc. which not only keeps their family culture alive but also creates a sense of identity for community along with destination (Chakravorty, S. P., 2022). Homestay tourism in Garhwal region foster the mutual understanding between guest and host through shared activities, effective communication and the most importantly, cultural immersion (Chand et al., 2024). As many as involvement of local communities will be in homestay their earnings, standard of living, livelihood, social networks will improve as a result, it also nurtures the exchange of culture between host and guest and this practice is very important for promoting the culture and tradition (Tiwari et al., 2021). A creative and supportive policies is demanded by Garhwal region which promote these practices and

educate the youth to improve their skills, which in turn may stop the out-migration of males and also increase socio economic development as Uttrakhand faces limited sources of income, environmental challenges, poor infrastructure which lead to distress migration (Joshi, B., 2018). Many villages of Pauri, Chamoli, Tehri, Almora are turning into “Ghost Villages” because only a few residents left behind in such cases homestay as a part of rural tourism can preserve the culture and helps in reverse migration of these areas and convert these ghost villages into host villages. The “Endogenous Tourism” framework needs to be implemented to maximize the economic benefitsto ensure that more households canbe benefitedhowever; this study identifies a gap in effective implementation strategies for establishing homestay program in remote areas (Kathayat, K. S. 2024). Tourist demand needs to align in the homestay offerings of Uttrakhand to prevent the shift of tourist traffic elsewhere (Bisht et al., 2023). To increase the tourist traffic it is also essential to establish the connectivity between facilitators and travelers which also ensure the security of homestay owners and tourist (Rauthan, S., & Pant, V. 2023). Improvement in tourist flow and their preferences to stay in the homestay accommodation contribute to poverty alleviation by providing additional source of income trough offerings such as local ingredients meals, guided tours for out-door activities and many more (Negi et al.,2023). (Novita et al., 2024) said that due to the disinterest of young generation in their own local culture arts and lack of active participation of local communities in culture preservation is the biggest challenge faced by homestay tourism to attract tourist towards the destination however, need for comparative research between region and countries to understand cultural preservation strategies.Additionally government guidance is necessaryto boost villager’s confidence in their heritage, enhancerural life experiences and promote the local culture (Jiang, Z. 2019). A Competition from commercial hotel is a challenge for homestay owners who offer similar amenities and services with trained staff at lower price to tourist therefore vocational training programs along with eco friendly practices is demanded by local communities (Giri et al., 2024). Government training program, awareness campaigns are also necessary, as caste consideration, limited investment finance, safety concern for both host and guest are also the major unavoidable issues which hinders the development of homestay in Himalayan region (Sanyal, et al. 2023). The partnership among homestay owner and the local government authorities in garhwal region are taking step towards the eco friendly practices, conserving energies through which the excellent services offered to guest while minimizing the harm to the environment and helps to promote homestay to large audience (Suardana et al., 2024). An unavoidable issue of Garhwal region is seasonal fluctuation,this fluctuation affects the tourist activities because of weather and geographical conditions that is the reason improved infrastructure, off-season packages, local communities engagement in tourism development are highlighted in demand (Sanyal et al.,2023).In search of better employment opportunities a significant driver of village abandonment is migrating due to which rural population is decreasing (Jaszczak et al.,

2018).Transiting "Ghost Villages" to "Host Villages" homestay tourism will require strategic approaches (Pankaj, P., & Pant, A. 2001).Since the homestay tourism will infill the deserted villages once more, provide stable employment, and preserve cultural as well as the unique regional identity (Chakraborty, B. 2020). Skill development programs for local youth and fostering cultural experience might make Garhwal a destination for tourists (Jaiswal, B., & Bisht, M. (2017). The Garhwal region is able to reach its full potential through the targeted programs which helps to overcome the challenges like limited resources, lack of infrastructure and the regulatory issues. This helps local communities to develop the tourism model which is both economically beneficial and preserve the culture(Giri et al., 2024). Garhwal can achieve the all-round development by diversifying the tourism products that allow homestay to promote socio-economic growth through socio-economic development and cultural preservation it also reduces the distress migration by generating employment opportunities while preserving the resources (Prajapat et al., 2023). In order to fill the infrastructural gaps and encourage resource sharing and intervention implementation in an appropriate manner, Garhwal can develop a sustainable model of tourism that may be replicated elsewhere with similar issues (Chourasia, B. 2024).

Methodology

The study takes on descriptive research design and depends on secondary data from Uttrakahnd Tourism and Ministry of Tourrism, to know the homestay impacts on socio economic, cultural activities and distress migration particularly in Garhwal region. Data from “The tourist statistics (2000-2023)” used in research study that provides a framework to address research objectives. The data helps to understand the long term tourist trend, tourism growth, etc. and highlights the correlations between increased tourism and homestays demand after the pandemic

Year	Tourist visit in Haridwar	Tourist Visit in Kedarnath	Tourist Visit in Dehradun
2000	5,316,980	300,000	450,391
2010	18,837,125	400,243	1,401,942
2020	4,016,250	135,287	592,079
2023	37,050,845	1,957,609	6,113,424

Data from Uttrakhand Tourism.

Moreover, March 2019 homestay data helps to know the registration of Gold, Silver, Bronze categories homestay. Where Gold category is about the premium, very expensive and top class services like Wi-Fi,

hygiene, furnishing, tour guide in homestay, in silver category mid range facilities with clean, comfort, stard meals and decent hospitality is offered. Browze categories are about budged homestay with affordable rooms, meals and essential services. In the data total beds refers to numbers of sleeping accommodations available in these homestays and Rural and Urban specify about the location of homestay in villages, outside, down town etc. The data below shows that Chamoli leads in Gold homestays which the availability of 100 sleeping accommodations. This also helps to know the contribution of homestay in rural tourism development.

The table shows the data of different categories homestay in Garhwal region (Tehri, Chamoli, Rudrapryag).

District	Gold Homestay	Silver Homestay	Bronze Homestay	Total Beds	Urban/Rural
Tehri	20	15	10	15	Rural
Chamoli	25	10	5	100	Rural
Rudraprayag	18	8	6	90	Rural

Source: Data from Uttarakhand Tourism.

Additional, the data of Total tourist arrival in 2010-2023 evaluate the growth of tourist in urban and rural areas in percentages. Growing preferences in rural areas somehow indicates the homestay.

Year	Total Tourists (Uttrakhand)	Rural Areas (%)	Urban arear (%)
2010	22,260,400	35%	65%
2023	59,636,601	40%	60%

Source: Data from Uttrakhand Tourism.

As well as, the data of Tourist engagement in Cultural events of Garhwal helps to know the role the cultural activities to promote and preserve the culture of destination.

Destination	Cultural Events Hosted (Annualy)	Tourist Participation (%)
Rishikesh	12	75%
Gangotri	8	65%
Yamunotri	5	55%

Source: Data from Uttrakhand Tourism.

Furthermore, rural tourist data is used to analysis the migration trend of Garhwal and the effects of homestay in reverse migration.

Region	Population Retention Rate (%)	Homestay contribution
Garhwal Rural	65	High
Garhwal Urban	80	Moderate

Source: Data from Uttrakhand Tourism.

Other than, data of Average Monthly Income from Homestays of Garhwal region helps to know the socio economy impact in region in 2022. This data tells that average incomes of Garhwal and Kumaon showing 30 to 25 % increases from the previous year respectively.

Region	Average Income	% increase from previous year
Garhwal	18000	30%
Kumaon	12500	25%

Source: Reported by Ministry of Tourism, 2022

Findings

1. Socio-economic Impacts

For the local community economy tourism is significantly contributing particularly in destinations like:- Haridwar, Kedarnath and Dehradun. The tourists are demanding for the diverse option of homestay like gold, silver and bronze. Chamoli disttict is leading to provde the premium services which shows the actively participation of both host and guest in tourism. The homestay are generating additional income, giving employment, support local businesses such as shops, transports, etc and fostering economic development and boosting the economy. Tourist arrival increases from 2000 to 2023 reflecting the growth and opportunities of small scale entrepreneur.

2. Cultural Impacts

Cultural heritage of Uttrakhand are preserving through the tourism especially in Risikesh, where every year in 12 cultural events 75% participations is of tourist only. Similarly in Gangotri and Yamnotri the tourist participation is 65% and 55% respectively. These cultural events are the platform of rich traditions, music, and dance, rituals highlighting the local life, awareness, and appreciation.

3. Impact on Migration

Tourism is also playing an crucial role to address the migration issues of Garhwal region. Through the development of homestay many areas such as Chamoli, Tehri, Kedarnath are benefited. Homestay enable community to stay in their own place as 65% of retention achieved in rural areas where as 80% in urban areas of Garhwal. Moreover, homestay foster the local markets, transportations, food services throughwhich tourism base income increases and employment generated within the local area which helps in reversing distress migration and ensures long term development.

Recommendations

- To minimize the environmental impacts, eco-friendly practices need to be implemented in homestay operations.
- Sustainable tourism standards need to develop in homestay to promote the responsible tourism for both host and guest.
- Requirement of vocational training programs focused on hospitality and tourism sector.
- Spotlight the community participation to generate more actively participation from the region.
- Showcase the traditional music, dance, dress etc. through workshops, festivals, events to promote culture and tradition.
- Enhance marketing activities to promote destination and Garhwal's homestay.
- Invest in skills of local communities to upgrade the services qualities of homestay.
- Improve the infrastructure of region to increase the accessibilities of guest.
- Encourage locals by proper presentation of the subsidies and schemes related to homestays.
- Plan tailor made itineraries of events, tours, activities to attract more and more tourist from world across.
- Provide discounts and incentives to tourist as per the occasions, seasons.
- Promote the homestay business encourages partnerships among owners.
- Enhance safety protocols in homestay for both hosts and guest.

Conclusion

Homestay in Garhwal region have emerged as a solution of various issues which significantly have an effect on socio-economic, cultural and the population's profile. Analysis of the study spot light on the homstay's contribution on local economy of Haridwar, Kedarnath and Dehadun particularly. Many categories like Gold, Silver and Bronze of homestay are derived through increasing demand of tourist as per different services levels. Homestay helps to generate the additional income, employment opportunities and also to preserve the culture. On the top of that homestay development helps in addressing migration problem within Gahwal region. To sustain these positive impacts of homestay and

to transform “Ghost villages” to “Host villages” by reawakening of communities, continues efforts are required on eco-friendly practices, skill development trainings, cultural promotion, vocational courses, development of infrastructure, Govt. supports.

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IMPACT OF TECHNOLOGY ON EVENT PLANNING

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ABSTRACT

Technological progress has instigated a significant transformation in the operational procedures of businesses, leading to the alteration of various phases in the lifecycle of events within the event management sector. This research delves into the intricate relationship between technological advancements and occurrences in the events industry, encompassing the extensive impacts across different tiers of events. It investigates the potential of augmented reality (AR) and virtual reality (VR) in enhancing events, such as virtual event tours, interactive displays, and immersive presentations. Event Management Applications offer a distinct approach within the realm of social media, tailored specifically for engagement related to events. Conventional practices like utilizing physical maps with markers and strings have been supplanted by interactive floor planning software, elevating event layout design precision and optimizing space usage and logistical operations to facilitate seamless event execution. This study advocates for the utilization of AR in event visualization to enhance the depiction of events by superimposing digital data onto real-world event settings, enabling more dynamic and interactive methods of accessing event details. Virtual Event Platforms present a comprehensive solution that goes beyond mere live streaming, providing avenues for interactive engagement through live participation, virtual booths, and audience interactions.

KEYWORDS: Event Technology, Event Planning and Management, Augmented Reality (AR), Virtual Reality (VR), Virtual Events

1. INTRODUCTION

The emergence of technology has indeed greatly transformed the event planning industry, if not even fundamentally changed how events are now conceptualized, planned, and executed. Previously, in the past, extensive manual labor, traditional tools, and face-to-face interaction were put into practice for

event planning. Then came the infusion of technologies—ground breaking ones like Augmented Reality, Virtual Reality, and others applying to event management—that ushered in new creative ways to make event planning efficient and engaging.

With technologies nowadays, event planners can transcend physical limitations in the environment by incorporating an imaginative setting into an event. For example, AR and VR offer a new kind of experience with features such as event tours, interactive exhibits, and fully immersive presentations that are very far from the possibilities of conventional methods. These technologies provide heightened sensory engagement for attendees, making events even more memorable and impactful.

In addition, there are some specialized applications that have been developed with regard to event management. Their use has further simplified the planning process. With these applications, there are more seamless coordination and communication on the aspects of execution. For instance, the use of interactive floor-planning software replaced such a method of floor planning as paper maps with pins and strings, assuring high accuracy in event diagramming and space utilization. The shift, therefore, has not only enhanced logistical efficiency but also added to smoother implementation of events.

The rise in virtual platforms for events, on the other hand, has allowed the scope of events to be widened beyond physical boundaries. Unlike simple live streaming, these offer comprehensive solutions on interactivity for live participation, virtual booths, and audience engagement features. This allows remote attendees to have a more inclusive and interactive time, thus extending the reach of events.

The relationship is symbiotic, but technology is no longer a luxury in event planners' repertoire who want to produce engaging, interactive, and memorable events. In an ever-evolving technology-driven world, the events industry can never stay static; there has to be continuous transformation and innovation that sets the yardstick for the upcoming events.

This paper looks into the multidimensional influence of technology on event planning and management. It further delves into how AR and VR are used to make event experiences even better, the role of event-management apps in boosting efficiency in the planning process, and finally, the overall features of virtual event platforms. These are the aspects that the research puts under scrutiny to underline the indispensable role that technology plays in molding the future of the event planning industry.

1.1. Background

Event management has always been a dynamic field with the need for great planning, coordination, and execution. With the traditional way of event planning in the past, there was more manual involvement, and tangible tools were more in use. To work on layouts and manage logistics, event planners used paper maps, pins, and strings frequently. Although functional, these methods remained subject to errors

and inefficiencies (Allen et al., 2020). Digital technologies have changed these conventional practices by introducing tools that make them much more precise and efficient.

One of the most significant technological advancements in recent years is interactive floor planning software development. These digital tools allow event planners to create accurate and detailed event diagrams, optimizing space utilization and improving logistical coordination (Smith & Johnson, 2019). By replacing paper-based methods, these applications reduce the likelihood of mistakes and enhance overall efficiency.

Another groundbreaking innovation is the application of Augmented Reality (AR) and Virtual Reality (VR) in event management. AR technology overlays digital information onto the physical world, providing dynamic and interactive ways to present event information (Jones, 2021). For example, event organizers can use AR to create virtual event tours, allowing attendees to preview event spaces in a highly engaging manner. VR, on the other hand, offers immersive experiences that transport participants to entirely virtual environments, where they can interact with exhibits, presentations, and other attendees in real-time (Brown, 2022).

Virtual Event Platforms have also gained prominence, particularly in response to the global COVID-19 pandemic, which necessitated a shift towards virtual and hybrid events. These platforms extend beyond simple live streaming, offering comprehensive solutions that include interactive features such as live participation, virtual booths, and audience interactions (Davis & Clark, 2021). This evolution reflects a broader trend toward creating more interactive and engaging virtual experiences that mirror the richness of in-person events.

1.2. Virtual Reality (VR) and Augmented Reality (AR) in Tourism and Events

The integration of Virtual Reality (VR) and Augmented Reality (AR) in tourism and events has revolutionized how experiences are designed and delivered. VR creates completely virtual environments, providing an unmatched immersive experience. For the tourism industry, this allows potential travelers to explore distant locations, wander through streets, visit landmarks, and engage in activities offered by the destination—all from the comfort of their homes. This virtual exploration acts as a powerful marketing tool and aids in decision-making by offering a tangible preview of the destination (Chung et al., 2018). In the context of events, VR can replicate entire venues or experiences, enabling remote participation that feels almost as real as being there in person. This technology extends the reach of events beyond physical limits, making them accessible to a global audience.

Conversely, Augmented Reality (AR) enhances the real world with digital overlays, enriching the experience for tourists and attendees. In tourism, AR can animate historical stories at ancient ruins, provide real-time translations of signs, or offer contextual information about sights through smartphones or AR glasses. This not only enhances the educational aspect of travel but also makes it more interactive and engaging. In events, AR can provide interactive schedules, wayfinding solutions, and personalized digital content that complements real-world happenings. This blend of digital and physical realms through AR transforms how attendees interact with events, ensuring a more engaging and memorable experience. Both VR and AR are crucial in redefining the boundaries of possibilities in tourism and event marketing, offering captivating experiences and resonating deeply with the modern consumer's desire for interactivity and immersion.

1.3. Scope of Technological Advancement in Events

The extent of technological progress in events with AR and VR is extensive and transformative, surpassing traditional operational enhancements to impact patron research, service provision, data management, and even event business models. This research covers the innovative drive instigated by these technologies, fostering innovation at the enterprise level and adaptation to advancements. We investigate their implications in domains such as supply chain management, where blockchain-based real-time event tracking shows potential for enhanced visibility and risk management. Our focus expands to shaping a more immersive, efficient, and influential future for the event management sector, leveraging the diverse potential of AR and VR.

1.4. Purpose of the Study

This study aims to explore the profound impact of technological innovations on the event management industry, focusing on the integration of AR, VR, and other digital tools. By examining the ways these technologies enhance event experiences and streamline planning processes, the research seeks to highlight their transformative potential. Furthermore, the study investigates the symbiotic relationship between technological advancements and the events industry, emphasizing that these innovations are not mere enhancements but essential components of modern event planning, this study seeks to answer the following research questions:

1. How do AR and VR technologies improve the overall experience and engagement at events?
2. In what ways do Event Management Apps facilitate event-oriented interactions compared to traditional social media platforms?

3. What are the advantages of using interactive floor planning software over traditional paper-based methods in event planning?
4. How do Virtual Event Platforms enhance audience interaction and participation in virtual and hybrid events?
5. What is the impact of technological advancements on the efficiency, engagement, and overall quality of event planning and management?

2. LITERATURE REVIEW

2.1. Event

Throughout history, events have played a crucial role in society, serving both as a means of celebration and as markers of significant changes in the lives of participants (Bowdin et al., 2012). Events are broadly defined as notable occurrences, but scholars like Shone and Parry (2001) and Matthews (2008) have critiqued Goldblatt's (2002) definition for its limited scope, which emphasizes celebration but excludes promotional events and sports competitions. This critique has led to the term "Special Events," which are described as unique occurrences with specific objectives that distinguish them from everyday life, providing unique experiences for participants (Shone & Parry, 2001). However, this definition also has its limitations, as it doesn't fully encompass the diverse experiences participants can have, as noted by Getz (1997), who highlighted leisure, social, and cultural areas.

The purpose and type of events are interrelated, as Matthews (2008) delves deeper into the definitions and genres within the event industry. Shone and Parry (2001) proposed a broader categorization of events, considering the evolution and diversity of the industry, influenced by societal changes and advancements in technology. Event managers now face higher expectations and need to be knowledgeable about technological capabilities, though comprehensive expertise in all technological aspects is not essential (Kasavana & Cahill, 2007). The lack of necessary technology at events like conferences can adversely affect their success and the organizer's reputation.

The event industry is influenced by many uncontrollable factors, which refer to the macro-environment or external environment (Goldblatt, 2011). Research into this area is crucial as events are integral to our culture, with increased leisure time and discretionary spending leading to a surge in the events industry, from public events to entertainment (Bowdin et al., 2012). With the growing demand for events, focusing on enhancing the attendee experience and fostering innovation is essential for success.

2.2. Technology and event technology

Technology permeates every facet of life, from communication to entertainment, and it continually evolves through innovation and advancements (Strom, 2012). The events industry is significantly impacted by these technological changes. As new technologies emerge, industry competitors must adapt or risk obsolescence (Waring, 2014). Companies leverage technology to maintain close connections with their customers, utilizing social media to raise awareness and websites for information sharing and collaboration (Kang et al., 2014). Although there is no formal academic definition of "Event Technology," a review of the literature suggests that it includes any technological application within the events industry that enhances, supports, and develops the event experience (Smit, 2012). Flowers and Gregson (2012),highlight how technological advancements can improve efficiency and effectiveness in the events industry. The development of Web 1.0, followed by Web 2.0, marked significant milestones in business and communication technology.

2.3. Augmented Reality (AR) in Event Management

Augmented Reality (AR) overlays digital information onto the physical world, creating an enhanced view that can be interacted with in real-time. AR has been increasingly utilized in event management to improve attendee engagement and provide immersive experiences.

Jones (2021) highlights the potential of AR to transform event visualization, offering dynamic and interactive ways to present information. For instance, AR can be used to create virtual event tours, allowing attendees to preview event spaces before arrival, thereby enhancing their overall experience. Additionally, AR can be used to provide interactive exhibits where attendees can engage with digital content overlaid on physical objects (Jones, 2021).

AR's capability to enhance spatial awareness and navigation within event venues is another significant advantage. Research by Carmigniani et al. (2011) indicates that AR applications can assist in wayfinding, providing attendees with real-time directions and information overlays, which improves the overall logistics and flow of events.

2.4. Virtual Reality (VR) in Event Management

Virtual Reality (VR) creates entirely immersive environments that transport users to a different space, offering unique opportunities for event management. VR is particularly valuable for creating virtual event experiences that are engaging and interactive.

Brown (2022) discusses the transformative potential of VR in event management, noting its ability to provide fully immersive experiences. VR can be used to create virtual booths and interactive

presentations, where attendees can interact with content and other participants in a virtual space. This is especially beneficial for trade shows and conferences, where networking and interaction are key components (Brown, 2022).

Additionally, VR can enhance remote participation in events. As highlighted by (Guttentag, 2010). VR technology allows attendees who cannot physically attend an event to experience it virtually, thereby increasing accessibility and broadening the event's reach.

2.5. Event Management Apps

Event Management Apps have emerged as essential tools for organizing and managing events. These apps offer a range of functionalities, from registration and ticketing to attendee engagement and feedback collection.

According to **Smith and Johnson (2019)**, Event Management Apps streamline the planning process by consolidating various tasks into a single platform. These apps can handle everything from scheduling and communication to data analytics and post-event reporting, making them invaluable for event planners.

Moreover, Event Management Apps enhance attendee engagement by providing personalized experiences. As noted by Allen et al. (2020), these apps can send push notifications, provide real-time updates, and facilitate networking through integrated social media features. This level of engagement helps maintain attendee interest and improves the overall event experience.

2.6. Interactive Floor Planning Software

Interactive floor planning software has replaced traditional methods of event layout design, such as paper maps and diagrams. These digital tools offer higher accuracy and improved logistics management.

Research by Cialdini and Goldstein (2004), demonstrates that interactive floor planning software allows event planners to create detailed and accurate event diagrams. These tools enable planners to visualize the event space, optimize the layout, and ensure efficient use of available space.

Interactive floor planning software also enhances logistical coordination. As highlighted by Smith and Johnson (2019), these tools can simulate different layout scenarios, allowing planners to anticipate potential issues and make necessary adjustments before the event. This proactive approach leads to smoother event execution and a better experience for attendees.

2.7. Virtual Event Platforms

The rise of Virtual Event Platforms has been accelerated by the global COVID-19 pandemic, which necessitated a shift towards virtual and hybrid events. These platforms offer comprehensive solutions that extend beyond simple live streaming.

Davis and Clark (2021) discuss the evolution of Virtual Event Platforms, noting their ability to provide interactive features such as live participation, virtual booths, and audience interactions. These platforms enable event organizers to create engaging virtual experiences that mimic the richness of in-person events.

Furthermore, Virtual Event Platforms offer significant advantages in terms of accessibility and scalability. As noted by Freeman and Spenner (2012), virtual events can reach a global audience, overcoming geographical limitations and reducing the costs associated with travel and accommodation. This accessibility makes virtual events an attractive option for both organizers and attendees.

2.8. The Symbiotic Relationship Between Technology and Event Management

The integration of technology in event management is not just an enhancement but a necessity. Technology enables event planners to create more engaging, efficient, and memorable events, which are crucial in an increasingly competitive market.

Research by Getz and Page (2016) highlights the symbiotic relationship between technological advancements and the events industry. As technology continues to evolve, it brings new possibilities for innovation in event planning and management. This ongoing transformation underscores the importance of staying abreast of technological trends to leverage their full potential in event management.

3. THEORETICAL APPROACHES

3.1. Conceptual Framework

Comprehending the impact of technology on events necessitates a multifaceted conceptual framework that draws upon various theoretical perspectives and models. Aligned with our research inquiries that concentrate on the influence of AR and VR on attendee engagement, service delivery, and strategic decision-making, we utilize multiple essential frameworks. For example, Dacko (2017), highlights the importance of mobile augmented reality (MAR) shopping apps from both the shopper's and retailer's perspectives, emphasizing the significance of technology-driven innovations in intelligent retail

environments. Scholz and Duffy (2018) empirically exhibit how consumers find relief when branded content is seamlessly incorporated into physical contexts, transforming consumer-brand connections through augmented reality encounters. Furthermore, Ryu and Lee (2018) examine three theoretical perspectives to elucidate the dynamics of technological progress in service innovation, enhancing the conceptual framework with valuable insights spanning various service sectors. These frameworks direct our exploration into the specific influences of AR and VR on key aspects of events, such as attendee engagement, service delivery, and strategic decision-making.

3.2. Theoretical Perspectives on Technology in Events

The landscape of theories concerning technology in events encompasses digital platforms, enterprise engineering, and strategic technology management. Resca et al. (2013) have put forth an all-encompassing framework that merges three viewpoints to clarify digital platforms as instigators for organizational and strategic metamorphosis. Sahoo et al. (2010) utilize Interpretive Structural Modeling (ISM) and Matrice d'Impacts Crois´es Multiplication Appliqu´ee `a un Classement (MICMAC) methodology to conceptualize strategic technology management, thereby offering strategic insights. Nosalska and Mazurek,(2019) introduce a framework for marketing principles in Industry 4.0, presenting a novel approach to shaping marketing strategies. These perspectives collectively enhance our understanding of technology's role in propelling strategic and organizational transformations.

4. METHODOLOGY

This study utilizes secondary data analysis to investigate the impact of technological innovations on the event management industry. By analyzing existing literature, industry reports, case studies, and other relevant documents, the study aims to provide a comprehensive understanding of how Augmented Reality (AR), Virtual Reality (VR), Event Management Apps, interactive floor planning software, and Virtual Event Platforms are utilized in event planning and management.

4.1. Research Design

The research design for this study involves the systematic review and analysis of secondary data sources to address the research objectives and questions. This approach allows for an in-depth exploration of existing knowledge and trends within the industry without the need for primary data collection.

4.2. Research Questions

The study seeks to answer the following research questions:

1. How do AR and VR technologies improve the overall experience and engagement at events?
2. In what ways do Event Management Apps facilitate event-oriented interactions compared to traditional social media platforms?
3. What are the advantages of using interactive floor planning software over traditional paper-based methods in event planning?
4. How do Virtual Event Platforms enhance audience interaction and participation in virtual and hybrid events?
5. What is the impact of technological advancements on the efficiency, engagement, and overall quality of event planning and management?

4.3. Data Collection Methods

Secondary data collection undertakes a meticulous review of academic literature, industry publications, and social media data. The academic literature review encompasses research articles and case studies, delving into the existing body of knowledge surrounding technology in event management and AR/VR. This systematic exploration of secondary sources contributes valuable context and depth to the overall research endeavor.

4.4. Data Analysis Methods

The analysis of secondary data involves a structured approach comprising several key steps. Initially, thematic analysis is conducted to identify and categorize themes and patterns that emerge from the literature and data sources, such as AR/VR applications, benefits of event management apps, advantages of interactive floor planning, and features of virtual event platforms. This is followed by a comparative analysis, where findings across different sources are compared to identify common trends, contradictions, and gaps in the literature. Subsequently, the findings are synthesized to provide a coherent narrative that addresses the research questions and objectives, integrating insights from various sources to draw comprehensive conclusions about the impact of technology on event management. Finally, a critical evaluation is performed to assess the reliability and validity of the secondary data sources, considering potential biases and limitations.

5. RESULTS AND DISCUSSION

This section presents the findings from the secondary data analysis on the impact of technological innovations in the event management industry. The discussion is structured around the key themes identified in the research questions: AR and VR technologies, Event Management Apps, interactive

floor planning software, Virtual Event Platforms, and the overall impact of technological advancements on event management.

5.1. Augmented Reality (AR) and Virtual Reality (VR) Technologies

Findings:

- **Enhanced Event Experiences:** AR and VR technologies have significantly improved the overall experience and engagement at events. AR enables attendees to interact with digital information overlaid on the physical environment, providing real-time updates, navigation assistance, and interactive exhibits. VR offers immersive experiences, such as virtual tours and interactive presentations, that transport attendees to a different environment (Jones, 2021; Brown, 2022).
- **Increased Engagement:** Studies show that events utilizing AR and VR report higher levels of attendee engagement and satisfaction. These technologies facilitate a more interactive and dynamic experience, which is particularly beneficial for trade shows, exhibitions, and educational seminars (Guttentag, 2010; Carmigniani et al., 2011).

Discussion:

The integration of AR and VR technologies into event management offers significant advantages. AR's ability to overlay digital information onto the real world enhances spatial awareness and navigation within event venues, leading to smoother logistics and a more enjoyable attendee experience. VR's immersive capabilities provide unique opportunities for remote participation, allowing attendees to experience events virtually when physical attendance is not possible. These technologies not only enhance engagement but also expand the reach of events to a global audience.

5.2. Event Management Apps

Findings:

- **Streamlined Planning Processes:** Event Management Apps consolidate various tasks into a single platform, streamlining the planning process. These apps handle registration, ticketing, scheduling, communication, and data analytics, making them invaluable tools for event planners (Smith & Johnson, 2019).
- **Personalized Attendee Experience:** The apps enhance attendee engagement by providing personalized experiences. Features such as push notifications, real-time updates, and integrated

social media facilitate networking and keep attendees informed, improving their overall satisfaction (Allen et al., 2020).

Discussion:

Event Management Apps are crucial for modern event planning and management. By centralizing all aspects of event planning, these apps reduce administrative burdens and improve efficiency. The ability to provide personalized experiences through these apps enhances attendee engagement and satisfaction, making them a vital tool for successful event management. Additionally, the data analytics capabilities of these apps offer valuable insights into attendee behavior and event performance, enabling continuous improvement.

5.3. Interactive Floor Planning Software

Findings:

- **Improved Accuracy and Logistics:** Interactive floor planning software allows for precise and detailed event diagrams, optimizing the layout and ensuring efficient use of space. These tools can simulate different scenarios, helping planners anticipate potential issues and make necessary adjustments (Cialdini & Goldstein, 2004; Smith & Johnson, 2019).
- **Enhanced Visualization:** The software provides a visual representation of the event space, which aids in planning and communication with stakeholders. This visualization capability helps in maximizing space utilization and improving overall event logistics (Smith & Johnson, 2019).

Discussion:

The transition from traditional paper-based methods to interactive floor planning software represents a significant advancement in event management. The precision and flexibility offered by these digital tools enhance logistical coordination and space utilization, leading to smoother event implementation. The visual representation of event layouts facilitates better communication and collaboration among event planners, vendors, and clients, contributing to more effective planning and execution.

5.4. Virtual Event Platforms

Findings:

- **Comprehensive Solutions:** Virtual Event Platforms provide a wide range of interactive features, such as live participation, virtual booths, and audience interactions. These platforms go beyond

simple live streaming, offering an immersive and engaging virtual event experience (Davis & Clark, 2021).

- **Increased Accessibility and Scalability:** Virtual events can reach a global audience, overcoming geographical limitations and reducing costs associated with travel and accommodation. This makes virtual events more accessible and scalable, attracting a broader audience (Freeman & Spenner, 2012).

Discussion:

The rise of Virtual Event Platforms has transformed the way events are conducted, particularly in response to the COVID-19 pandemic. These platforms offer comprehensive solutions that replicate the richness of in-person events, enhancing engagement and interaction. The increased accessibility and scalability of virtual events make them an attractive option for both organizers and attendees. As technology continues to evolve, Virtual Event Platforms will likely become even more sophisticated, further enhancing the virtual event experience.

5.5. Overall Impact of Technological Advancements

Findings:

- **Increased Efficiency and Engagement:** The integration of technological innovations, such as AR, VR, Event Management Apps, interactive floor planning software, and Virtual Event Platforms, has significantly increased the efficiency and engagement of event planning and management (Getz & Page, 2016).
- **Continued Transformation:** The events industry is continuously evolving with technological advancements, leading to new opportunities for innovation and improvement. Staying abreast of these trends is crucial for event planners to leverage their full potential (Getz & Page, 2016).

Discussion:

Technological innovations have become integral in the practice of contemporary event management. This allows for tools and solutions that are bringing improvements in efficiency, engagement, as well as overall quality of the events. With each passing day, the dynamic setting of today and its advancement open endless opportunities for innovation, which is why being on par with both trends and technology bears significance for all planners. Key for future success in the industry is the integral integration of technology with event management.

CONCLUSION

Based on a secondary data analysis, the paper discussed the transformation wrought on the event management industry due to technological innovations. Below is a summary of findings.

1. **AR and VR Technologies:** Augmented reality and virtual reality technologies have taken the experience of events and engagements of the participants to a whole new level by interactive and immersive exposure. Dynamic event environments, real-time updates, and remote participation can be made possible using these technologies.
2. **Event management applications** simplify event planning by providing one source for most of these tasks, personalizing experiences for each user, and offering valuable data analytics that enhance efficiency and attendee engagement.
3. **Interactive Floor Planning Software:** This software is in use to increase the accuracy of event diagramming, maximize space usage, and contribute to operational coordination. It provides features with the help of visual representations that ease the process of better planning and communication.
4. **Virtual Event Platforms:** End-to-end solutions that go beyond simple live streaming and come with interactions, making events more accessible and scalable. This enables the creation of global reach and immersive virtual experiences.
5. **Overall Technological Impact:** Improvement in technology has led to efficient, highly involved, and quality management of events. The key drivers for innovation and change have been consistent to the point that future success still maintains technology integration as a vital factor.

6.2. Implications

Several very important implications arise from the use of technological innovations in the management of events:

- **Augmented Attendee Experience:** With the help of AR, VR, and Event Management Apps, experiences can be better made more engaging, and personalized hence resulting in higher satisfaction for the attendees.

- **Better Coordination and Efficiency:** An interactive floor planning software and an event management application facilitate the process flow, alleviate the administrative burden, and improve logistical coordination of the implementation of events.
- **Expanded Reach and Accessibility:** With Virtual Event Platforms, events can be accessed globally and without limitations. They allow for scalable solutions that would accommodate a large number of participants.
- **Continuous Innovation:** The rapidly evolving technological scenario calls for constant innovation and change within the event management industry. Therefore, event planners need to remain updated with all the latest tools and trends to maximize their potential.

Suggestions for Future Research

Valuable insights may be derived from this study, but some areas need to be further pursued:

1. **Longitudinal Studies:** Future research could explore the possibility of carrying out longitudinal studies to trace the long-term influences of certain specific technologies on event management practices and their outcomes.
2. **Comparative Studies:** Comparative studies between different technologies or platforms could provide a deeper understanding of their relative effectiveness and best use cases.
3. **Impact on Different Types of Events:** Technological innovations may differentially impact different types of events, such as corporate events, trade shows, festivals, and private events.
4. **User Experience Analysis:** In-depth user experience studies will illuminate how end-users interact with and perceive the varied technological tools, enabling better design and implementation.
5. **Cost-Benefit Analysis:** To firmly invest in technology, planners might want to investigate the cost and assess the relative value of deploying the different technologies in the event management process.

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Exploring the Challenges and Barriers to Adopt Sustainable Green Practices: A study of Delhi NCR Hotels

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Abstract

Sustainable development is the urgency of the world. Sustainable Green practices in the hospitality sector are also becoming important due to rising environmental concerns and regulatory pressures. This study explores the challenges and barriers in adoption of green practices in hotels in Delhi NCR. However, the adoption and sustained implementation of such practices face numerous challenges, especially in regions like Delhi NCR. This study investigates the primary barriers to adopting green practices in hotels in Delhi NCR, focusing on economic, institutional, and cultural dimensions. It follows exploratory methodology and data has been collected through qualitative interviews with managers of 12 hotels and through the analysis of available literatures from authentic sources. A finding of the study basically focuses over the economic support, government policies, trainings of the employees, etc. This study identifies key areas and provides recommendations for stakeholders to overcome these challenges. The findings underscore the need for policy support, stakeholder collaboration, and awareness campaigns to foster sustainable practices.

Keywords: Green practices; Sustainability; Hotels; Delhi NCR; Challenges.

1. Introduction

Sustainability concerns have become a major consideration for most industries and the hospitality industry is profiled as one of the areas where the impact on the environment is great. Hotels use large amounts of energy and water and produce a lot of waste, thus there is the need for the implementation of green practices. However, even as awareness and regulations are increasing, hotels in Delhi NCR continue to face challenges that hinder their efforts towards going green.

Delhi and the cities around it, which together are called the National Capital Region (NCR), is an important area for hotels and hospitality services. Because of its social and economic importance,

dealing with the sustainability problems in particular regions of hospitality industries can provide a model for other regions in the country. This research focuses on the implementation of green practices in 12 hotels of Delhi NCR region by means of qualitative interviews to understand the economic, institutional, and cultural challenges that these institutions face.

1.2. Research Objectives

- To identify the key challenges faced by hotels in adopting green practices in Delhi NCR.
- To analyze the role of economic, institutional, and cultural factors in sustaining these practices.
- To recommend strategies for enhancing the adoption and continuity of green practices.

2. Literature Review

2.1. Global Perspective on Green Practices in Hospitality

The hospitality industry worldwide is increasingly prioritizing sustainability. Research indicates that adopting eco-friendly practices not only boosts brand image but also lowers operational expenses and enhances guest experiences. For example, Merli et al. (2019) pointed out that green initiatives resonate with guest expectations, resulting in greater satisfaction. Nevertheless, challenges such as high upfront costs and a lack of regulatory support impede broad implementation (Bohdanowicz, Zientara, & Novotna, 2011).

In India, the hospitality industry's stance on sustainability differs widely. While major cities like Bengaluru and Mumbai have made strides in green initiatives, the Delhi NCR region encounters distinct hurdles related to its climate, regulatory intricacies, and elevated operational costs. According to Kaur (2021), economic feasibility and low awareness among stakeholders remain significant impediments to adopting sustainable practices in Indian hotels. Studies like Singhal et al. (2018) and Sharma et al. (2018) further highlight the role of policy clarity and stakeholder collaboration in overcoming these barriers.

2.2.Economic Barriers

2.2.1. Initial Investment Costs

The high initial costs of implementing green technologies, such as energy-efficient lighting, water recycling systems, and waste management solutions, were identified as a significant barrier. Of the 12 hotels interviewed, 10 cited limited access to affordable financing as a critical issue. Al-Aomar and

Hussain (2017) observed similar challenges in their study of hotel supply chains in the UAE, underscoring the universal nature of financial barriers.

2.2.2. Operational Costs

While green practices promise long-term savings, the operational costs associated with maintaining eco-friendly systems deter smaller hotels. For instance, one manager stated, “We understand the benefits, but the ongoing costs are unsustainable without government support.” This aligns with findings from Abdou, Hassan, and El Dief (2020), who emphasize the need for financial incentives to support green initiatives.

2.3.Institutional Barriers

2.3.1. Regulatory Ambiguities

Policy inconsistency emerged as a major concern. Hotel managers highlighted the lack of clear guidelines and the absence of robust monitoring mechanisms. Eight respondents expressed frustration over the irregular enforcement of environmental regulations, making it difficult to plan long-term sustainability projects. This finding echoes Yusof and Jamaludin (2014), who documented similar issues in Malaysian green hotels.

2.3.2. Lack of Incentives

Hotels in Delhi NCR do not receive adequate incentives for adopting green practices. Compared to international counterparts, Indian hotels often operate in a policy vacuum, discouraging proactive environmental efforts. This sentiment was also observed in research by Khalil et al. (2024) and Chaini et al. (2024), which advocate for stronger institutional support.

2.4.Cultural & Other Barriers

2.4.1. Resistance to Change

Resistance to change among both staff and guests was a recurring theme. Managers from 7 hotels noted difficulties in convincing employees to adopt new operational routines aligned with sustainability goals. Similarly, guests often perceive green practices as compromises on luxury. Verma and Chandra (2018) highlight the importance of aligning staff training and guest communication to mitigate these challenges.

2.4.2. Awareness and Training

Limited awareness and training further exacerbate cultural barriers. Only 4 of the 12 hotels reported conducting regular training sessions for staff, highlighting a critical gap in capacity building. According to Shanti and Joshi (2022), comprehensive training programs can significantly enhance the adoption of green practices. Additionally, Gunduz Songur et al. (2023) suggest integrating green technology education into hospitality curricula.

2.4.3. Comparative Insights

Hotels in Delhi NCR lag behind those in cities like Bengaluru, where proactive policies and stakeholder engagement have fostered better adoption of green practices. Prakash et al. (2023) underscore the role of localized solutions and community involvement in overcoming sustainability challenges. Mathur et al. (2019) further highlight how consumer preferences in metropolitan regions like Delhi can drive the adoption of sustainable practices.

3. Methodology

3.1. Research Design

This study employs a qualitative research design, focusing on in-depth interviews with hotel managers and a thematic analysis of the data. Primary data was collected from 12 hotel's representatives across various categories in Delhi NCR, ensuring diversity in operational scale and resources. Semi-structured interviews were conducted with 12 hotel managers to explore their perspectives on challenges in adopting and sustaining green practices. Industry reports, journal articles, and government policies were reviewed to contextualize the findings and support the analysis.

3.2.Data Analysis

The interview data was analyzed using thematic analysis to identify recurring themes and patterns. Statistical method used to analyse the data.

4. Findings & Results Analysis

The analysis of responses from the qualitative interviews with 12 hotel managers in Delhi NCR revealed the following key findings:

Section	Question	Key Responses	Percentage/Response
Section 1: General	1. What is the	Hotels ranged from 3-	60% were 4-star

Information	name and category (star rating) of your hotel?	star to 5-star categories.	hotels; 40% 3-star and 5-star hotels.
	2. How long has your hotel been operational?	Hotels had operational experience ranging from 5 to 20+ years.	50% operational for 10–20 years; 30% for 5–10 years.
	3. What is your role in the organization, and how long have you been associated with it?	Respondents were primarily General Managers or Sustainability Heads with 5–15 years of experience.	70% had more than 5 years of experience.
Section 2: Current Green Practices	4. Does your hotel currently implement any green practices? If yes, please specify.	Common practices included energy-efficient lighting, water conservation, and waste management.	80% implemented at least basic green practices.
	5. What motivated your hotel to adopt sustainable practices?	Regulatory compliance and corporate social responsibility were primary motivators.	60% cited regulatory pressures; 40% CSR and branding.
	6. Are there specific areas where green practices have been prioritized?	Energy efficiency and water conservation were most prioritized areas.	70% prioritized energy; 60% water conservation.
Section 3: Challenges in Adoption	7. What are the main economic barriers your	High initial costs and lack of financial incentives were major	75% cited cost; 60% mentioned lack of incentives.

	hotel faces when adopting green practices?	economic barriers.	
	8. Are there any institutional challenges, such as lack of policy clarity or support?	Policy clarity and enforcement were inconsistent and hindered implementation.	65% expressed dissatisfaction with institutional support.
	9. How do cultural or social perceptions influence your hotel's green initiatives?	Staff resistance and limited guest awareness were key cultural barriers.	50% noted staff resistance; 40% guest indifference.
Section 4: Support and Recommendations	10. Have you received any financial support for implementing green practices?	Limited financial support was reported.	Only 20% received subsidies or grants.
	11. What kind of support would be most helpful to improve adoption?	Financial aid, training programs, and clear policy guidelines were highlighted as crucial.	70% emphasized financial support; 50% training programs.
	12. What role do you think stakeholder collaboration can play in overcoming challenges?	Stakeholder collaboration was deemed essential for knowledge-sharing and financial assistance.	60% recommended stronger collaborations.

Section 5: Awareness and Training	13. Are your employees trained or made aware of green practices?	Regular training programs were infrequent.	40% conducted periodic training sessions.
	14. Do you believe guest awareness influences your hotel's sustainability initiatives?	Guest preferences were considered moderately influential.	50% indicated guest awareness as a factor.
Section 6: Outcomes and Sustainability	15. What positive outcomes has your hotel experienced after adopting green practices?	Outcomes included cost savings, improved branding, and higher guest satisfaction.	60% cited branding; 50% cost savings; 40% guest satisfaction.
	16. Are these outcomes sufficient to encourage continued implementation?	Outcomes were motivating but required sustained support for scalability.	70% found outcomes encouraging but needed ongoing aid.

5. Discussion

The findings highlight that while hotels in Delhi NCR are increasingly aware of the importance of sustainable green practices, significant barriers hinder widespread adoption. Economic constraints remain the most pressing issue, as high costs and limited access to financial support deter investment in green technologies. This aligns with global studies, which also underscore the need for economic incentives to drive sustainability in the hospitality sector.

Institutional barriers further complicate the landscape, as unclear or inconsistent government policies leave hotel managers uncertain about compliance and long-term benefits. These findings emphasize the importance of robust policy frameworks tailored to the needs of the hospitality industry.

Cultural and social resistance presents another critical challenge. A lack of awareness among employees and guests reduces the overall effectiveness of green initiatives. Training programs and guest engagement campaigns could address these gaps by fostering a culture of sustainability within hotels.

Stakeholder collaboration emerged as a key area for improvement. Establishing partnerships between hotels, NGOs, and government agencies could provide the necessary resources and expertise to overcome existing barriers. Successful examples from other regions suggest that such collaborations can lead to significant improvements in sustainability practices.

The results underscore the need for targeted strategies, including economic support, policy clarity, employee training, and stakeholder collaboration, to accelerate the adoption of green practices in Delhi NCR hotels. These initiatives can serve as a model for other regions in India, promoting sustainable development in the hospitality sector.

6. Suggestions & Recommendations

Policy interventions should focus on developing clear and consistent guidelines for green practices while offering financial incentives, such as subsidies and tax rebates, to encourage hotels to adopt sustainable measures. Stakeholder collaboration can be enhanced by fostering partnerships between government bodies, NGOs, and hotel associations to create a supportive ecosystem for sustainability. Additionally, knowledge-sharing platforms should be encouraged to promote the exchange of best practices. Regular training programs are essential for building staff capacity and addressing resistance to change, while guest awareness campaigns can help align customer expectations with green initiatives. Economic support can be provided through access to low-interest loans and grants for hotels investing in green technologies, along with the establishment of public-private partnerships to alleviate the financial burden on individual establishments.

7. Conclusion

Addressing the challenges to adopting green practices in Delhi NCR hotels requires a multifaceted approach that combines economic, institutional, and cultural interventions. This study, based on primary data from 12 hotels, highlights the critical barriers and provides actionable recommendations for

stakeholders. By fostering policy clarity, enhancing stakeholder collaboration, and building awareness, Delhi NCR's hospitality sector can make significant strides toward sustainability.

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Impact of Digital Transformation on Employee Engagement & Productivity

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Abstract

The developmental change and widespread application of modern digital technologies and tools, as well as their widely used application, have changed the working environment and working conditions of employees. For that reason, traditional approaches and methods are being repositioned and changed in order to become more intelligent and agile. As a result, activites related to employee engagement, like concepts, methods, and practices, must be reexamined and adapted to the needs of the new workplace. Modern technologies enable remote work, flexible working hours, more challenging and interesting tasks, but also lead to a variety of challenges among which are technologically caused stress, over-reliance on technology, work life conflict, and burnout syndrome. To meet the challenges of digital transformation, organization needs highly motivated and engaged human resource at all the level of business operations. This paper aims to examine the diverse effects of digital transformation on organizational management, specifically focusing on productivity, employee engagement, and innovation. Most of the organizations in the present complex business era have realized the dynamic nature of business and looking how information technologies are bringing digital transformation. In the present exploratory study, an attempt is made to analyze the digital transformation and its impact on employee's engagement. The research provides valuable insights for managers to understand the relationship between digital transformation and employee's engagement and how much these components affect in strengthening employee's engagement. Some of the suggestions and recommendation are made to examine the generalizability of finding in other organization in broader applications.

Keywords :- Digital Transformation, Employee Engagement, Employee Productivity, Innovation

Introduction

Every area, whether public and private, is undergoing a digital transition (DT). According to the European Commission, the 2030s will be known as the "digital decade," when the corporate fabric will undergo changes in its business models because of the DT process. As digital technology became the principal means for many workers to stay connected and productive, a slow transition toward remote working for organizations that had already been going on for decades was abruptly accelerated (Ozimek, 2020). Since early evidence indicates increased productivity within specific industries and roles, and larger levels of remote working are anticipated in the future, many believe that this transition will not be reversed (Bartik et al., 2020). Both managers and employees' long-standing opposition to remote work seems to have crumbled as a result of the change in work style (Colley & Williamson, 2020).

Suciaji et al. (2023) assert that digital transformation will significantly improve an organization's capacity for innovation in its operational performance. Employees are expected to perform effectively and pick up new skills and abilities in keeping with current trends & technological breakthroughs during this era of change that is driving organizations toward digitalization. The digital transformation of a business has a significant effect on employee performance, which in turn affects productivity (Shwedeh et al., 2023).

In the context of the Fourth Industrial Revolution, digital transformation (DT), an organization-wide endeavor to improve processes for all stakeholders through the adoption of digital technology, is no longer only a fad but a requirement. Corporate culture and leadership are essential for facilitating digital transformation and improving worker performance (Suciaji et al., 2023). Peak performance from employees may be facilitated by a company culture that supports and fosters individual work discipline and supportive leadership (Wijono, 2018). The digital transformation that organizations are going through will continue as long as existing technology enables it, and this will have a big impact on innovation in the business's operational performance. The organization's ability to fulfill its vision and mission depends heavily on the creativity and experience of its workforce. They may help a company succeed when paired with their dedication, drive, and creative solutions and ideas. Employees that actively participate in the digital transformation process are not only beneficiaries of the change but also help to ensure that it is implemented successfully at all organizational levels.

A plan for human capital development is essential for addressing the difficulties posed by digital transformation. Organizations must take important actions to guarantee that their human resources remain current and capable of keeping up with technological advancements in the face of such rapid developments. First and foremost, companies need to thoroughly evaluate the talents needed in this

digital age and pinpoint any skill shortages in their workforce. They should then provide suitable training and development to assist staff in enhancing their skills and fulfilling the demands of the company. Additionally, this may entail employing techniques like continuous training, certification, or technology training. Finally, companies must foster an atmosphere that helps workers adjust to change, promotes creativity, and inspires people to keep learning and participating in the possibilities and challenges presented by digital transformation. Businesses may maximize employee potential and stay competitive in the rapidly evolving digital age by including a thorough human resource development plan.

Review of Literature

Employee Engagement

The degree of zeal and dedication that workers have for their jobs and company is known as employee engagement. Since digital transformation alters how workers connect with their jobs, coworkers, and the company overall, it may have a significant effect on engagement. Digital technologies can, on the one hand, improve employee engagement by giving workers greater freedom, improved lines of communication, and chances for individualized training and growth. However, improper management of digital change can result in employee disengagement, loneliness, and digital weariness.

Tawas (2022) defines employee performance as the amount of effort an employee puts forth in doing the tasks assigned to him and the results that an individual or group within an organization produces within a given time frame. Improving the organization is the aim of performance management for high-scoring personnel. Performance is the result of an employee's quantity and quality of work, or a person's capacity to fulfill duties in accordance with their assigned responsibilities to accomplish organizational goals in a manner that conforms to the organization's established morals, ethics, and legal requirements, according to Sutar in Manunggal (2020).Employee performance is the level of achievement and output that employee attains in carrying out their duties within a specified time. This may be evaluated by examining how well the employee accomplishes set goals, how well they carry out their duties effectively and efficiently, and how much they contribute to the aims of the businessSari (2023).

Conceptual Relationship between Digital transformation & Employee Engagement

An firm may gain a lot from digital transformation, including lower expenses, better customer satisfaction, and enhanced productivity. Employee engagement levels may be impacted, though, if it results in major changes to the way they operate.

Source: *Image: Starfish Taylorhttps://www.ir.com/guides/digital-workplace-strategy-guide-to-success*

Employee engagement may be impacted by digital transformation in the following ways:

- **Job role change:** When new technology is implemented, employees might have to pick up fresh competencies or embark on new duties. While some employees may find this exhilarating, others may find it daunting or overwhelming. Giving staff members proper training and assistance might boost their confidence in their new positions.
- **More cooperation:** Using collaborative devices and platforms that facilitate easier staff collaboration is a common aspect of digital transformation. Because they feel closer to their coworkers and the company, employees may become more engaged and have a feeling of shared purpose.
- **Greater autonomy:** Employees may have greater power and autonomy over their job as a result of the digital revolution. While some workers may find this uplifting, others may find it burdensome or frustrating. Employees might feel more at peace with their greater authority if clear expectations and boundaries are provided.
- **Remote work potential:** Digital transformation may also make remote work possible, which some employees may find to be quite advantageous. For certain workers, though, it can also be isolating, and new approaches to cooperation and communication could be needed.

What is an engaged worker?

A Utrecht University study found that engaged workers are more committed, take pride in their work, like it, and perform it better. Creating an atmosphere that inspires workers to want to engage with their work and their teams is another goal of the digital workplace. In the digital workplace of the twenty-first century, flexibility, change, and constant development are important to the roles of both employer and employee. If they could have the flexibility of hybrid working, 64% of workers would choose a lower-

How to empower workers: An employer's viewpoint: -

Gallup's State of the worldwide Workplace study states that employee engagement fell from 22% in 2019 to 20% in 2020 on a worldwide scale. Additionally, US businesses may lose up to $550 billion annually because of disengaged workers.Keeping those numbers in mind, if HR teams and management cultivate a digital workplace environment that results in long-term engagement, success may be written into their digital workplace strategy. Gaining workers' commitment to match their digital workplace with their values and employee empowerment is a crucial aspect of an employer's responsibility and a sound approach. This covers far more ground than just their pay.

Image: Qlearsite{https://www.ir.com/guides/digital-workplace-strategy-guide-to-success}

Engagement in the workplace: An Employees ‘ Perspective

When workers are engaged, it indicates that they sincerely care about and are enthusiastic about the success of their organization. They actively look for methods to be more inventive, creative, and cooperative because they feel appreciated and cared for during their employment experience. Additionally, highly engaged workers are more inclined to try out new procedures and systems and to embrace any changes in workplace strategy without protest.

Employees that are engaged are:

- They operate efficiently and are proud of their job.
- Devoted supporters of their place of employment
- Encouraged to be more inventive and productive
- Willing to share their thoughts and opinions
- Working together to achieve shared objectives and being eager for development able to communicate
- Supportive of management and coworkers

Digital Transformation & Employee Productivity: -

One of the main areas of attention for digital transformation is productivity, which is the effectiveness with which a company transforms inputs into outputs. By simplifying processes and lowering the need for manual involvement, automation, artificial intelligence, and advanced data analytics have the potential to greatly increase productivity. However, not all businesses will see the same level of productivity effect from digital transformation; this varies depending on the industry, the maturity of the digital technologies used, and the organization's capacity for change management.

The possibility of creating new value for the company is one advantage of digital technology. the consequences of the digital transition on workers' duties and output. According to research by Indriyani et al. (2023), the digital shift has a major influence on employee performance & skill levels. The digital transformation enables employees to focus on high-value work, streamline processes through automation, and complete tasks efficiently. In the wake of the digital revolution, employees need to learn novel abilities and skills to satisfy the needs of the organization. They must be able to stay up to date with the newest technological trends and breakthroughs in order to become more productive and efficient. According to research on the component of digital transformation, most employees think they have good digital skills, are fast to take advantage of opportunities, and have benefited from investing in the digital sector. This suggests that the majority of employees are satisfied with the implemented digital transformation. This skill enables individuals to comprehend and become proficient with a variety of digital devices and platforms that are used to boost efficiency and productivity in addition to operating digital apps utilized in the workplace. Furthermore, the findings demonstrate that PT Pelindo Regional 2 Cirebon staff members can react swiftly to novel chances.

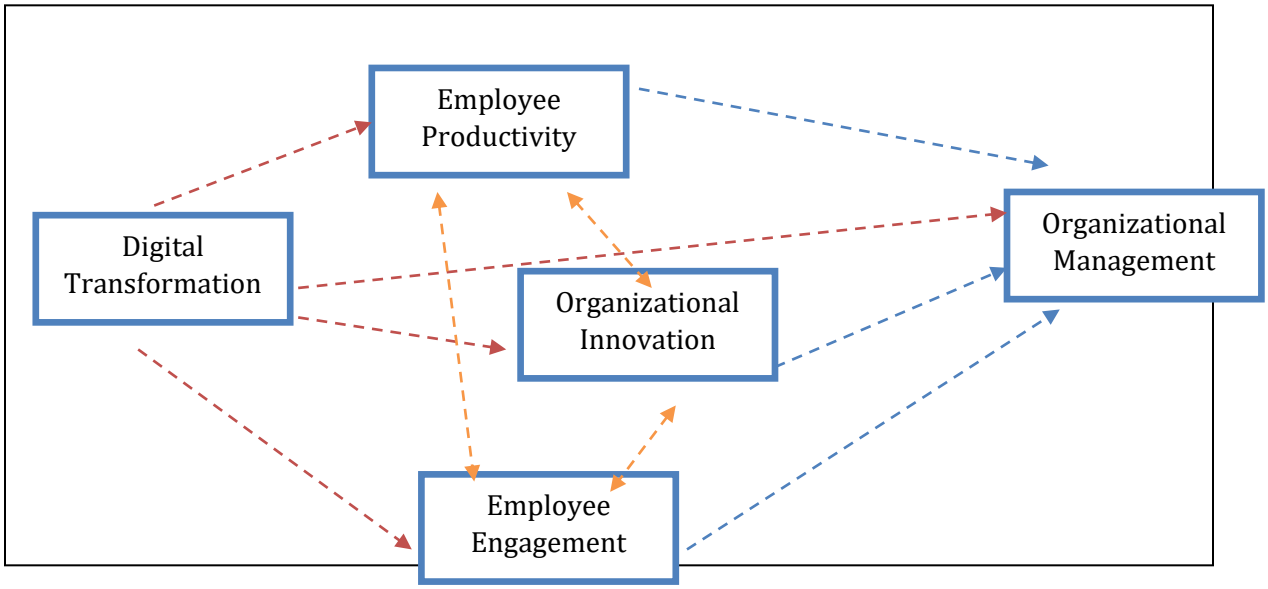
Influence on Innovation

The process of developing novel concepts, goods, or procedures that benefit a company is known as innovation. Because it gives businesses the data and resources they need to experiment, iterate, and launch new ideas faster, digital transformation is a major force behind innovation. But cultivating an innovative culture calls for more than just using digital technologies; it also entails promoting risk-taking, creativity, and teamwork. Finding the ideal balance between utilizing digital technology and upholding a human-cantered approach to innovation is a problem for many firms.

Effect on Productivity: One of the main areas of attention for digital transformation is productivity, which is the effectiveness with which a company transforms inputs into outputs. By simplifying processes and lowering the need for manual involvement, automation, artificial intelligence, and advanced data analytics have the potential to greatly increase productivity. However, not all businesses will see the same level of productivity effect from digital transformation; this varies depending on the

industry, the maturity of the digital technologies used, and the organization's capacity for change management.

Conceptual Framework of the Study:



Study Methodology:

This study uses a methodical approach to reviewing the literature in addition to analyzing actual data from industry reports and case studies. To guarantee that the conclusions are relevant considering the quickly changing digital ecosystem, the literature evaluation concentrates on research carried out starting in 2015. Relevance to the subjects of innovation, employee engagement, and productivity in the context of digital transformation is one of the selection criteria for research. Both quantitative and qualitative methodologies are used in the study of empirical data. Industry studies and surveys that offer metrics on innovation, engagement, and productivity in businesses that have experienced digital transformation are the source of quantitative data. Case studies that provide insights into the difficulties and achievements that businesses have encountered over their digital transformation journey.

Hypothetical Data Analysis w.r.t Productivity

Digital transformation has significantly increased productivity in the industrial industry. For instance, a major manufacturing business used AI-driven analytics in conjunction with IoT-enabled sensors on its production line to track the operation of its machinery in real time. Overall productivity increased by 25% because of the company's ability to anticipate and stop equipment problems. Nevertheless, the shift necessitated a large initial investment in staff training and technology. Employees who were worried about their job security also initially opposed the firm, but these worries were mostly allayed by open communication and retraining initiatives.

To improve efficiency, a large financial services organization implemented a computerized workflow management system. Routine jobs including data input, document processing, and customer support questions were automated by the new system. Consequently, the business reported a 30% decrease in processing times, which increased customer satisfaction by 20% and increased productivity. There were difficulties with the system's deployment since it necessitated redesigning the organization's current procedures and changing its culture to be more transparent and accountable.

Table 1 presents hypothetical data on productivity changes after digital transformation in various sectors.

Hypothetical Productivity Changes Across Sectors Post-Digital Transformation.			
Sector	Pre-Transformation Productivity Index	Post-Transformation Productivity Index	% Change
Manufacturing	85	106	24.7
Financial Services	90	117	30
Healthcare	78	95	21.8
Retail	82	102	24.4

Hypothetical Graph: The graph below shows the employee engagement score changes before and after digital transformation in different work models

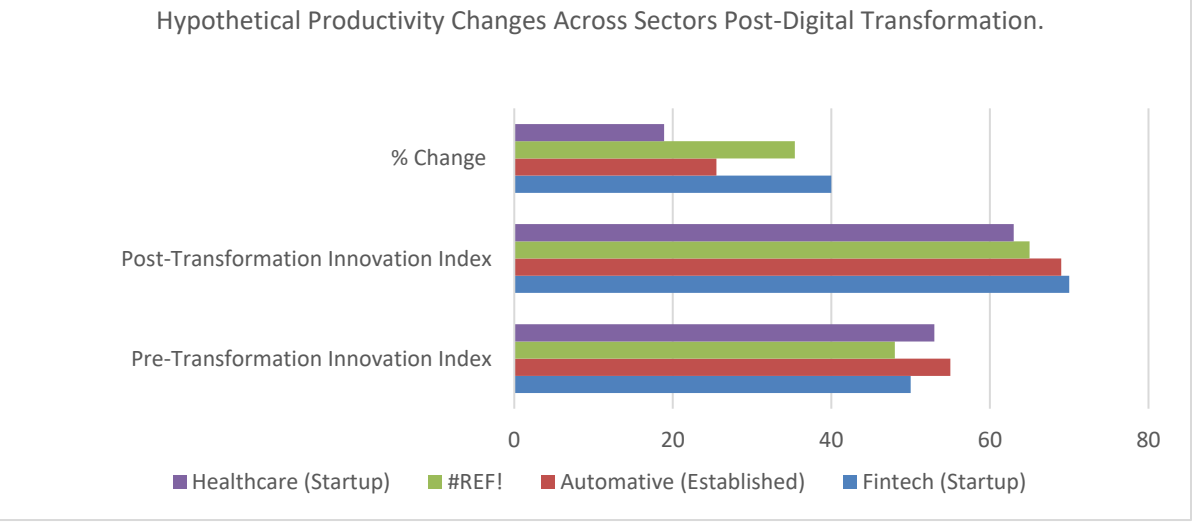


Table 2: Hypothetical Productivity Changes graph Across Sectors Post-Digital Transformation.

Analysis of Empirical Data Organizations that have completely embraced digital transformation claim an average productivity rise of 15-20%, according to quantitative research of productivity parameters across a variety of industries. The automation of repetitive processes, the use of sophisticated data analytics for decision-making, and the capacity to promptly adjust to market developments are all

credited with this improvement. Nonetheless, it is impossible to ignore the difficulties posed by digital transition. Organizations frequently encounter opposition to change, high implementation costs, and the requirement for ongoing technological investment. Furthermore, companies frequently see a brief decrease in productivity during the early phase of implementation as staff members get used to new tools and procedures. This means that the advantages of digital transformation won't be immediately felt.

Hypothetical Data Analysis w.r.tEmployee Engagement:

Using digital collaboration technologies including cloud-based file sharing, project management software, and video conferencing, a technology company effectively made the shift to a totally remote work style. Regular employee surveys showed that staff engagement increased by 15% because of the change. Workers cited improved autonomy and work-life balance as major elements influencing their higher levels of engagement. Nonetheless, the company acknowledged the necessity of addressing some drawbacks of working remotely, such loneliness and the fuzziness of work-life borders. The company used virtual team-building exercises and offered resources for mental health help to lessen these problems.

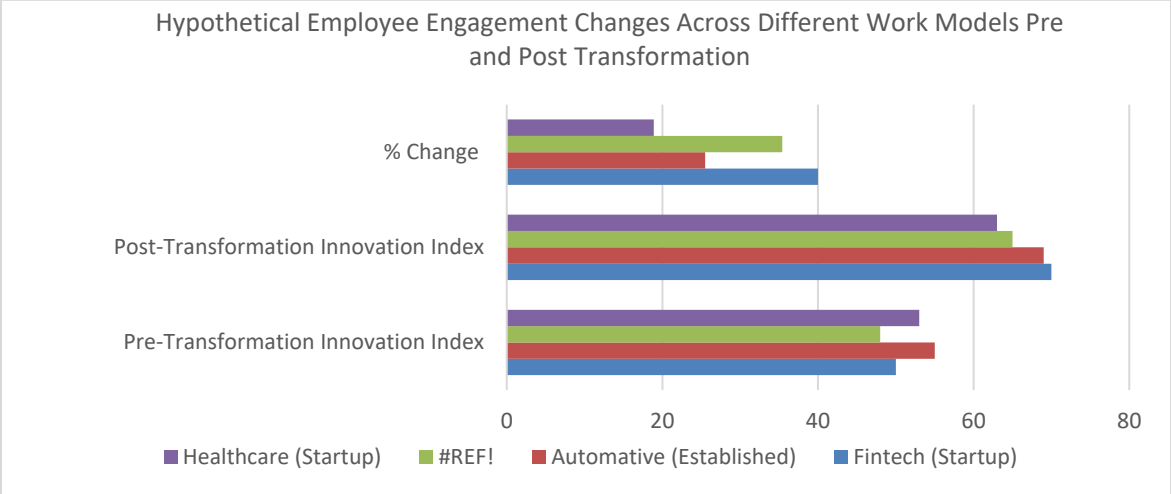
A global company implemented a hybrid work paradigm that permits staff members to alternate between working in the office and working remotely. To keep the workforce cohesive and guarantee efficient communication between several locations, the organization made use of digital tools. Although overall employee involvement increased and many workers expressed gratitude for the flexibility, some said it was difficult to keep motivated and build personal relationships. To allay these worries, the organization encouraged managers to keep lines of communication open with their personnel and promoted frequent in-person meetings.

Table :3 provides hypothetical data on employee engagement changes after digital transformation (Author)

Hypothetical Employee Engagement Changes Across Different Work Models			
Sector	Pre-Transformation Engagement Score	Post-Transformation Engagement Score	% Change
Technology Firm	70	80	14.3
Multinational Corporation	68	76	11.8
Retail Chain	60	65	8.3

Healthcare Provider (Hybrid)	65	72	10.8

Hypothetical Graph: The graph below shows the employee engagement score changes before and after digital transformation in different work models



Employee engagement has increased by 10–12% in companies undergoing digital transformation, according to data from many industry studies. The main forces behind this increase are digital technologies that facilitate communication, enable flexibility, and present chances for skill growth. However, how effectively organizations handle the shift will determine how successful these programs are. The total effect on engagement is determined by a number of factors, including the management of digital weariness, the availability of support for staff, and the inclusion of digital technologies.

When it comes to employee engagement, the challenges of digital transformation include making sure that every person has access to the digital tools they need, resolving privacy and data security issues, and avoiding digital fatigue. Additionally, companies need to be aware of how technology may depersonalize relationships at work, which might have a detrimental effect on employee engagement and morale.

Hypothetical Data Analysis w.r.t Innovation:

Innovation and digital transformation are frequently used interchangeably in the startup environment. A fintech start-up quickly prototyped and tested new financial solutions by utilizing digital platforms. The business gained a competitive edge in the market by cutting its product development time by 40% through the use of cloud computing, big data analytics, and artificial intelligence. The success of the start-up was largely dependent on its capacity to iterate rapidly and react to client feedback. But in order

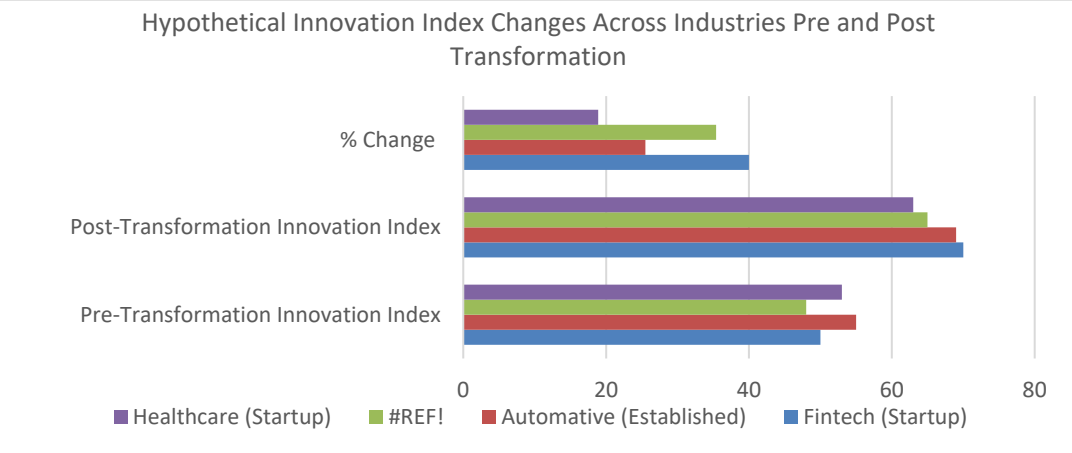
to keep ahead of the competition, the business also had to deal with issues pertaining to data protection and the requirement for constant innovation.

To spur innovation in its product development process, a conventional automobile company adopted digital transformation. The business used cloud computing, artificial intelligence, and the Internet of Things to build a networked platform that made it easier for people in different departments and places to collaborate. As seen by the quantity of new trademarks filed and goods introduced, the company's innovation output grew by 25% consequently. Additionally, the corporation was able to better understand client wants and adjust its goods because of the digital tools. Nonetheless, the business encountered opposition from certain staff members used to more conventional methods of operation, underscoring the need for change management in the process of digital transformation.

Table 4: presents hypothetical data on innovation metrics after digital transformation in various industries

Hypothetical Innovation Index Changes Across Industries			
Sector	Pre-Transformation Innovation Index	Post-Transformation Innovation Index	% Change
Fintech (Startup)	50	70	40
Automative (Established)	55	69	25.5
Healthcare (Startup)	48	65	35.4
Retail (Established)	53	63	18.9

Hypothetical Graph: The graph below illustrates innovation index changes across different industries before and after digital transformation.



According to empirical evidence, digital transformation has been associated with a 20–25% boost in innovation capacity, especially in sectors that place a high value on collaborative work environments and data-driven decision-making. Businesses can experiment, iterate, and launch new ideas faster thanks to digital tools like artificial intelligence (AI), big data analytics, and cloud computing. Additionally, these tools break down walls and promote an innovative culture by facilitating communication across departments and geographical regions.

Nonetheless, there are a lot of difficulties with digital transformation when it comes to innovation. Common obstacles that organizations encounter include cultural reluctance to change, the difficulty of integrating new technology, and the requirement for ongoing upskilling. Employee burnout may also result from the pressure to innovate constantly, especially in fast-paced sectors where there is a perpetual need for new goods and services.

Prospects and Difficulties

Prospects:

Organizations have a lot of potential to improve employee engagement, productivity, and creativity via digital transformation.

Scalability: Businesses may swiftly and effectively expand their operations thanks to digital tools. For instance, cloud computing enables businesses to build their IT infrastructure as needed, facilitating expansion without requiring a substantial initial hardware investment.

Data-Driven Decision Making: Better decision-making is made possible by increased access to data. Organizations may make data-driven decisions that boost performance by using advanced analytics technologies, which offer insights into market trends, consumer behavior, and operational effectiveness.

Employee Development: Digital platforms provide individualized learning and development opportunities that support career advancement and skill improvement. Employees may learn new skills and remain relevant in a job market that is changing quickly thanks to AI-driven learning paths, virtual coaching, and online training programs.

Improved Collaboration: Digital technologies make it easier to collaborate across geographical boundaries and departments, dismantling organizational barriers and promoting more productive teamwork. Real-time communication channels, cloud-based project management software, and virtual collaboration platforms facilitate a more integrated and connected workplace.

Difficulties/Challenges:

Organizations must overcome several obstacles brought about by digital transformation, notwithstanding the enormous benefits.

Opposition to Change: One frequent obstacle to a successful digital transformation is organizational opposition. Workers who are used to old methods of working could be hesitant to embrace new technology or alter their workflows. Overcoming this opposition and guaranteeing a seamless transition depend heavily on effective change management.

Cyber security: The risk of cyber-attacks is enhanced by our growing reliance on digital technologies. Businesses are more susceptible to data breaches, cyber-attacks, and other security risks as they digitize more aspects of their operations. Protecting sensitive data and upholding stakeholder confidence require the implementation of strong cyber security procedures and making sure staff members receive cyber security best practices training.

Digital tiredness: In remote and hybrid work situations, in particular, the continuous use of digital tools can result in digital tiredness. The blurring of work-life boundaries, the need to be connected all the time, and the deluge of digital messages can all lead to employee burnout. Companies need to be aware of these issues and put preventative measures in place to avoid digital exhaustion. Some of these measures include encouraging frequent breaks from digital devices, establishing clear expectations for communication, and fostering work-life balance.

Skill Gaps: Companies with a big, diversified staff may find it difficult to meet the requirement for ongoing upskilling. New abilities like data analysis, digital literacy, and knowledge of developing technologies are frequently needed for digital transformation. To close these skill gaps and guarantee that their staff members are prepared to succeed in a digital world, organizations need to make investments in training and development initiatives.

CONCLUSION:

Traditional management techniques are changing due to digital transformation, which has a significant effect on innovation, employee engagement, and productivity. Businesses that successfully complete this transition stand to earn a competitive edge, increase productivity, and happier employees. But there are difficulties along the way. Organizations frequently face challenges in achieving the full advantages of digital transformation, including talent gaps, cybersecurity threats, resistance to change, and digital weariness.

Adopting a strategic strategy that is in line with the organization's overarching objectives and values is essential to a successful digital transformation. This entails making the appropriate technological investments, giving staff members continual training and assistance, encouraging an innovative culture, and putting strong cybersecurity safeguards in place. By doing this, businesses may improve their performance now and set themselves up for long-term success in a world that is becoming more and more digital.

In conclusion, digital transformation is a crucial part of contemporary organizational management, even though it also brings with it opportunities and difficulties. Businesses will be more prepared to prosper in the digital era if they welcome this change and successfully handle its effects on output, employee engagement, and creativity.

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ANALYZING THE PERFORMANCE OF THE HEALTH INSURANCE SECTOR IN THE DIGITAL ERA

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ABSTRACT

During the past few decades, the Indian insurance sector has transformed dramatically and contributed significantly to the country's economic development.The insurance sector represented 4.2% of GDP in 2022, with 3.2% from life insurance and 1.0% from non-life (general) insurance, indicating its importance to the financial system.As a result of the increasing participation of private players, improved distribution capabilities and operational efficiencies, India's non-life insurance business has experienced an impressive growth over last years.In 2022-23, health insurance had been the largest segment within the non-life insurance market, contributing 38.02% of overall premiums collected. Inspite of imperative growth in health insurance, approximately 514 million people across India covered under health insurance schemes in 2021, represented merely 37% of the people in the country. Around 400 million individuals representing 30 % of the population are missing middle (PIB, 2021)

So, the current study provides a comprehensive analysis of all trends, challenges and opportunities faced by health insurance sector in last decade. Along with this,the Indian health insurance industry is undergoing a powerful transformation due to technological advancements and regulatory policies(ForbesIndia, 2024). So, the paper explores the role of the tech driven trends in health insurance sector for enhancing customer experience and improving access to healthcare services

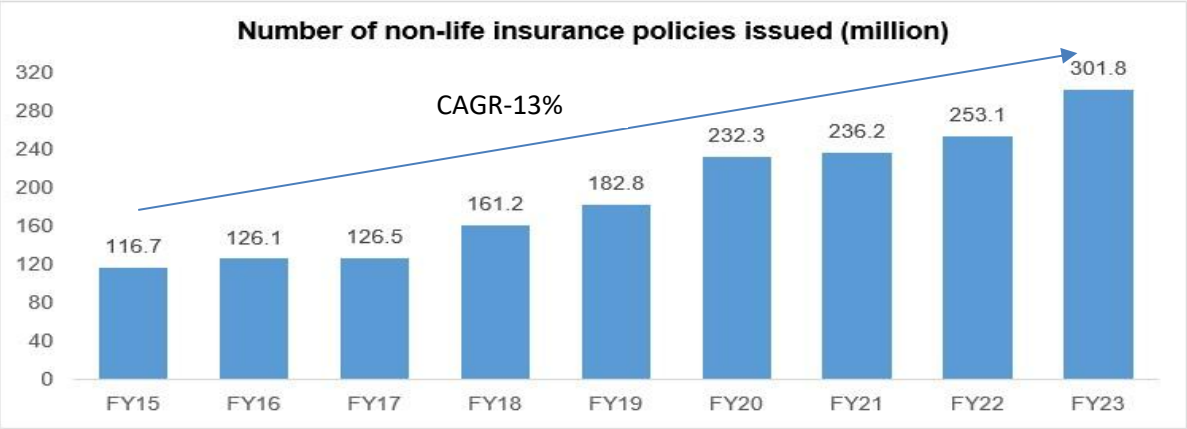
Keywords: Health Insurance Premium, Insurance Regulatory and Development Authority of India (IRDAI), Standalone Insurer, Digitalization,

INTRODUCTION TO NON-LIFE INSURANCE IN INDIA

The general insurance sector in India includes non-life insurance products such as motor, health, property, and marine insurance. This sector has experienced robust growth over the past decades. India is currently the fourth-largest general insurance market in Asia and the 14th-largest globally. The density of the general insurance sectors has doubled, growing from US$ 11 in FY15 to US$ 22 in

FY23, yet its penetration still lags at 1.0% of GDP as of FY23, indicating significant upside potential compared to global standards. Over the past two decades, the general insurance business in India has recorded impressive growth, driven by increased participation from private players, enhancements in distribution capabilities, and operational efficiencies.

An amount of Rs. 2570 billion (US$ 30.77 billion) in premiums were underwritten by the Indian non-life insurance industry in 2022-23, growing by 16.40% from 2021. Twenty-seven private sector insurers (including standalone health insurers) underwrote Rs. 1580 billion (US$ 18.92 billion) compared with Rs. 1300 billion (US$ 15.56 billion) in 2021-22. Underwritten premiums by the three public sector insurers outside India reached Rs. 34.34 billion (US$ 411.11 million) in 2022-23 compared to Rs. 33.03 billion (US$ 395.43 million) in 2021-22, a growth of 3.96%(IBEF, 2024).



Source: IRDAI

Figure-1 Status of Number of Non-life Insurance policies issued in last one decade

The number of non-life insurance policies has grown more than doubled indicating CAGR of 13 % in last few years. The number of policies issued in India grew from 116.7 million in FY15 to 301.8 million in FY22. This growth is due to the growing demand in a number of associated sectors, especially in healthcare industries. As shown in the figure, Health insurance business serves as the largest segment in the non-life insurance sector contributing around 38.02% of the total premium collected in 2022-23(IBEF, 2024)

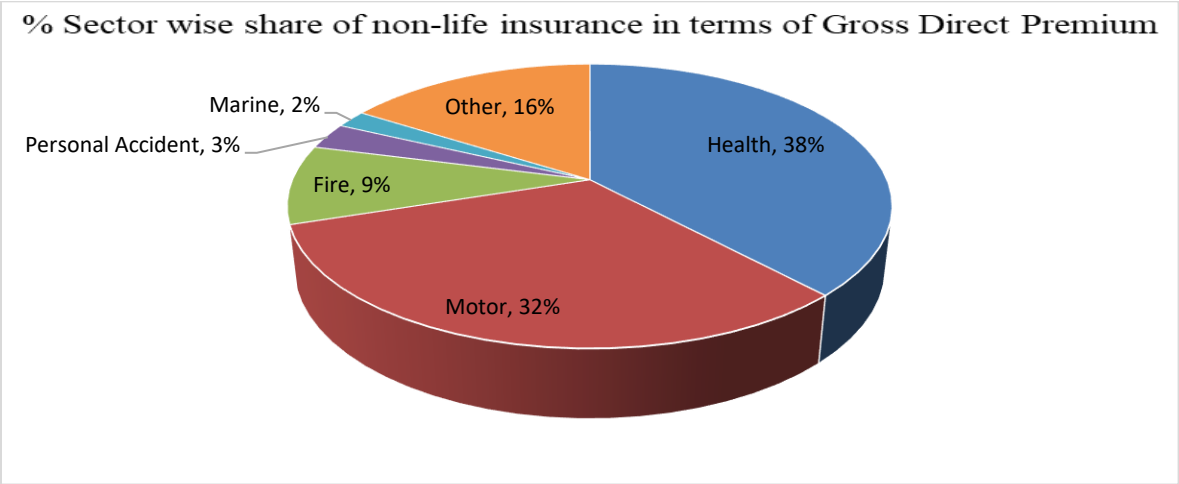


Figure-2: Status of gross direct premium collection in non-life insurances in 2022-23

The health insurance segment (excluding personal accident and travel) reported a growth of 22.5% in FY23, with the premium growing to Rs. 8,94,918 million from Rs. 7,30,515 million in FY22.

LITERATURE REVIEW

(Agrawal, 2023)this study explores key factors driving the demand for health insurance, such as increasing healthcare costs, changing lifestyles, and growing awareness of financial protection. Further, the author recommended to promote accessible, affordable, and effective health insurance in India.

(Dutta, 2020) The study concluded that there is a significant relationship between earned premium and underwriting loss. There has been increase of premium earnings which instead of increasing profit for the sector in fact has increased underwriting loss over the years. Massive competition by new players and heavy burden of commission paid for increasing premium collection has imposed heavy cost burden on insurance sector as a whole, which in turn has negatively affected the profitability of the sector.

(Binny & Gupta, 2017)The paper discusses the current trends in the health insurance sector in India, highlighting both opportunities and challenges. It identifies key growth prospects and obstacles in the industry. The study suggests that health insurance is an expanding sector in India, and that companies should focus on improving their businesses through innovative products and new business models. It also emphasizes the need for a universal health insurance program to support families living below the poverty line. Additionally, medical tourism is recognized as a growing industry, presenting an opportunity for health insurance companies to expand their operations. The paper further recommends the creation of a common information database to facilitate information sharing, which could help consumers assess prices, quality, and services offered by health insurance providers.

(Kamarlaila & Mahalakshmi, 2024)The study shows that health insurance in India has been growing consistently year after year. The data indicates that both premium collections and claims paid have experienced double-digit increases, while the number of insured individuals continues to rise steadily.

As majority of the studies has talked about growth of health insurance sector with special emphasize on premium collected and P/L of the companies in this sector but very few literature evidences are available dealing with impact of adoption of technology in health insurance sector so current study deals with analysing the current status of health insurance sector in India and growth there to in last one decade. Further the study also focused on role of Tech driven trends enhancing the efficiency of the sector and services offered to customers. The study is analytical in nature and covers the data since 2013-14 to 2023-24.

OBJECTIVES OF THE STUDY

1) To analyse the current landscape of the health insurance market in India in last one decade
2) To explores the role of the tech driven trends in health insurance sector for enhancing customer experience and improving access to healthcare services

HEALTH INSURANCE SECTOR IN INDIA

In the event of unexpected medical expenses, health insurance plays a crucial role in preventing individuals from facing financial hardships. It provides a range of benefits, including preventive care, emergency treatment, and long-term care. As well as serving as a financial protection, health insurance promotes access to quality healthcare, promotes a healthier society, and enhances the well-being of individuals.

As medical costs rise and emergencies can occur suddenly, it is essential to emphasize the importance of health insurance in today's fast-paced world. Health insurance isn't just a choice; it's a necessity. An insurance policy that protects your health is of utmost importance in a world full of uncertainties. A sudden illness or an unforeseen accident can throw a wrench in our plans. This is when health insurance becomes incredibly valuable, enabling you to remain financially stable at a time when you need it most.

Status of Health Insurance Sector

There are 26 life insurers, 25 general life insurer, Eight (08) standalone health insurances, 12 reinsurers and 2 specialized insurers in India as on March 31, 2024.
Total premium collected against insurance policies as on March 31,2024 is INR 11,196.13 billion out of which health insurance segment accounts for premium of Rs 1,166.94 billion representing contribution

of 10 percent. Further, total claims paid in given year is around INR 881.01 billion which is 11.5 % of total claim paid in both life and non-life insurances.

Table-1

Year Wise status of Health care policies and premium collected

Year	No.of policies Issued (in '000s)	No. of Persons Covered (mn)	Gross Premium (₹mn)	Average Premium Per Policy
2013-14	10,026.1	216.23	1,74,945	17,449
2014-15	10,929.2	288.03	2,00,962	18,388
2015-16	11,815.9	358.96	2,44,475	20,690
2016-17	13,137.4	437.46	3,03,917	23,134
2017-18	14,729.8	481.99	3,70,286	25,139
2018-19	20,681.6	472.04	4,48,728	21,697
2019-20	17,932.6	498.71	5,07,581	28,305
2020-21	23,739.4	514.75	5,82,379	24,532
2021-22	22,625.1	520.42	7,30,515	32,288
2022-23	22,641.8	550.04	8,94,918	39,525
2023-24	26,829.0	572.87	10,76,807	40,136
CAGR	**10.34**	**10.23**	**19.93**	**8.69**

Source-irdai

As shown in table-1, Number of policies issued in last 10 years has increased at CAGR of 10.34 percent. Number of policies issued in health insurance category were 26,829 thousand in year 2023-24, an increase from 10,026 thousand in 2013-14. In year 2023-24 572.87 million of persons were covered under health insurance and the number has increased from 216.23 million in 2013-14 indicating a CAGR of 10.23 percent

During the year 2023-24, General and Health insurance companies collected INR 10,76,807.4million as health (excluding Personal Accident and Travel) insurance premium registering a growth of about 20.32 percent over the previous year and CAGR of 19.9 % in last 10 years.

Sector Wise Analysis

There are 4 public sector insurers, 21 private sector insurer and 7 stand-alone insurers catering to the needs of health insurance segment.

Public sector represents 38 percent of share in terms of gross premium collected with CAGR of 14.23 percent. The share of private sector insurers and stand-alone health insurers is around 32 and 30 percent respectively in 2023-24. The compounded annual growth rate has been highest in case of stand-alone insurers at 30.9 percent (as indicated in table-2).

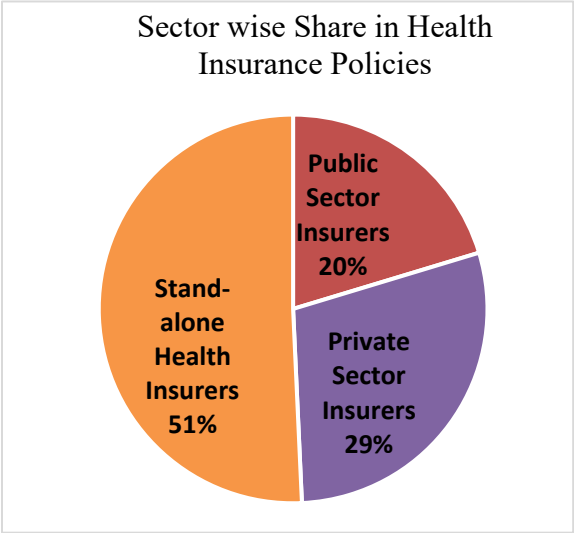
Table-2

Sector Wise Average Premium per Policy (₹ Mn)			
Year	**Public Sector Insurers Total**	**Private Sector Insurers Total**	**Stand-alone Health Insurers Total**
2013-14	19,288	18,905	10,675
2014-15	21,970	17,072	10,853
2015-16	25,648	18,778	12,639
2016-17	31,496	18,661	13,780
2017-18	35,211	20,657	15,983
2018-19	40,290	12,938	16,173
2019-20	44,739	27,160	17,464
2020-21	39,076	21,214	16,294
2021-22	64,095	30,687	18,294
2022-23	84,867	38,420	21,986
Absolute Increase (%)	340	103	106

Source: IRDIA

As shown in table-2, public sector has a sizable presence in terms of average premium collected comparing with private and standalone health insurers. Absolute premium collected by public sector health insurer has increased by 340 percent while that of private sector and stand-alone health insurer have increased by 103 and 106 percent in last 10 years.

Further, gross premium collected by insurer in 2023-24 is INR 409.93 billion, percent increase from premium collected amounting 390.58 billion. Gross premium private sector insurer has shown comparatively higher growth of 37 last one year and stand-alone health registered growth of 27.4 percent in collected in 2023-24.



public sector with 5 in 2022-23 collected by

percent in insurer have premium

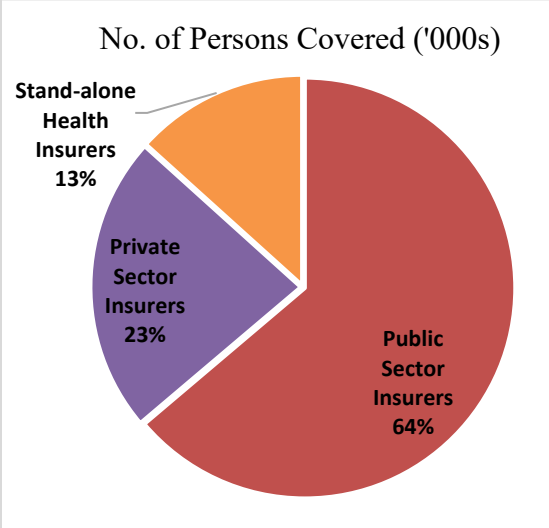


Fig-3 Sector wise share in health insurance policies and insured person

Public sector insurers cover 20% of the total insurance policies in 2022-23. This indicates a smaller share in the market compared to the private and health-specific insurers.Private sector insurers account for 29% of the total policies. This is a sizable portion, indicating that many consumers are opting for private insurers. Stand-alone health insurers dominate the market, with 51% of the total policies purchased in 2022-23.

In terms of absolute coverage, public sector insurers cover the largest number of individuals, with 3,50,991 thousand people (64% of the total), indicating that government-backed insurance options are the most widely used. This suggests a large portion of the population relies on public sector insurers, possibly due to more affordable or subsidized coverage. Private sector insurers cover 1,25,809 thousand people, accounting for 23% of the total. Although their coverage is smaller compared to public insurers, private sector insurers still cover a significant number, which could reflect a preference for more customized or diverse insurance products. Stand-alone health insurers, which focus exclusively on

health coverage, cover 73,235 thousand people (13% of the total). While this is the smallest share, the percentage highlights the growing importance of specialized health insurance, though it still has a relatively smaller reach compared to public and private sector insurers.

Health insurance business is classified into three classes of business namely Government sponsored, group and individual. In terms of number of lives covered, about 45 percent of the lives were covered under government sponsored health insurance schemes, about 45 percent in group business and the remaining about 10 percent under individual policies issued by general and health insurers. In terms of amount of premium, the share of Group business was the highest (51.68 percent), followed by Individual (38.55 percent) and Government business (9.77 percent) (Annual Report of Insurance 2023-24-IRDAI).

H01: There is no significant difference in premium collected, policies logged and persons covered among Public sector, private sector and standalone insurers

Applying one way Anova to find significant difference between premium collected, policies logged and persons' covered, the results indicates that there is a significant difference in premium collected and persons covered by three groups at p=0.003 and 0.000 respectively, i.e. $p<0.05$, so we reject the null hypothesis

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Premium	Between Groups	93500.268	2	46750.134	7.348	.003
	Within Groups	171780.192	27	6362.229		
	Total	265280.460	29			
policies	Between Groups	11625423840567.264	2	5812711920283.632	.984	.387
	Within Groups	159553754676154.100	27	5909398321339.040		
	Total	171179178516721.340	29			
Person covered	Between Groups	414176368859.467	2	207088184429.733	90.693	.000
	Within Groups	61651879159.500	27	2283402931.833		
	Total	475828248018.967	29			

While there is no significant difference in terms of policies logged by all three groups over last 10 years, we accept null hypothesis as the p value is 0.387 (f=0.984) i.e. $p>0.05$.

State Wise representation of Health Insurance Sector

Major 10 states/UTs account for 86.6% of the total gross premium and 82.3 % of total policies issued in 222-23. The remaining 13.4% in case of gross premium collected and 17.7% for number of policies issued is covered by "Others," which includes all other states and regions not individually listed. This simply indicates concentrated penetration of health insurance business in selected states only

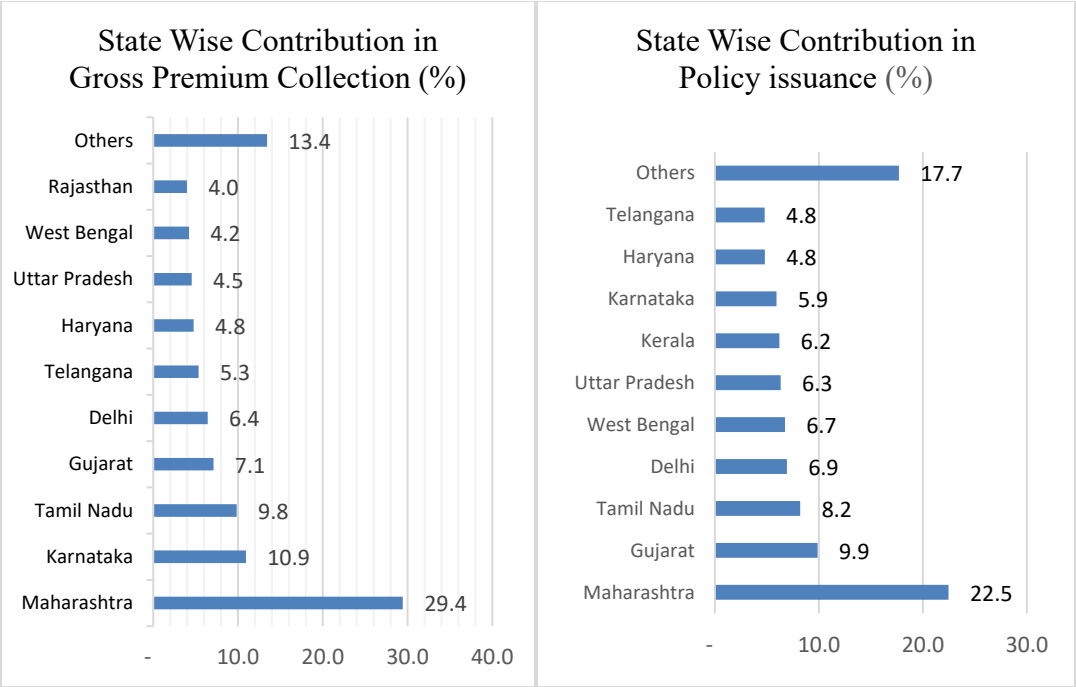


Figure-4: State wise contribution in number of policies and premium collected

Maharashtra leads with the highest share, contributing 29.4% of the total gross premium, which suggests it is the largest market for health insurance in the country. Following Maharashtra, Karnataka (10.9%) and Tamil Nadu (9.8%) also have significant shares, indicating strong insurance penetration in these states. Other states likeGujarat (7.1%), Delhi (6.4%) Telangana(5.3%), Haryana (4.8%), Uttar Pradesh (4.5%), West Bengal (4.2%), and Rajasthan (4.0%) each contribute smaller but still considerable portions to the overall premium pool.

Further stating about the percentage distribution of insurance policies issued across various states and Union Territories (UTs) in India, Maharashtra leads the list with the highest share, accounting for 22.5% of the total policies issued, indicating it is the largest market for insurance in the country. Gujarat follows with 9.9%, while Tamil Nadu (8.2%) and Delhi (6.9%) also represent significant portions of the market. West Bengal (6.7%), Uttar Pradesh (6.3%), and Kerala (6.2%) contribute similarly, showing a strong demand for insurance in these states. Karnataka (5.9%) and Haryana (4.8%) also play notable roles in the overall distribution. Finally, Telangana (4.8%) completes the list of top ten states.

Claim Settlement in Health Insurance Sector

When buying, renewing, or transferring a health insurance policy, the primary concern is often how the insurance company manages claims. The claim settlement track record of a general or health insurer reflects the percentage of claims it successfully settles in a financial year compared to the total number of claims it receives. Claims can be of two types i.e. Cashless claim and reimbursement claims. Under cashless claims, policyholders can avail of treatment at network hospitals without paying upfront, as the insurer directly settles the medical bills with the hospital. This is typically used for planned and emergency hospitalization.

If the insured person undergoes treatment at a non-network hospital or pays for the treatment upfront, they can file a reimbursement claim. The insurer will reimburse the medical expenses after verifying the bills and documents submitted by the policyholder.

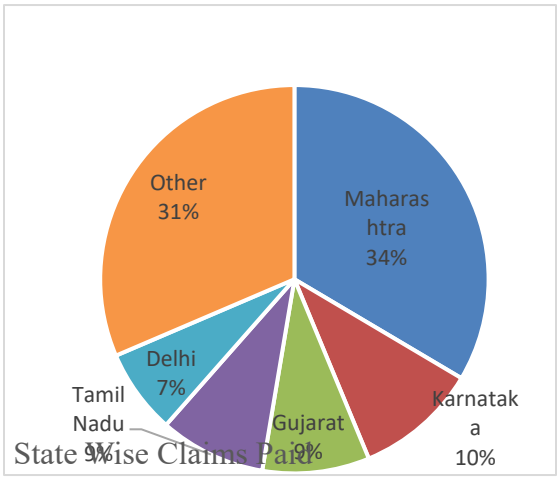
Table-3

Year wise Status of Claim under Health Insurance

Years	No of Claims Settled (in '000)	% of Claim settled to total	Claim Paid During Year (Amount in INR Mn)	% of Claim amount paid to total
2014-15	9,235.78	86	1,82,229	69
2015-16	8,034.53	82	2,17,589	76
2016-17	11,039.08	82	2,75,460	79
2017-18	14,544.74	85	3,02,440	78
2018-19	15,912.56	81	3,49,828	79
2019-20	16,771.27	84	4,00,256	81
2020-21	14,030.76	84	4,33,546	69
2021-22	21,852.20	86	6,94,985	70
2022-23	23,575.05	86	7,09,298	72
CAGR	**12.4**		**18.5**	

As indicated in above table, number of claims settled in since 2014-15 has grown at CAGR of 12.4 percent, while total claim paid has growth at CAGR of 18.5 percent.

Number of claims in 2022-23 were 23,575 thousand which further increased to 26,859 thousand in 2023-24 indicating absolute growth of 14 percent in one year. In case of claim paid amounting INR 834,932 million in 2023-24, there is an absolute growth of 17.7 percent since 2022-23. Though there is notable growth in the amount of claim settled each year, still only around 70 percent of total claim requested has been paid off in last three years as against 83 percent of number of claims registered.



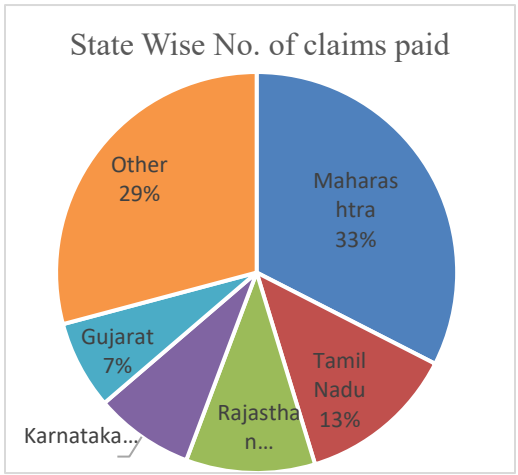


Figure-5 State wise Status of claims settled and amount paid (Data as on 2022-23)

Maharashtra is leading state in terms of number of claims settled, followed by Tamil Nadu, Rajasthan, Karnataka and Gujarat. 29 percent of the total claims has been settled by other states/UTs, other than these five major states. Similarly, Maharashtra is leading in terms of amount of claim paid off in 2022-23 by settling 34 of total claims raised in the country.

During 2023-24, insurers have settled about 83% of total number of claims registered and have repudiated about 11% of them and the remaining about 6% were pending for settlement as on March 31, 2024.During 2023-24, general and health insurers have settled 26.9 million health insurance claims and paid an amount of Rs 834.93 billion towards settlement of health insurance claims. The average amount paid per claim was Rs 31,086(Ray, 2024).

Amongst various channels for distribution of health insurance policies, individual agents contributed a major share in total health insurance premium at 30 percent followed by 29.3 percent contribution by brokers and 26.7 percent by direct sale (especially through other than online). Rest of the channels accounted for merely 14.3 percent contribution in total premium of health insurance

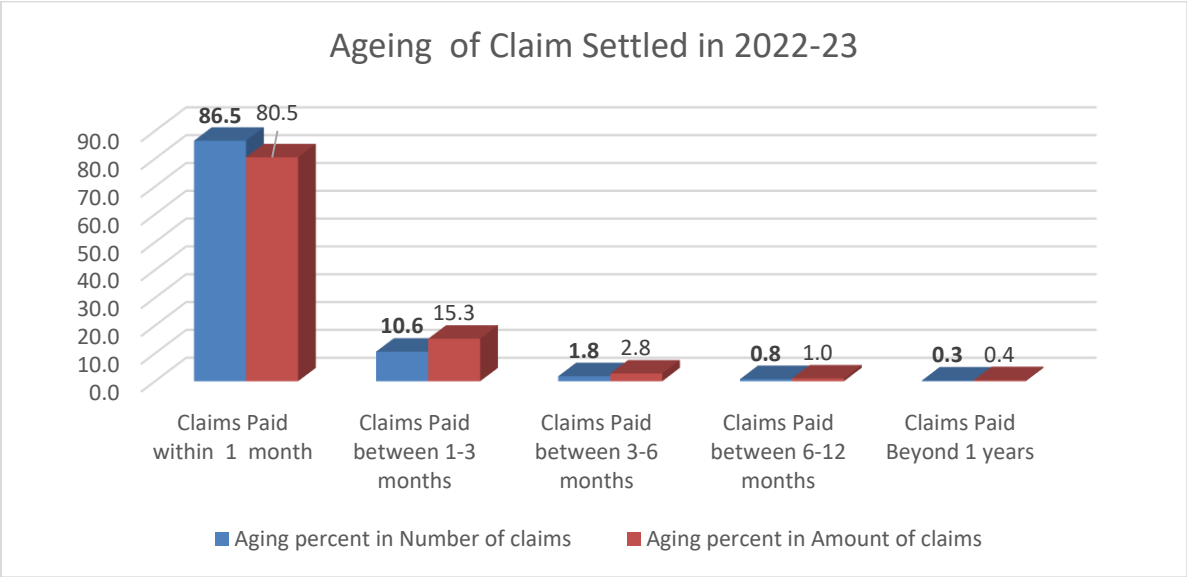


Figure-6: Ageing wise claim settlement status

86.5 percent of claims settled in 2022-23 and 80.5 percent of amount settled in stated year was done within 1 month. 10.6 percent of cumber of claims and 15.3 percent of amount was settled in 1-3 month. Only 2.9 percent of claims and 4.2 percent of amount of claim was settled beyond 3 months. This simply indicates the efficiency of health insurance sector in process of settling claims

Digitalisation in Health Insurance

Technological advancements are transforming every industry and the insurance ecosystem is not left untouched. Digital integration into standard and vital Health Insurance processes, such as policy issuance, claim management, and renewal process, has streamlined things, ensuring a seamless customer experience. Acting as a powerful tool, technologies like big data, artificial intelligence (AI) and machine learning (ML) are reshaping the insurance industry for the better.

By increasing insurance accessibility, enhancing simplicity and transparency, new age insurers are putting all efforts to match up the increased demand of health insurances. This has prompted companies towards adoption of disruptive technologies and to stay ahead of the competition. From underwriting to risk analysis, digitalisation has taken over many insurance processes (ForbesIndia, 2024).AI-powered chatbots and virtual assistants have enabled insurers to personalize customer service effectively. Additionally, AI algorithms combined with ML models are streamlining the underwriting process, making it more efficient and accurate, while allowing insurers to tailor products based on individual risk profiles. Moreover, the automation of manual processes is not only providing customers with a seamless experience but also enhancing operational efficiency.Five technology-driven trends are reshaping the health insurance sector in 2023 and beyond (Ekambaram, 2023). These include:

Accelerating Automation in Claims Processing: With a surge in healthcare claims and insurers struggling to meet growing demands, the Insurance Regulatory and Development Authority of India (IRDAI) has set a deadline for claims settlement within 30 to 45 days, leaving little room for error. Health insurers and Third-Party Administrators (TPAs) are turning to automation to address this challenge. By leveraging real-time channels, rule engines, and Robotic Process Automation (RPA), insurers can streamline workflows, improve processing accuracy, reduce errors, and enable faster, touchless claims handling. Hospitals also benefit from shorter payment cycles when they submit cleaner claims, making automation a game-changer for the industry.

Cloud and AI/ML Driving Technology Transformation: Health insurance companies are adopting advanced technologies to future-proof their operations. They are upgrading their infrastructure and migrating core systems to cloud platforms such as Amazon Web Services (AWS) and Google Cloud Platform (GCP) to increase agility and scalability. Additionally, insurers are utilizing AI/ML and advanced analytics to transform their service architecture and improve customer experiences. These technologies are applied in various areas, from policy issuance to fraud detection, with AI/ML being especially valuable in identifying false and fraudulent claims, which account for 15% of all health claims.

Digital Tools Revolutionizing Healthcare Cost Containment: In India's competitive health insurance market, insurers are focusing on controlling costs. The IRDAI has proposed a cap on Expenses of Management (EOM), prompting insurers to innovate by revamping their shopper portals, automating lead capture, and exploring direct-to-customer sales via platforms like Paytm. Technologies such as blockchain, RPA, WhatsApp integration, and AI chatbots are being adopted to reduce administrative expenses. With the government aiming for Universal Health Coverage by 2030, these digital tools will play a key role in reducing premiums and improving care delivery.

Collaboration with Wearable Tech to Promote Wellness: With non-communicable diseases (NCDs) contributing to 65% of deaths in India, insurers are partnering with wearable tech companies like Fitbit and GOQii to promote wellness among members. Wearables, along with other interconnected devices, enable Remote Patient Monitoring (RPM) by capturing vital data in real-time. This data can reduce the need for frequent hospital visits and help in managing chronic diseases. Insurers are also working with wellness platforms like HealthifyMe and digital therapeutics companies like Wellthy Therapeutics to offer health programs that focus on wellness and chronic disease management.

Interoperable Digital Health Records: Despite technological progress, the healthcare industry still relies on manual processes due to the lack of standard data exchange protocols. To achieve Universal Health Coverage, India needs an interoperable digital ecosystem. The Unified Health Interface (UHI),

part of the Ayushman Bharat Digital Mission (ABDM), aims to create this by facilitating seamless access to medical records nationwide through the ABHA health ID. This could revolutionize healthcare in India, similar to how UPI transformed payments. By leveraging technologies like Natural Language Processing (NLP), digital health records can enhance clinical documentation, improve clinical decisions, and deliver comprehensive care.

In India, the integration of technology in the healthcare insurance sector is changing the landscape of the industry. The adoption of automation, AI/ML, wearables, and digital tools for cost containment, along with digital health records and interoperability, is transforming the way health insurers work. These trends aim to democratize health insurance, reduce costs, serve beneficiaries better, and improve overall health outcomes. The benefits of tech enablement in the healthcare insurance sector are immense, and it is an exciting time for the industry.

CONCLUSION

As the health insurance sector in India is expanding at a compound annual growth rate (CAGR) of approximately 20-25%, with this upward trend expected to continue as more individuals seek health coverage. Despite this growth, health insurance penetration in India remains relatively low compared to global averages, highlighting significant room for further expansion. According to data provided by the insurance regulator, the net incurred claims in the health insurance business of general and health insurers reached Rs 761.60 billion in 2023-24, reflecting an increase of approximately 18% compared to the previous year. The Incurred Claims Ratio (ICR) for the health insurance sector also decreased slightly from 88.89% in 2022-23 to 88.15% in 2023-24(Ray, 2024).The sector is well-positioned for continued growth, driven by rising awareness, government initiatives, and technological advancements. Although considerable progress has been made, there is still a large, untapped market, particularly in rural areas and among lower-income groups, offering insurers ample opportunities for further expansion and innovation.

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Using of Mobile Banking Applications to promote M-Commerce: A Sustainable Marketing Strategy

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Abstract

There has been huge development seen in M-Commerce application over the few years in India. For faster and more efficient transactions, buyers are switching to M-Commerce. M- Trade is in huge demand as it is easily incorporating in this innovative market .When we talk about cell phones these days; they are not utilized for sending or receiving messages. It has become as source of exchange and online trading business. An effort has been made in this work to ascertain the various elements that affect the reception concerning M-Banking in respective of M-Commerce. The tremendous growth in the mobile devices in India reveals that the majority of Indians have adapted to cell phones and its innovations. Using a portable device is not restricted for calling, informing, and recreations but it is being practically utilized by an individual, private, business or any other entity. Due to security concerns and attentiveness, most people conduct M-Commerce through E-trade. Article sheds light on the future of M-commerce, challenges, and numerous uses of M-Banking and various schemes launched by RBI and Government to promote M-Commerce with Mobile Banking.

Keywords: M-Commerce, E-Commerce, Innovation, M-Trade, M-Banking.

1. Overview

Many thought that the 1980's was the period of personal computer technology, while the 1990s were the decade of e-commerce and the Internet, marking the start of the twenty-first century is symbolized by the emergence of computing on mobile devices. The term "m-commerce," or mobile commerce, (Qingfei 2008) is basically a subset of Online shopping (Sharma, 2009) and a expansion of online shopping (Wakefield & Whitten, 2006) carried out in a wireless setting, particularly online (Turban & King, 2003). Electronic commerce is logically followed by mobile commerce (Mahil, 2008 & Au, 2007). M-commerce has grown in importance as a research area for online retailers. When the Global

Mobile Commerce Forum was initially released in 1997. The word was created by Kevin Duffey "M-Commerce," which stands for "Mobile Commerce." wireless network technology's ability to bring electronic commerce and transaction capabilities right into the hands of customers anytime and anywhere. The term "m-commerce" describes the use of wireless technology in the online buying and selling of products and services, such as PDAs and mobile phones (Chaffey 2007). Utilizing mobile devices, like devices, PDAs, smart tablets, and mobile phones, to use the wireless application protocol (WAP) to access banking networks for Financial services are referred to as cell phone banking, or mobile banking (m-banking) (Shaikh & Karjaluoto, 2015).

The subset of e-commerce technology known as "m-commerce" refers to transactions made online using mobile devices (Sujata Deshmukh, Prashant Deshmukh).Mobile hand technology is a subset of e-commerce that is more affordable, more flexible, and more effective for its customers, but it differs in that it makes use of wireless technology, claims K.S. Sanjay (2007).

M-commerce has investigated and demonstrated potential issues with mobile commerce. They made an effort to highlight the advantages and drawbacks of wireless technology (Tandon, Mandal, and Saha). More interconnected circumstances that allow mobile device carriers to stay connected everywhere and at all times are ideal for m-commerce (O'Dea and Abraham, 2000). Furthermore, some scholars describe m-commerce as a financial transaction made using a mobile device to exchange goods and services (Turban et al., 2004; Wei and Ozok, 2005).

M-commerce focuses on data-driven business transactions and value exchanges between consumers of wireless networks and mobile devices (Cronin, 2003; Feng et al., 2006). Mobile commerce (m-commerce) has investigated and showcased potential issues within the field. (Tandon, Mandal, and Saha) They had attempted to highlight the advantages and issues associated with the use of wireless technology.

Telecommunications corporations have recognized the promise of m-commerce and made considerable investments in its development. In certain countries, more people own mobile phones than utilize the Internet combined. By 2019 (Statista) there will be more than five billion mobile phone users worldwide.

Mass-market smart phones, the ease and engagement of internet shopping into the real retail and mortar world thanks to quick connections and feature-rich applications. While on the go, customers may do price comparisons, search for goods and services details, Find merchants, download and save vouchers, explore, and buy tickets, merchandise, and services. Retailers, transportation companies, and other service providers are increasingly embracing mobile technology to improve the customer experience,

even though infrastructure rollouts of contactless point of sale (POS) machines are no longer preventing service acceptance. (The 2015 Mobile Economy)

1.1 Smart phones

Smartphone's have become an indispensable part of our daily lives. A Smartphone is defined here as a mobile phone with an operating system (e.g. Apple iOS, Android, Windows Mobile, Palm or Blackberry) that offers internet connectivity and allows the user to install apps, or small-sized applications. This should not come as a surprise as mobile smart phones are quickly becoming the most popular and widespread form of communication society has to offer. Aubrey and Judge (2012) see "Smartphone-enabled, connected consumers" as the drivers of the Omni-channel, noting that "they do not care whether they buy online, via mobile or in-store as long as they get the product they want, when they want it at the right price" (p. 33). According to the International Telecommunications Union (ITU), a United Nations agency that conducts statistical data on Information Communications Technology (ICT), mobile device usage has grown at an amazingly fast rate in the past 10 years. With this has come a giant leap forward in the proliferation of smart phones and their use to access the internet. As current mobile trends develop, it has become apparent that mobile smart phones cannot be ignored in marketing research initiatives any longer. As far back as 2003, Le-Marie Thompson wrote a journal article entitled „Death of Landline, " where she analyzed this exact phenomenon. Beyond the fact that almost all adults in the developing world own a cell phone, Thompson identifies that the one "group that is fostering this shift towards mobile phones is young adults" (Thompson, 1). An increasingly significant and growing portion of society use Smartphone's as a primary way to access the internet, check their emails, and respond to surveys.

1.2 Mobile-Commerce Applications

Mobile apps are a significant aspect of m-commerce; Whitfield (2013) estimates there were 1.2 billion people worldwide using mobile apps at the end of 2012, if figures continue to grow at a constant rate of 29.8 percent each year, there will be 4.4 billion users by the end of 2017. Mobile apps have a huge potential market, Portio Research (2013) predicts that there will be more than 200 billion app downloads per year by the end of 2017, with revenue reaching 63.5 billion US dollars. It has been noted that in some countries app users spend more time connected than mobile site users, which includes apps for e-tailing companies such Amazon and eBay (Comscore, 2012). Furthermore, these e-tailers are finding that consumers are willing to use Smartphone apps to enhance their shopping experience (Nielsen,

2012). Mobile apps have become a more acceptable way to conduct mobile commerce than mobile sites (Compuware, 2013). The adoption of mobile apps will have significant influence on m-commerce.

Today, mobile application (App) is a new emerging mobile technology and has been widely used. This new mobile artifact not only overturns the traditional business model of mobile industry, but also creates new avenues of mobile market opportunities. Mobile applications, or "mobile apps," are transforming the retail world. In this new environment, "unless conventional merchants adopt an entirely new perspective – one that allows them to integrate disparate channels into a single seamless Omni-channel experience – they are likely to be swept away" (Rigby, 2011, p. 26). The "apps culture", as one industry watcher explains, is one growing to the point that "if you haven't embraced it yet, you probably will, since ultimately every Smartphone user on the planet is expected to buy into it" (Johnson, 2010, p. 24). Origins of the „app economy" can be traced back to the launch of the i-Phone in 2007 followed by the App Store in 2008. Since then, the global market for apps has been growing at unprecedented rates. Analysts estimate app downloads have increased from $ 24.9 billion in 2011 to $ 81.4 billion in 2013. This number is expected to rise up to $ 310 billion by 2016. The App Store was one of the first commercially successful digital distribution platforms because it challenged the monopoly of the „walled garden" through which mobile operators controlled content.

1.3 Mobile Commerce Apps and India

India is a source of enormous demand for apps. Even though smart phone penetration is estimated at just 10 percent of total mobile users India experiences 100 million downloads per month placing it amongst the top five regions for Google Play, the official Android app store. App distribution in India is therefore, dominated by international app stores such as Android's Google Play, Nokia' s Ovi Store and Apple's App Store. This is in sharp contrast to other Asian economies such as South Korea and China where local app stores play an equal, if not greater role, in the dissemination and payment of apps than their international counterparts(Salz p. 2014). Affordability of mobile data is another key factor driving this trend. According to the International Telecommunication Union (ITU), India is one the countries for cheapest phone plans with data. India also represents an opportunity at the "Bottom of the Pyramid" users due to the huge potential demand for affordable smart phones and apps from this segment. Unlike developed markets where the Android/Apple duopoly on the OS level is firmly established due to the high penetration of Apple i-Phones and Samsung smart phones, India offers space for other operating systems, particularly those that are designed to operate on lower-end devices(OS platforms such as Symbian still enjoy significant market share in India(Saxena,2014).

India's Top 10 E-Commerce Mobile Apps

Mobile APP	User reviews	Average Rating
Flipkart	1.2 Minute	4.2
Myntra	282,000	4.0
Amazon	294,000	4.1
Snap deal	738,000	4.2
Paytm	731,479	4.3
Ola	178,744	3.9
Uber	239,993	4.2
Jabong	99,369	3.9
Shop Clues	99,614	3.9
Meru	35,434	3.8

Source: Google Play Store 2015-16

Statement of the Problem

Mobile commerce is changing the ways and rules to do the transactions and business. Mobile commerce is not only providing timely services, convenience, personalization and ubiquity but on the whole it is offering value for money to the consumers. The use of mobile phones by youth has stirred a plethora of research in different fields. Indian mobile users have high disposable income and young consumers known as Generation Y primarily uses the phone as they are very tech-savvy. Recent applications show the huge acceptance and success of mobile commerce amongst youth (Panneerselvam 2013). The Mobile communication has attracted by youth, and quite often in a narrower subset of young adults, that is, the university students (Economides and grousopoulou, 2009; Haverila, 2013). This gives birth to the question that, where is India placed at this situation? With rapid increase in the number of smart phones, average mobile data consumption per smart phone in India is expected to increase five times and account for 99 per cent of total traffic from mobile phones by 2021, The number of smart phone subscriptions in the country is expected to record a significant jump and touch 810 million by 2021.Young Smartphone users aged 15-24 years, drive the need for better data speed and data coverage and have a higher inclination to pay a premium for the same," according to a study conducted by telecom equipment manufacturer Ericsson This study explores the perception of young Under-graduate

& Post-Graduate University consumers towards usage concerning M-commerce Apps and identifies m-commerce affects on consumer's purchase intention and buying behavior. Youth are positioned in a social environment of relationships, expectations, rights, and power, as Durham (2010: 116)

Rationale of the study

Purchasing products and services via a mobile phone, utilizing a mobile coupon, mobile banking, and mobile ticketing are all included in the broad category of mobile commerce. It has a lot of promise given the extensive usage of mobile devices and the changing way of life of Indians.

Past research on m-commerce/mobile technologies have been undertaken either locally in Malaysia (Marthandan, 2009) or China (Park & Yang, 2007).

Adoption models were developed in this research to forecast the uptake of mobile technology by consumers. It's interesting to note, nevertheless, that these studies have demonstrated that the model suggested is specific to their nation and that it should also be evaluated in other nations. According to Jacob and Isaac (2008), one of the main factors contributing to the growing number of smart phone purchases is university students. Predicting Young (18–25) Consumer Decisions to Use Mobile Commerce in the Context of India has received relatively little research to date. Consumer decisions to adopt mobile commerce in the setting of India. App economy in India has a bright future. India is home to the second-largest telecom network in the world. According to Nielsen Informate Mobile Insights (2013), the majority of mobile data users in India are under 25 years old. A brand is effectively positioned for a longer period of time when marketers target consumers at an early stage of consumption. People from Generation Y are youthful and full of curiosity. According to Butcher (2011), mobile phones are the most efficient way to connect with these youthful customers. Because they have a strong sense of adventure and a high spending power, marketers try to target this consumer niche. For this reason, it is imperative that marketers understand Generation Y in order to use effective mobile marketing techniques to draw in this demographic (Campbell, Fauth, Silsbee, & Geraci, 2000).

Review of Literature

A search was conducted on electronic databases such as Elsevier, Emerald, Science Direct, Google Scholar, and others, which collectively contain most of the body of work by reviewing the existing literature on organizational and management studies in order to evaluate the corpus of work. The search terms employed in this analysis were "m-commerce drivers," "buying behavior," "perceived trust," "ease of use," and "attitude toward use." Both combined and individual construct searches were conducted.

The main points and conclusions of every study paper were taken from the publication year and arranged chronologically, as shown below.

Sanjay Narayan Sinha, Dr. Gautam Tanty, Rashmi Ranjan (2019) this study provides a background While e-commerce provides a large selection, easy delivery options, and a wide range of products, mobile commerce (M-Commerce) provides a mobile phone platform for online transactions, indicating the potential growth and expansion of M-Commerce in the coming years.

Debarun Chakra borty (2018) the existing status and future prospects of mobile commerce in India are discussed in this paper. The study finds the variables influencing the uptake of mobile commerce in India, where most people use m-commerce to exchange goods and services, as well as the development of m-commerce applications in that country.

Tanushree Chauhan, Prof.Pankaj Dalal (2014) This study provides the various scopes and advantages that Mobile internet has given businesses new opportunities as well has how innovation and up gradation has been the key for growth of M-Commerce in near future

Amandeep Kaur (2019) The study provides the information about the technological up-gradation and innovation in the field of M-Commerce, study finds that how M-Commerce and Business are Correlated to each other and as the evolution and changes in telecom sector 3G, 4G spectrum the chances of growth for m-commerce in near future is very high

Dr. Kiran Chana (2016) the opinions of female consumers on their daily use of mobile apps and M-commerce are included in this study. The majority of the women supported using M-commerce in their everyday lives. This study focuses on primary data from randomly chosen women who use M-commerce in Chennai City. Questionnaire based on five point Likert scale

Chandan Gupta, Prof. Anil Chandok (2016) the study focuses on M-commerce platforms because of the growing need for M-commerce applications in India. The findings show that although M-commerce has entered the Indian market, it is still in its infancy and is developing their daily. The primary barriers to the expansion of M-commerce are a lack of user confidence and expertise.

Aifaz A. Saikh, Richard Glavee Geo (2023) This research, which is based on the SOR (Stimulus Organism Response) Model, shows how money services support the transition from traditional to mobile money services and serve as a consistent force behind the inclusion of all people in digital finance.

Elena Higveras-Castillo, Francisco J. Liebana, Cabanillas (2023) The UTAUT-2 m-commerce model served as the basis for this study, which found that major socio demographic factors had little

bearing on behavioral characteristics or intention in both population segments from developing and developed countries.

Thembekile O. Mayayise (2023) study's foundation was PRISMA. The research's conclusions show that seller reputation, product reviews, price, and the accessibility of profile photos had a significant impact on the adoption of m-commerce, the context of trust, and the shortage of empirical studies on the C2C market**.**

Rahul Yadav, Vivek Kumar Singh, and Prabhat Ranjan Singh (2015) The study, which concentrated on artificial intelligence, discovered that automated applications still need to test the advanced machine learning capabilities of advanced automated networks. These characteristics include fast transmission, high dependability, and low latency.

Irfan Achmad, Firmansyah, Rahmat Yasiradi, Rio Gentur Utomo (2021) the adoption TAM Model and its effect on m-banking adoption served as the foundation for this study. The impact of self-efficacy on attitudes toward use, perceived ease of use, and perceived credibility, according to the findings, has a significant effect on the adoption of mobile banking

Anine Holt Moenpetersson, Sanchit Pawar, Asle Fagerstrom Qualitative Research (2023), study based on m-commerce and its impact with Chat bots, findings states that Emojis, human personalities, helpfulness, and courteous communication styles all improve the user experience of banking chatbots for customers.

Issam Alhadid and Evon M. Abu-Taieh from Sabah Abu-Tayeh (2022) looked on the effects of UTAUT, TPB, and TAM on the uptake of mobile banking. The most significant variables, such as effort and performance expectations, may be used to forecast Jordanian clients' future intentions to utilize mobile banking.

The goal of the research project by Mohammad Wasiq, Amar Johri, and Prakash Singh (2022) is to find out how m-commerce might benefit from the use of ANOVA, Bivariate Regression Model, and Personal Economics. The results show that safety and convenience of use were the two most significant determinants of m-commerce users' usage of the services.

Alejandro Valencial, Luis German, Ruiz-Herrera (2023) the author use technology adoption model, theory of planned behavior were utilized to determine the various drivers of m-commerce findings of the research states that Attitude Towards use, Usage intention, Trust, Perceived usefulness are the key drivers of technology acceptance for m-commerce

Eshatir Radiat Godhuli and Shahedul Hasan (2023) The study's findings, which the author presents using the technology adoption model and partial least square structural equation modeling, demonstrate that users' intents are positively impacted by perceived trust, enjoyment, and simplicity of use.

Hela Ben Abdennebi (2022) the study's conclusions show that perceived security, happiness, and trust were important factors in the acceptance of mobile banking. The author presents these findings using a technological adoption model and partial least square structural equation modeling

Luis Gutman, Fernando Santini, Tiago Oliveria, and Cataria Neves (2023) According to the research's Meta analysis, the intention to use m-banking was largely influenced by factors like perceived utility, ease of use, security, and trust.

Mumtaz M. Debei, Yogesh K- Dwivedi, Omar Hurjan (2022) the author used stimulus organs response as m-commerce model and structural equation modeling technique was used for measuring the impact findings was Crucial Suggestion provided to decision-makers within the mobile telecommunication industry from a useful perspective stand point

Manisha Sharma, Shubhojit Banerjee , Justin Paul (2022) Attention, Interest, Desire, Action AIDA model was used along with structural equation modeling SEM, findings states that Neural Network Increasing tendency has positive influence on social media which is positively affecting the cognitive level of the consumer

Aijaj A. Shaikh, Richard Glaver-Geo, Robert Ebo Hiason (2023) the results of a stimulus organism response model (SOR) study show that the main elements influencing the adoption of mobile banking are the mobile agent's credibility, service quality, and client empowerment.

Elena Higueras Castillo (2023) the author used UTAUT-2 model to determine the variations in M-Banking adoption the findings of the paper were Demographic Variables, Influence, Intention and Behavioral Variable were the key point of difference for the adoption of m-banking

Frank J. Van Centhe, Cedric Sueur, Julie Vallee, and Giovanna Fan cello (2023) The Ecological Momentary Assessment method was employed to identify the factors influencing M-Banking adoption. The paper's conclusions were parking and leisure activities are crucial to a person's mental health.

Zhang Tao, Zhang Li, Chen Ding Jun Model Parameters (2023) Second Multiplication Curve Fitting model was used to find out the variables finding of the research states that the Preventing increase model's accuracy is excellent

Vandana Ahuja, Deepak Khazauchi (2016) in these paper two models UTAUT, TAM was used in order to find out the variables which affect an impact how mobile apps are used. The paper's conclusions

were A person's personal online worth and level of finances are two more moderating factors for the impact of mobile apps.

Hua Li and Shan Du (2019) The TAM Technology Adoption Model was utilized to ascertain the necessary conditions for the deployment of M-Banking. The results show that adoption and upgrading are required to raise customer happiness and provide a better service system.

Shivganga Maindargi, Pritam Kothari (2020) Technology adoption model was being used by the authors in their research TAM to ascertain the various factors which are responsible for growth of retail banking the findings of the research states that Growth and Success of the Retail depend on the banks' capability and aptitude to handle obstacles and make the most of chances

Susanto Hery Purnomo (2023) the author employed structural equation modeling to ascertain how the general public will be affected by the introduction of mobile banking. The research study concludes that there is a positive indirect relationship between customer happiness and the mobile banking services' e-commerce offerings.

Gayathri.S, Buvaneswari (2020) the author used Technology Adoption Model and the variables were examined using structural equation modeling to determine how different factors affected the uptake of mobile banking. The study concludes that customers were more influenced by service quality to use mobile banking

Orkida Illori, Kreshnik Bello (2014) Technology adoption model was used to find out the various aspects of m-banking adoption. The study finds that Adoption and Implementation with innovation is the challenge of the banks in today's scenario which needs to improvised and upgraded

Vaggelis Saprikis, Giorgos Anlogiaris, Androniki Katarachia (2022) the author uses UTAUT, UTAUT-2 model and the application of structural equation modeling for analyzing variables , finding of the research states that Better understanding with customers, strategies should also be formulated in order to be benefitted in near future in terms of adoption of M- Banking

Martin Vejacka, Tomas Stofa (2017) the adoption of M-Banking by customers is influenced by a number of characteristics, including perceived security, trust, and attitude toward adopting the technology. These variables were identified using the technology adoption model. The adoption of electronic banking is positively impacted by behavioral intention to use.

Adi Alsyouf, Abdulwali Lutfi (2023) the study's findings suggest that health organizations' adoption of personal health records is aided by perceived ease of use and intention to use. A structural equation

model was used to determine all of the variables that could affect how simple it is for people to adopt mobile banking.

Ddamulira Vincent, Dr. Ariyo Gracious (2023) the author uses SPSS In order to examine the variables, the study's conclusions were Participation in trade associations, inventive methods, and invention and awareness can all support electronic banking, which will be advantageous in the long run

Objectives:

- To determine the factors that contribute to M-Commerce's popularity using M-Banking Apps
- To illustrate M-Commerce's future in India
- To determine India's M-Banking Challenges
- To determine the current M Commerce needs with innovation
- To examine the current state of mobile commerce and its potential expansion in relation to mobile banking.

RESEARCH METHODOLOGY

Research Methodology is a tool or technique used by the researcher to complete or achieve a specific objective related to their research areas. It includes the sources from where the Data has been gathered by the investigators that is Primary and Secondary data respectively. Research used in this paper is exploratory and descriptive research and literature review and government sites have been used for secondary data.

Factors responsible for growth of M-Commerce with M-Banking

- The finance sector, comprising major financial institutions, banks, stock market players, and share brokers, is highly reliant on mobile commerce. Whenever a customer needs money or wants any type of banking or finance-related service, they can register for or access services via phone calling or Short Message Services (SMS). A user can transact, transfer, or pay a bill from its bank account by utilizing mobile commerce services. Furthermore, banks provide customer service that is available via phone around-the-clock.
- **Telecommunication Sector:** The business sector is being compelled by the increasing popularity to create a new, widely accessible platform for commerce. Due to its distinct features, mobile commerce has seen a huge increase in traffic. The user has the choice to transfer to any bank or financial institution if they are unhappy with the service they are receiving from the

subscribing company or if they discover a better deal elsewhere institution or bank.

- **Service/Retail Sectors**: Retail and service industries are also among the top industries that have benefited the most from mobile commerce. M-Commerce has been extremely beneficial to these industries. Numerous business transactions, regardless of size, are concluded using mobile devices. The customer would be able to schedule the order, hire a carrier or courier service, and most importantly, pay the associated fees via mobile.
- **Information industry:** To provide IT specialists with training in this area, a distinct industry has emerged. Mobile commerce has been widely used in the IT industry to provide a variety of information on a single portable device that is considered "mobile," such as traffic updates, sports scores, financial news, and stock updates. In spite of the enormous appeal of mobile
- **Ease Purchase and Delivery:** The uniqueness of Cell phones convenient sound players and video players. The availability of M-Commerce has made it easy for consumer and supplier both to purchase and supply goods whenever they want from any place. Goods and services can be supplied and delivered easily
- **Quickness**: M-Commerce has provided the quickness mode approach. Every consumer want quick delivery and as a dealer you want quick response for your exchange. So with the evolution of E/M-Commerce the facility of quickness has arrived which is the key for any consumer or supplier.
- **Pervasive approach**: Online purchasing has the benefit of being more convenient, while mobile commerce has the advantage of being widely used. As M-Commerce is not only used in India but also outside the geographical territory. M-Commerce can carry out online exchanges in various geographical areas.
- **Cheap 4 G Services**: Availability of Cheap 4G Services and Exchange of cash to different banks. Now day's various telecommunication sector has been emerged there is a cut throat competition amongst them as a result of it the customer get 4G Services very easily or consumer can afford such facility very easily, which helps in ease exchange of goods and services.
- **Wide Achieve Capacity**: Mobile Gadgets or advanced mobile phones give moment availability to their clients as it has wide achieving capacity as it is not only related to one specific domain but also having wider reach in other domain also. It is only possible because of M-Commerce and it's up gradation.
- **Innovation and up- gradation**: Innovation and Up-gradation is the key for any business organization as this is the pillar in 21st century which has emerge tremendously over the past whether it is e-commerce, m-commerce and many more.
- **Time Efficiency**: The main advantage of M-Commerce it provides time efficiency to every

consumer at the time of purchasing of goods through online shopping which will increase the perception of consumer towards online shopping as M-commerce saves time and cost at the same time.

- **Improved Organization Performance**: The other benefit of M-commerce is that every organization should improve the organization performance by adopting E-commerce in their organization as it has a significant impact on raising staff performance and morale.

Challenges in M-Banking

- **Lack of Awareness and Personal touch**: The biggest challenge in M-Commerce is that most of the people are unaware about the usage and benefits of it. As well as the people feel very inconvenient in shopping as they are not having face to face interaction while doing shopping online as they feel it very inconvenient.
- **Accessibility**: Accessibility is also a major concern in M-Commerce as it is available in urban and semi-urban areas but its usage is not known to rural people hence it is lacking somewhere with this reason.
- **Integrity**: As we all know integrity is the key for survival and growth of any business organization but sometimes it becomes very difficult to manage all the things once a while like flexibility, easiness and many more.
- **Data Availability:** Another challenge of M-Commerce is that the companies don't have accurate data of the people as there so many sources from which people tries to communicate as it becomes very difficult to maintain the accurate data of the customer.
- **Government laws**: There are certain tax impositions which have been levied by the government which discourage the m-commerce business in various respective domains. As the changes are very frequent and affects the working of every business organizations.
- **Quality**: Quality is critical to the survival, growth, and expansion of business as every business should have to be quality conscious specially m-commerce. But always it is very difficult to maintain the same quality every time as customer also have other options available and different consumer have different mind sets regarding this.
- **Identity verification of consumer**: The challenge for m-commerce business is that the identity of the customer becomes very difficult as to identify each and every consumer is using different sources to book their goods and services it is very challenging to some extent.
- **Unaware about government policies**: Most of the businessmen are not aware about the certain policies and schemes of government recently launched for the promotion of m-commerce sector like 5G launching, Digital campaign etc.

THE CURRENT STATE OF M-COMMERCE IN INDIA

It is projected that the Indian online market will increase to US$ 200 billion by 2026 from US$ 38.5 billion in 2017. The e-commerce industry has grown significantly as a result of increased internet and Smartphone usage. India has 604.21 million internet users as of December 2018, and by 2021, that number is predicted to rise to 829 million. . By 2020, it is expected that India's internet economy would have grown from USD 125 billion in April 2017 to USD 250 billion. India's e-commerce revenue is expected to grow from US$ 39 billion in 2017 to US$ 120 billion in 2020, or a rate of fifty-one percent annually.

RBI'S METHODS FOR M-BANKING AND M-COMMERCE.

- Banks that possess a license, are supervised, and are physically present in India are authorized to provide mobile banking services. Mobile banking services can only be offered by institutions that have put in place core banking solutions.
- The services will only be available to bank customers and/or those who own debit or credit cards issued in accordance with the current guidelines of the Reserve Bank of India.
- In order to provide this capability to their customers, Banks may also use a business correspondent that has been appointed in compliance with RBI guidelines.
- Mobile-based banking services would be subject to the Reserve Bank's suggestions on "Anti Money Laundering (AML)," "Know Your Customer (KYC)," and "Combating the Financing of Terrorism (CFT)," as they are altered from time to time. Suggestions on "Anti Money Laundering (AML)," "Know Your Customer (KYC)," and "Combating the Financing of Terrorism (CFT)," as they are altered from time to time.
- In order to promote their mobile banking registration and activation procedure, as well as its usage, banks may also run customer education and awareness campaigns in many languages via various communication channels.
- A strong clearing and settlement infrastructure that runs around-the-clock is required to achieve the goal of a national mobile banking framework that facilitates interbank settlement.
- According to the Payment and Settlement System Act of 2007, bank and non-bank businesses wishing to implement such systems, whether bilateral or multilateral, must obtain permission from the Reserve Bank of India.

SCHEMES AND POLICIES

- Digital India program, Unified Payment Interface (UPI), GeM, etc., have been important contributory reasons to the growth of E-commerce in recent years, it noted.
- Through the use of sponsored media, merchants can increase income by using an m-commerce advertising campaign to increase brand awareness, customer loyalty, and eventually sales.
- Ed-tech, hyper local, and food-tech are some more emerging e-commerce areas. The ONDC network was founded by the Indian government in 2022 with the intention of democratizing e-commerce by providing MSMEs with equal opportunity to thrive in the digital economy.
- The Ministry of Commerce & Industry established Niryat Bandhu @ Your Desktop, an online certificate program for export-import businesses, in September 2015. It is a part of the Niryat Bandhu Scheme.
- October 1st, 2022 will see the commercial introduction of fifth-generation, or 5G, services in India. Prime Minister Narendra Modi will make the announcement at the India Mobile Congress.
- The goal of Jeevan Pramaan is to digitize the entire process of obtaining a life certificate for pensioners. With this initiative, the pensioner is no longer needed to appear in person before the certification body or the disbursing agency. Since 2014, more than 685.42 lakh certificates for Digital Life have been issued.
- In July 2022, the MeriPehchaan platform—a National Single Sign-on (NSSO) system—was launched with the intention of simplifying citizen access to government portals. Together with NSSO, 4419 services from various Ministries and States were provided.

FUTURE PERSPECTIVE AND SCOPE

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M-commerce has a bright future ahead of it. The industry is having an impact on India's micro, small, and medium-sized enterprises (MSME) in terms of funding and technology. India's M-commerce market is predicted to overtake the US market by 2034 due to its quick growth. The expansion of m-commerce creates jobs and boosts export earnings. The government is also launching new schemes and policies for strengthening the e-commerce/m-commerce in India. The various schemes like 5G launching, digital India, PMSY and many more if such schemes are known than the growth, and profitability can be seen more in this sector.

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TITLE OF THE PAPER: ROLE OF DIGITAL TRANSFORMATION IN REDEFINING TEACHING AND LEARNING PRACTICES

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Abstract

The advancement of digital technologies has been several years and affected various fields, and educational sectors are not an exception. The rationale of this research paper is to uncover how technology or use of digital technology is helping to redefine teaching and learning profiles of current teaching and learning contexts. The purpose of this research is thus to gain a deeper and more nuanced understanding of how innovation is changing how teachers teach, how learners learn, and how students participate in the process of learning within the digital media environment.

In pursuit of this, secondary data was gathered from research articles, Reports, and Cases. As a result, the research follows a positivism philosophy, which asserts external reality and a measurement of relationships between factors. The qualitative research paradigm involved the use of deductive research method in applying existing theories in addressing the issue of digital transformation of education and the explanatory research design applicable in examining causal relationships between the use of digital technologies and educations practices.

Results have shown that embracing technology in learning environments causes changes in teaching practices and in the manner students learn. Furthermore, there has been an increase in the use of digital technology in enhanced teaching and learning that has brought interaction, collaboration, and students' activities and engagement; brought turnover of teaching from informative modes to discovery learning.

These findings' implications are that educational institutions need to purposefully integrate digital transformation into their learning environments to efficiently compete and fit into the contemporary needs of learners. Also, teachers should be well-prepared to use those technologies when teaching and making necessary changes to their behaviours. Last way, one more area of intervention for policymakers should consider is how to maintain equality in terms of availability and use of digital materials in order to avoid differences in results achieved. This research provides a new knowledge addition to the ongoing debates in literature on digital transformation and may help educators, administrators and policymakers exploring possible uses of technologies for better teaching-learning processes.

1. Introduction

Digital transformation plays a crucial role in education as it helps in enhancing the experience of the mentors, learners, alumni as well as aids the institution in order to manage the data of the students as well as other tasks effectively. Considering the projected expenditure funds for virtual and augmented reality is forecasted to be elevated from $1.8 billion in 2018 to $12.6 billion by 2025 in order to advance EdTech reflected in figure 1 (statista.com, 2024). The adaptation of the digital technologies is beneficial in the education institutes which assists in enhancing the learning facilities and providing better knowledge to the mentors along with students in order to operate advanced technologies effectively.

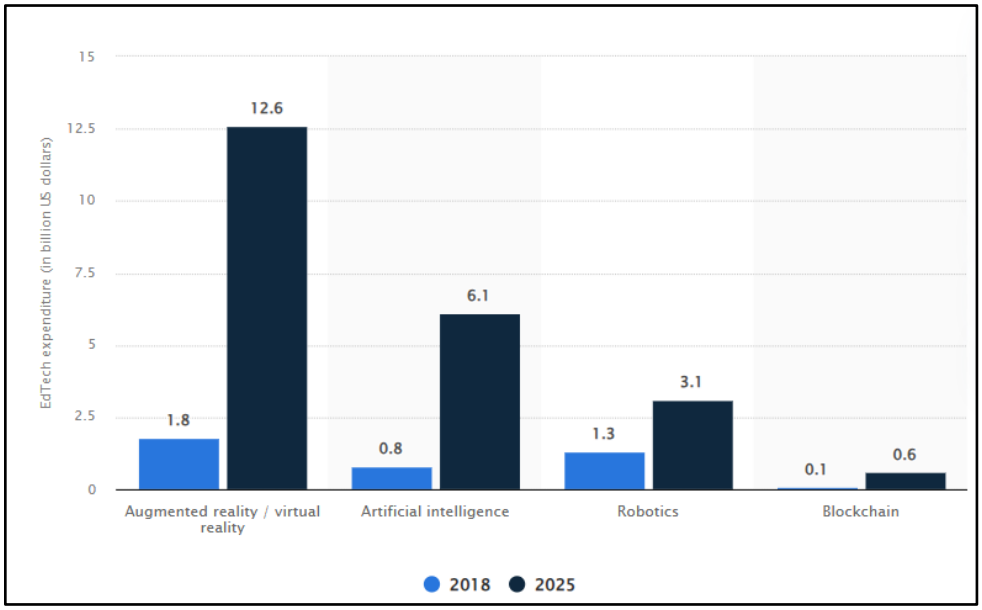

Figure 1: Projected expenditure on using advanced education technology across the globe

(Source: statista.com, 2024)

1.1 Aim and Objectives

Aim

The aim of this research is to analyse deeper understanding of the changes due to innovation in education and the role of digital transformation in the procedure of redefining learning along with teaching practices.

Objectives

- To analyse the significance of digital transformation in learning and teaching practices
- To identify multiple challenges in the integration of digital technologies and fostering innovation in redefining learning and teaching practices

- To evaluate the impact of digital transformation in learning and teaching practices
- To access recommendations for the inclusion of digital technologies to enhance learning and teaching practices

1.2 Research Background and Rationale

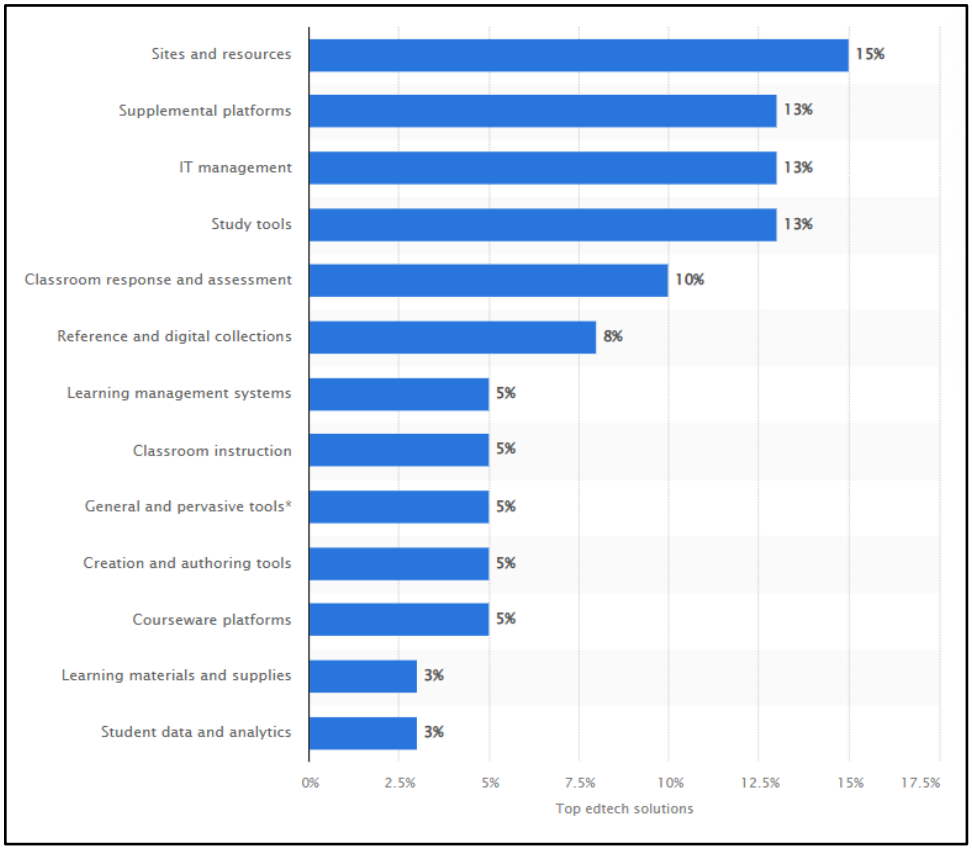

Figure 2: List of edtech solutions accessed by teachers and students

(Source: statista.com, 2024)

Digital transformation in the field of education focuses on leveraging technology to enhance students' learning experience by providing personalised learning, accessible learning materials, interactive content and others that redefines the learning practices. For instance, 15% of the teachers and K-12 students in the US accessed sites and resources educational technology (EdTech) solutions mirrored in figure 2 (statista.com, 2024). Additionally, the most followed by 13% supplemented platforms that are majorly used for individual learning to access online activities, research and others (statista.com, 2024).

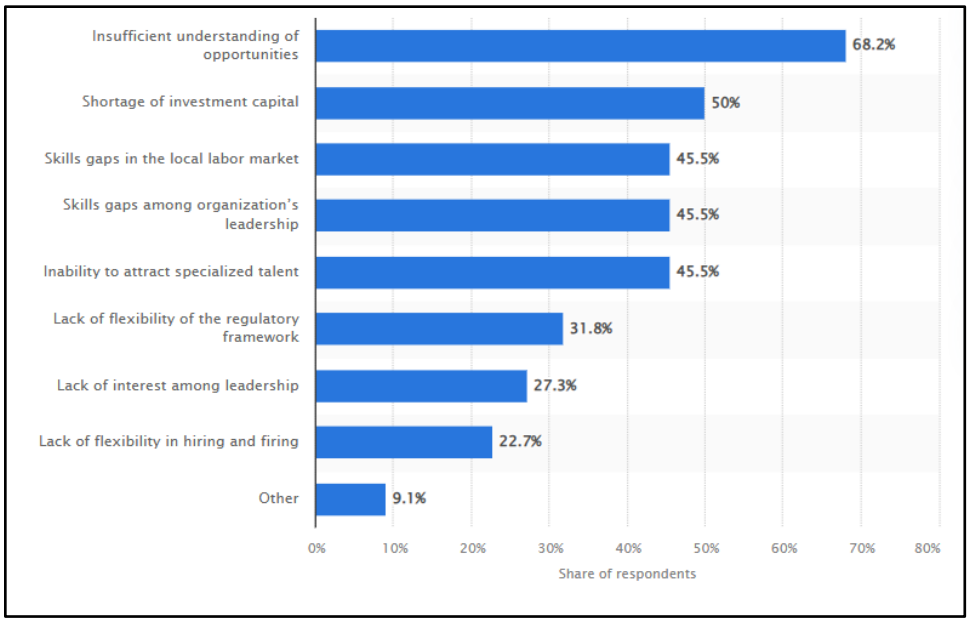

Figure 3: Issues in adapting new technologies in education industry

(Source: statista.com, 2022)

Apart from the positive attributes of the major challenge prevailing in digital transformation in the education industry is lack of understanding of opportunities. The reports revealed that 68.2% of the respondents feel that "inability to understand the opportunities" is one of the major barriers in adopting new technologies in the education industry and 50% believe shortage of investment capital in 2020 reflected in figure 3 (statista.com, 2022). Issues in the usage of digital technologies can reflect due to lack of comprehending the opportunity in the education.

2. Literature Review

2.1 Importance of digital transformation in teaching and learning practices

The focus on the digital transformation is beneficial in the education industry as it helps in enhancing the training factors for the students and enhances flexibility for the teachers to teach effectively despite the location. As per the opinion of Haleem *et al.* (2022), it has revealed that the usage of the digital platforms is beneficial in accessing the learning materials anytime and anywhere. In this context, the usage of digital technologies can be helpful for the learners in order to access the learning materials in order to revise the topic taught in class.

On the other hand, Mohamed Hashim, Tlemsani & Matthews (2022), has mentioned that digital transformation helps in boosting adapting learning that aids in enhancing the knowledge of the students. Considering this attribute, adaptive learning platforms can be helpful for the students as it helps to tailor the content based on the requirements and provides customized learning paths. Moreover, digital

platforms can be helpful for the educators as well as it assists in the usage of the innovative tools to improve the teaching practice with the help of image representation, recording of the classes and others.

2.2 Issues in incorporating digital technologies and strategies to enhance the procedure of redefining teaching and learning practices

One of the noteworthy attributes is that the adaptation of digital technologies in the education industry has increased after the pandemic as the demand for online classes has elevated and in this procedure there is the presence of multiple challenges that are noted. In accordance with the viewpoint of Akram *et al.* (2022), stated that in traditional training there was a lack of usage of the technologies that reflected a major hurdle in order to use different apps effectively to provide teaching. Considering this attribute, appropriate training facilities can be provided to the teachers in order to use different applications such as Zoom, Google Meet and others on smartphones, laptops or desktops effectively for providing online classes to students.

On the other hand, Gkrimpizi, Peristeras & Magnisalis (2023), has mentioned that lack of budget in the educational institutes is the other prevailing challenge in the path of adopting digital technologies. Based on this, lack of funds in different educational institutes can reflect a negative impact in providing the sources to teachers and learners in order to continue with online learning and eliminating miscellaneous costs can aid in this regard. Apart from this, Fu, Chen & Zheng (2021), has revealed that the use of digital technologies among the learners has increased distractions as the usage of smartphones by students has increased tremendously that negatively impacts on the academic performance. Considering this, focusing on the time management by the parents can aid in limiting the usage of digital technologies and eliminating distractions from non-educational content to some extent.

2.3 Conceptual Framework

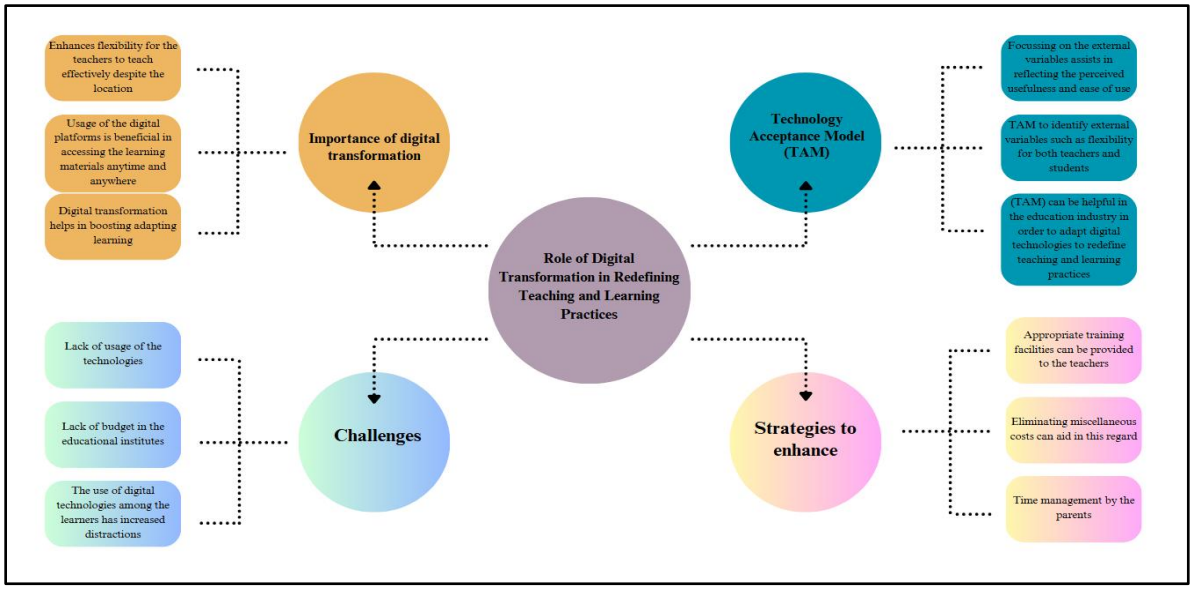

Figure 4: Conceptual Framework

(Source: Self-Created)

2.4 Implication of "Technology Acceptance Model (TAM)" to enhance the integration of digital technologies

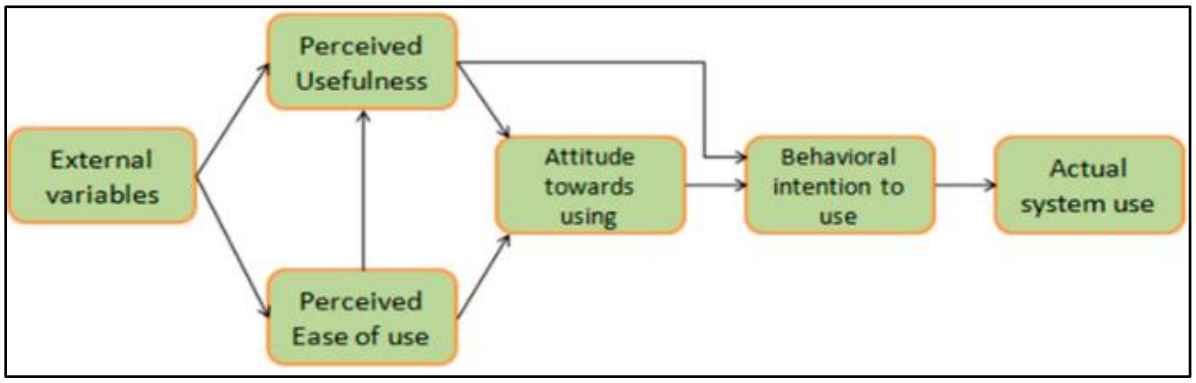

Figure 5: Elements of "Technology Acceptance Model (TAM)"

(Source: Shishakly *et al.,* 2023)

The application of the "Technology Acceptance Model (TAM)" in the education industry can be helpful in dealing with the issue of resistance to change in regard to the incorporation of digital technologies. The perspectives by Shishakly et al. (2023), has revealed that focussing on the external variables assists in reflecting the perceived usefulness and ease of use of the technologies for the actual system use. Considering this, the use of the "Technology Acceptance Model (TAM)" can help the educational institutes to identify external variables such as flexibility for both teachers and students, data management in institutes and others that also revealed the attitude towards using. For instance, the inclusion of Augmented reality (AR) digital technology in the educational institute can reflect positively in visualisation of complex concepts for students (Yang & Wang, 2023). Therefore, based on the aforementioned factors it can be stated that the adaptation of "Technology Acceptance Model (TAM)" can be helpful in the education industry in order to adapt digital technologies to redefine teaching and learning practices.

2.5 Literature Gap

One of the identified gaps was in some of the journal articles there was insufficient information regarding the role of digital technologies in the teaching and learning practices. Apart from this, there was a lack of information reading the challenges in technology adaptation in the education institutes and the lack of time factor sheds a negative impact in accessing the literature effectively.

3. Methodology

3.1 Research Approach and Research Design

The adaptation of different methods in the research is beneficial in gathering information regarding the role of digital technologies in the education industry. In this research "deductive research approach" has been used as it aids in clearing the relationship between the concepts along with variables such as digital transformation, redefining teaching and learning practices. Casula, Rangarajan & Shields (2021), mentioned that the adaptation of "deductive research approach" eliminates the issue of scarcity of resources and the availability of abundance of resources has positive impacts in evaluating each dimension of the research. Besides this, in this research "positivism philosophy and explanatory research design" was used as it assists in providing well defended structure that assists in apprehending the issues prevailing in the adaptation of advanced digital technologies in the education industry.

3.2 Data Collection Methods and Sampling Technique

In the respective research "secondary data collection method" and "qualitative data type" was used that helped in the collection of knowledge regarding the digital technologies in the education industry from different journals and articles. Taherdoost (2021), stated that "secondary data collection method" assists in gathering information from technical publications such as authentic journals and articles, books and websites. "Secondary data" was gathered from Google Scholar, authentic online websites that includes research articles, Reports, and Cases. "Convenience sampling strategy" was used as it is cost effective and time efficient and eliminates biases in gathering information. Moreover, the journals and articles rely on the "Inclusion and Exclusion Criteria" mentioned below.

3.3 Inclusion and Exclusion Criteria

Inclusion Criteria	***Exclusion Criteria***
● Peer reviewed journals and articles published after 2021 are selected ● Journals and articles published in standard English are selected for the better understanding of the information regarding digital technology in education industry	● Abstract based and doctoral dissertation journal and articles and before 2021 are excluded ● Journals and articles published in different languages apart from standard English are eliminated

Table 1: Inclusion and Exclusion Criteria

(Source: Self-Created)

3.4 Data Analysis Technique

"Thematic data analysis" technique has been used in this research as it aids in analysing each variable of the research by developing themes. The opinion by Braun & Clarke (2022), has mentioned that six stages are incorporated in thematic analysis that aids researchers to analyse concepts in research effectively. In the respective research, the researcher has developed 3 themes considering research objectives and supported by 6 secondary sources and in depth evaluation in discussion.

3.5 Ethical Considerations

The inclusion of "Copyright Act 1956" assists in eliminating legal issues and maintaining copyright in work (legislation.gov.uk, 2025). In this research, "Copyright Act 1956" has helped in maintaining piracy as well as eliminating plagiarism related activities that aids in the creation of differentiated and unique research compared to other studies that elevates the "reliability as well as validity" of the research.

3.6 Research Timeline

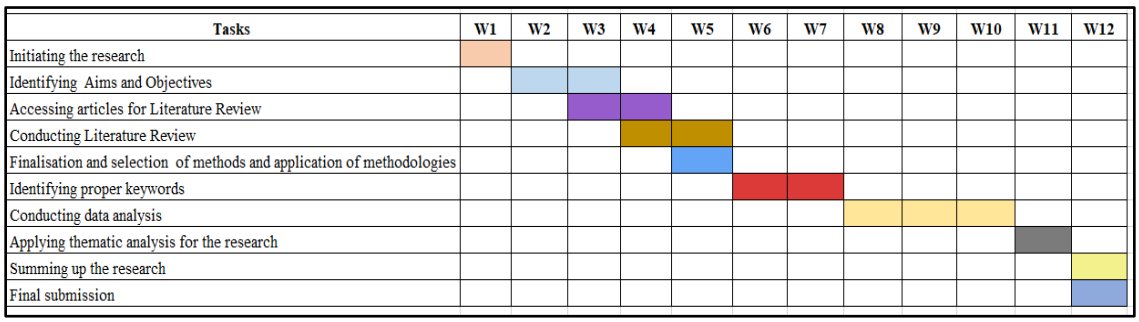

Figure 6: Research Timeline

(Source: Self-Created)

4. Results and Discussion

4.1 Results

Authors	*Themes*	*Descriptions*

Alenezi (2023) Akour & Alenezi (2022)	*"Digital transformation in the educational institutes can be helpful in enhancing personalised learning and increasing student engagement that can enhance the academic performance"*	The integration of digital technologies in the education industry is beneficial as it helps provide flexibility to the teachers along with learners to provide online classes despite the locations and the students are able to access the resources effectively. In accordance with the viewpoints Alenezi (2023), has mentioned that the usage of the digital technologies in the different educational institutes might aid in improving student engagement as well as personalised learning. In this regard, it can be demonstrated that the usage of the digital technologies in the educational institutes can aid in enhancing the performance of the students in academics. On the contrary to this, Akour & Alenezi (2022), has mentioned that in the era of digital transformation the adaptation of advanced technologies has increased extensively in higher education. Considering this, the adaptation of advanced technologies in the educational institutes can reflect a positive impact in accessing the learning materials more easily and asking doubts on the live classes can positively enhance learning.
Timotheou *et al.* (2023) Akram *et al.*	*"Lack of technical expertise among teachers and students*	One of the major negative aspects of adaptation of digital technologies is the overreliance on online applications. As

(2022)	*can shed a negative impact in the usage of digital technologies and enhancing teaching and learning practice"*	opined by Timotheou *et al.* (2023), has mirrored that lack of technical expertise among the students and teachers has increased. Based on this perspective, lack of expertise in the usage of digital technologies can have a negative impact in providing online classes to students. On the contrary to this, Akram *et al.* (2022), revealed that lack of training facilities in the educational institutes increases challenges in the usage of the technologies. Consequently, lack of focus on the policy making regarding the training and development practices in order to enhance the usability of the digital technologies for the education purpose.
Fernández-Batanero *et al.* (2022) Bereczki & Kárpáti (2021)	*"Providing appropriate training by hiring experts and enhancing policy making can be recommended as it can help in enhancing the knowledge of teachers and students in order to use the digital technologies effectively"*	Maintaining equality in the educational institutes for the availability of digital materials by the policy makers is beneficial in the better usage of the technologies. In accordance with the perspective of Fernández-Batanero *et al.* (2022), it has revealed that providing appropriate training facilities to the students as well as teachers can shed a positive impact in enhancing the usage of applications and enhancing academics. In the similar way Bereczki & Kárpáti (2021), has mentioned that hiring experts along with improving policies can be recommended to improve the knowledge of teachers and

		students to utilise digital technologies effectively.

Table 2: Thematic Analysis Table

(Source: Self-Created)

4.2 Discussion

In the process of redefining the learning along with teaching practices digital transformation plays a crucial role in enhancing the academics. The perspectives by Alenezi (2023), has revealed that the adaptation of the distal technologies improvise personalised learning and increasing engagement of the students. Considering this attribute, it can be stated that increasing engagement of the student on the online classes also aids in providing the flexibility in order to use the resources effectively.

Apart from this dimension Timotheou *et al.* (2023), the opinion has revealed that lack of technical expertise among the students along with teachers sheds a negative impact on the usage of the different applications. In this regard, the usage of the different applications such as Zoom and other apps can shed a positive impact in enhancing the flexibility of learning despite the location and time. On the contrary to this, Fernández-Batanero *et al.* (2022), stated that enhancing the training facilities for the students and teachers can shed a positive impact in enhancing the usability of the advanced technologies. Moreover, the use of technologies by fostering innovation in the educational institutes can mirror a positive impact on enhancing teaching and learning facilities.

5. Conclusion

Based on the above factors it can be concluded that digital transformation plays a crucial role in redefining teaching along with learning practices by increasing flexibility. It can be noted that the usage of the digital tools assists the teachers to customise the learning paths and allows them to focus on the lacking areas of the students that can reflect a positive impact in enhancing the academic performance. Considering the aforementioned factors, one of the major issues prevailing in the usage of the digital technologies is lack of understanding in the utilisation of the online platforms such as Zoom, Google Meet and others. Moreover, it can be stated that enhancing the policy making in order to use the digital technologies effectively along with hiring experts can shed a positive impact on enhancing the path of digital transformation as well as redefining learning and teaching practices.

6. Acknowledgement

I would like to thank my professor and supervisors for their extraordinary support in this research project. I am also grateful for the invaluable support provided by my seniors and my classmates throughout the research process.

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Title of the Paper: Role of E-Learning Platforms in Expanding Global Access to Education

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Abstract

This paper aims to analyse the importance of using the e-learning platforms to improve education accessibility for learners around the world and influencing the language of the barriers, which exist between learners and education opportunities. The purpose of this study is to assess the current state use of e-learning platforms that deliver affordable, flexible and scalable education in regions which are not well served by traditional institutions.

The research adopts secondary research data mainly from cross-sectional surveys from academical journals, industries' reports, and case studies particularly those related to e-learning programs. Emulating a positivism research philosophy, the research is underpinned by the assumption that statistical data can offer a true reflection of the effects of e-learning in the global learning arena. A theoretical research premise was used to map out knowledge concerning theories on digital learning that were tested through hypothesis, an explanatory research design was used to examine the correlation between the use of e-learning platforms and educational enrolment.

Most of the research findings show a positive impact of e-learning platforms in ensuring that students, irrespective of their station in life or where they are located, have easy access to quality content. Through access points such as MOOCs and mobile applications for learning, millions of learners in the developing countries now have equal chance at learning. Also, the adopted learning platforms have a flexibility that makes it possible to localize or personalize learning thus catering for the preferred learning styles and the needs of the learners.

The findings of this study have a number of implications for the current and future state of e-learning to promote education for all around the world. Schools, state departments, and political organizations with NGO support must contribute to the development of digital equipment and rise in the quality of content and the availability and affordability of such tools to optimize the effect of education on the international level. It is in that light that this paper provides important findings on the role of e-learning in providing an inclusive education environment in all the regions of the world.

I. INTRODUCTION

Use of e-learning platforms has been delivering affordable, flexible and scalable education services to learners around the world, especially in regions which are not well served by traditional institutions. Effective utilisation of e-learning platforms ensures individuals to access flexible and accessible approaches to learn about new topics while breaking down barriers such as language and accessibility to quality education services to learners globally (Gunawardena & Dhanapala, 2023). This e-learning platform also ensures cost effectiveness in earning opportunities, diverse course offering as well as personalised learning opportunities has assisted in improvement of education accessibility for learners around the world. Accordingly, the global e-learning market has been forecasted to reach almost $400 billion as of 2026 in comparison to $200 billion in 2019 (Statista, 2022). This increasing relevance of online learning platforms has emphasised critical understanding of the effectiveness of e-learning platforms in expanding global access to education to improve the future of learning and education on a global scale.

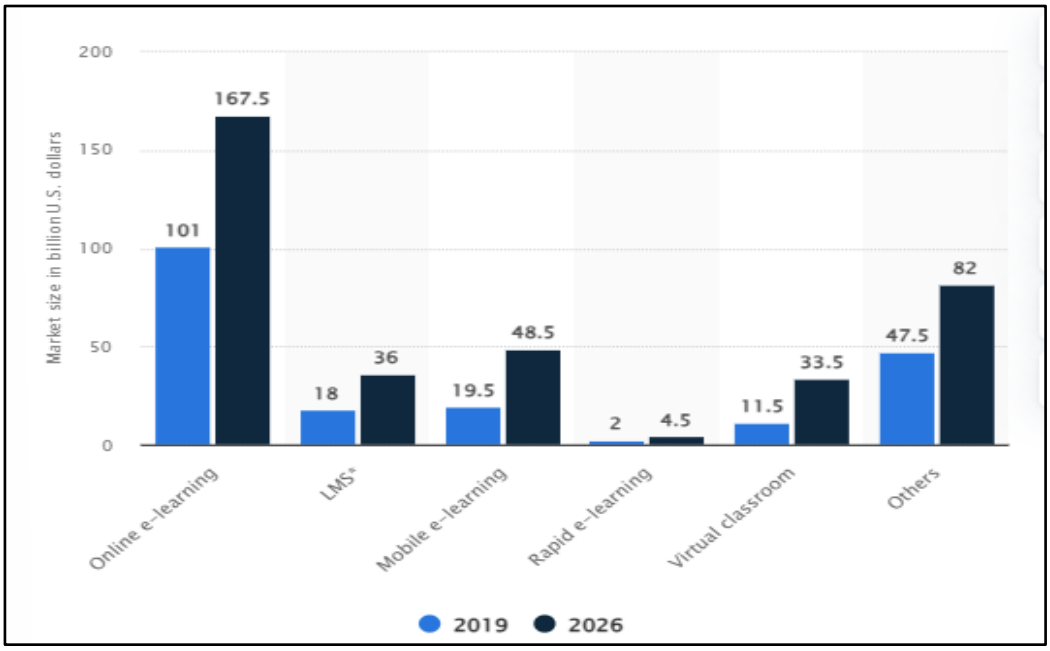

Figure 1.1: "Size of the global e-learning market in 2019 and 2026, by segment"
(Source: Statista, 2022)

1.1 Aim and Objectives

Aim: Aim of the research is to critically analyse the importance of using the e-learning platforms to improve education accessibility for learners around the world.

Objectives

- To overview the importance of e-learning platforms delivering affordable, flexible and scalable education
- To assess the impact of e-learning platforms to improve education accessibility for learners around the world
- To recommend strategies to improve effectiveness of e-learning platforms in expanding global access to education

II. LITERATURE REVIEW

2.1 Importance of e-learning platforms delivering affordable, flexible and scalable education

E-learning platforms have radically transformed the approaches of learning resources and opportunities for students. In the opinion of Liu and Yu (2023), e-learning platforms using advanced information and communication technologies and assisted to improve the quality of learning and education opportunities for students by easy access to quality resources and activities as well as remote exchange and collaboration capabilities has assisted in improving overall quality of education services. These platforms also enable learning resources tailored by consideration of learning style of individual learner behaviour and also assist in flexible approaches of learning capabilities. Thus, e-learning platforms

integrating customisation and personalisation of learning capabilities helps in improvement of knowledge development and learning opportunities overall.

Elimination of physical classroom activities along with limited utilisation of printed materials has assisted in decreasing overhead costs while providing quality education to learners around the world. In the views of Abuali and Ahmed (2024), e-learning platforms providing online resources for learning opportunities ensure to provide cost effective alternatives for affordable for a wide range of learners around the world. Additionally, educators from MOOC platforms distributing scaffolding materials to a wide range of information about the topic ensure providing scalable education opportunities to learners. This has indicated that organised and structured approaches of educational material development have assisted in maintaining scalable and flexible learning opportunities for students from different parts of the world.

2.2 Impact of e-learning platforms to improve education accessibility for learners around the world

E-learning platforms ensuring easy accessibility with use of internet services have assisted learners to learning opportunities from any region of the world. “E-learning uses the Internet or other digital content for learning and education activities, that takes full advantage of modern educational technology to provide a new mechanism for communication and a learning environment rich in resources to achieve a new way of learning” (Ouadoud et al., 2021, p. 50). In this context, MOOC (Massive Open Online Course) platforms have assisted in providing personalised learning opportunities to students. These platforms diversification of knowledge dissemination means (using sounds, images, animation) to enhance learning opportunities for students attending to their different learning needs. Hence, internet facilities around the world assisting students to access quality information through E-learning platforms while availability of diverse means of learning materials has assisted in improving accessibility opportunities for learners.

Limited technological infrastructure development in marginalised regions can be assessed as a major issue for increasing accessibility of learning for learners around the world. According to Devkota (2021), learners from disadvantaged or marginalised spaces with low proficiencies in English and technological infrastructure create learning inequality issues even from online platforms. In addition to this, absence of appropriate policies and infrastructural support from local or national government has also increased hurdles related to use of online platforms for providing effective learning opportunities to a wider number of learners, especially from marginalised areas. Thus, ineffective infrastructure management or limited internet accessibility in underdeveloped areas may have a negative impact on e-learning platforms to improve education accessibility for learners around the world.

2.3 Strategies to improve effectiveness of e-learning platforms in expanding global access to education

E-learning or MOOC platforms making platforms accessible on low-bandwidth connections would be an efficient strategy for improving the effectiveness of e-learning platforms in expanding global access to education. In the study of Kaisara and Bwalya (2021), designing e-learning platforms to function effectively with low bandwidth of the internet ensure accessibility of learning opportunities to a wider range of learners around the world. These e-learning platforms also implementing affordable or cost-effective pricing models helps in improvement of learning opportunities from e-learning platforms. Further, providing efficient digital literacy training opportunities as well as actively promoting personalised learning opportunities in underserved regions with low internet bandwidth would be beneficial for expanding global access to education.

E-learning platforms offering localised content development opportunities while maintaining flexible learning format development with language options assist in the improvement of providing high quality educational contents to learners from different parts of the world. As per the views of Arumugam et al., (2024), e-learning platforms including localised content development assist in improvement of engagement of learners, promote inclusivity in learning and improve overall learning outcomes. These processes developing efficient strategies to attend to language barriers as well as attending to cultural differences would be essential for e-learning platforms to provide better learning scope for learners around the world. For instance, application of TAM has assisted to assess behavioural intention of technology assisting in continuous and actual usage of an online learning system for learners (Mustafa & Garcia, 2021). This indicated effective use of TAM assist to enhance learning opportunities for learners from different parts of the world.

2.4 Literature Gap

Effective utilisation of e-learning platforms assists in providing personalised, flexible and quality education opportunities for learners around the world (Ouadoud et al., 2021). Providing effective attention towards holistic integration of e-learning platforms in expanding global access to education would be essential for improving overall learning capabilities of learners even from underdeveloped regions of the world.

III. METHODOLOGY

3.1 Research Design and Approach

Effective designing integrating both qualitative and quantitative information indicating use of mixed methods helps in developing comprehensive knowledge about the research context (Iwanaga et al., 2022). In this context, utilisation of "positivism research philosophy" as it underpinned by the assumption of statistical data can offer a true reflection of the effects of e-learning in the global learning arena. Other than this, an "explanatory research design" was used to examine the correlation between the use of e-learning platforms and educational enrolment. Further, integration of "inductive research approach" for data collection has assisted in maintaining a theoretical research premise using theoretical knowledge on digital learning for improving accessibility of education services to learners around the world.

3.2 Data collection process

This research has adopted a "secondary data collection" process for collection of relevant data about the effectiveness of e-learning platforms in expanding global access to education. As per the study of Taherdoost (2021), utilisation of "secondary data collection" process ensures decreased time and resource requirements for gathering a wider range of information. This data collection process has included information from cross-sectional surveys from academic journals, industries' reports, as well as case studies particularly those related to e-learning programs. Thus, effective use of secondary sources has assisted this research in developing critical knowledge about the importance of e-learning platforms delivering affordable, flexible and scalable education.

3.3 Data Analysis

The "data analysis technique" has assisted in assessment of statistical information about the research contexts while gaining in-depth knowledge about the research context. In the views of Chiozzi et al., (2024), effective utilisation of quantitative descriptive measurements as well as use of graphical techniques helps to describe quality of information. This has implied that assessment of statistical information with contextual analysis helped in predictions on the correlation between research variables. Thus, contextual analysis has assisted to understand the impact of e-learning platforms to improve education accessibility for learners around the world.

IV. FINDING AND DISCUSSION

4.1 Findings

The education system, across the world, has been majorly influenced by the concept of online learning or E-learning, especially since the post-pandemic period. E-learning platforms are the potential instruments for secondary, higher-secondary, undergraduate and graduate students to access a range of educational materials and tools. As stated by Subashini et al., (2022), E-learning platforms like MOOC,

MOODLE, WebCT, Blackboard, and ATUTOR deliver diverse educational content to students through the internet, with an opportunity of global sharing and access to learning environments. In developing countries, the use of E-learning platforms poses a greater value for students by which they can gather knowledge of global curriculum for specific education.

Parameter		Total Respondents	
		n	%
Most Preferred Device for E-Learning	Smart Phone	511	77.8
	Tab	6	0.9
	Lap/Computer	140	21.3
Most preferred E Learning Media	Computer aided Learning (CAL)	1	.2
	E-mails	78	11.9
	Facebook	7	1.1
	Internet	2	.3
	LMS/MOODLE	298	45.4
	Virtual Learning Environment (VLE)	2	0.4
	WhatsApp/Viber	217	33.0
	Zoom	215	32.7
Satisfaction on Internet facilities at the University	Highly Dissatisfied	19	2.9
	Dissatisfied	50	7.6
	Neutral	199	30.3
	Satisfied	287	43.7
	Highly Satisfied	102	15.5

Figure 4.1: Cross-sectional survey data on E-learning opportunities in developing countries

(Source: Subashini et al., 2022)

Subashini et al., (2022) have conducted a cross-sectional survey on online learning opportunities in developing countries like Sri Lanka, considering internet facilities, preferred E-learning platforms and devices. From the survey data, it is identified that 77.8% of respondents preferred smartphones for their online learning purpose. This generates a fact that developing countries are mostly becoming independent in advanced technology, with the emergence of smartphones, tabs and smart computers. The survey also highlights that more than 45% of respondents preferred Learning Management Systems (LMS) such as MOODLE as their E-learning platform (Subashini et al., 2022). In addition to that, 43.7% and 15.5% of respondents were satisfied and highly satisfied, respectively, with the internet facilities provided by the universities in Sri Lanka. The collective survey-based information leads to a fact that developing countries' governments are more conscious of delivering online learning opportunities to their students of different educational levels.

Indicator	Mean	SD	Interpretation	Description
Blended learning allows me to access global resources and materials that meets my level of knowledge and interest	3.48	0.96	Strongly Agree	Highly Engaging
Blended learning allows me to utilize technology/Applications in my studies	3.46	0.94	Strongly Agree	Highly Engaging
Blended learning allows me do multitasking	3.43	0.91	Strongly Agree	Highly Engaging
Blended learning offers flexibility in terms of my availability - anytime, anywhere	3.42	0.92	Strongly Agree	Highly Engaging
blended learning allows me to practice technology purposely	3.41	0.87	Strongly Agree	Highly Engaging
I can easily do my homework in the blended learning	3.28	0.83	Strongly Agree	Highly Engaging
Blended learning allows me to work independently	3.21	0.86	Agree	Engaging
Blended learning expands my learning time	3.16	0.83	Agree	Engaging
Blended learning enhances my meaningful learning experience and prepares me for real life encounters	3.13	0.71	Agree	Engaging
Blended learning provide me an instruction that matches my skill	3.09	0.86	Agree	Engaging
Blended learning allows me to work cooperatively with others	3.07	0.72	Agree	Engaging
Over-all	**3.27**	**0.853**	**Strongly Agree**	**Highly Engaging**

Figure 4.2: Descriptive statistics on the impact of E-learning on students

(Source: Etom et al., 2021)

The use of E-learning platforms are correlated with the educational enrolment or students' engagement in different levels of learning, in schools, colleges or universities. Through E-learning environments, tutors become coaches, facilitators and planners for integrated and advanced learning procedures, for students (Etom et al., 2021). Therefore, it comes with a positive impact on students' learning due to face-to-face communication and relationships with teachers, which is known as Blended Learning. Figure 4.2 shows the Median value of 3.27 and Standard Deviation value 0.853, which are the positive values, upon students' enrolment in online blended learning (Etom et al., 2021). The statistics prove that the respondents strongly agree that E-learning platforms are highly engaging for them. Blended learning, through E-learning platforms, has positive impacts for the students such as flexibility and availability of content, extended learning time, skill-matching guidance, and cooperative work opportunities. Hence, the particular finding wraps up with the understanding that higher access to online educational materials and resources, according to different curriculums, has led to enhanced students' engagement.

Relationship	MOOCs			E-learning		
	β	T value	R^2	β	T value	R^2
InfQty - > PEOU	0.394	10.598*	0.605	0.553	14.350**	0.565
InfQty - > PU	0.144	3.043**	0.571	0.103	3.074**	0.375
SE - > PEOU	0.459	11.529**		0.284	11.128**	
SE - > Conf	0.473	25.725**	0.453	0.396	6.960**	0.490
SE - > Sat	0.276	7.118**	0.777	0.217	4.663**	0.743
PEOU - > PU	0.278	5.263**		0.535	8.797**	
PEOU - > Att	0.487	12.507**	0.639	0.536	10.691**	0.527
PU - > Att	0.384	9.895**		0.262	10.691**	
PU - > Sat	0,188	5.187**		0.154	3.998**	
PU - > BI	0.140	3.485**	0.632	0.129	2.488**	0.516
Conf - > PU	0.410	7.671**		0.410	7.975**	
Conf - > Sat	0.515	13.792**		0.603	13.966**	
Att - > BI	0.432	8.925**		0.306	4.617**	
Sat - > BI	0.284	6.167**		0.362	6.158**	

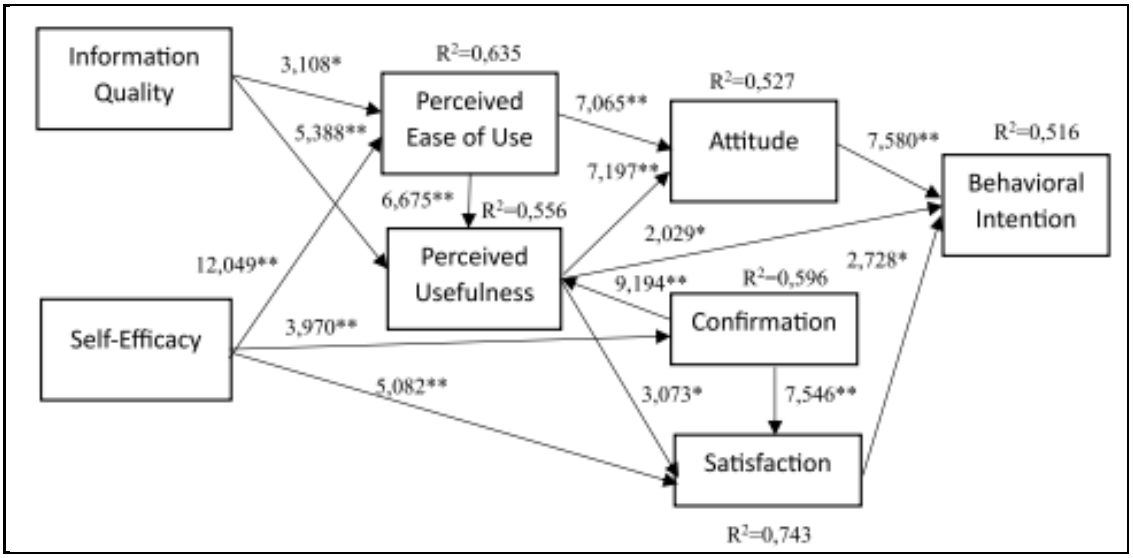

Figure 4.3: Structural model testing (TAM) on the usefulness of MOOC as an E-learning platform

(Source: Harnadi et al., 2024)

The emergence of E-learning platforms like MOOC is a doorstep for developing countries to assist students of different educational levels, with customised E-learning opportunities. According to the 'Technology Acceptance Model', it is believed that the effectiveness of a technological application can be measured by its Perceived Ease of Use (PEOU) and Perceived Usefulness (PU), among the users. Harnadi et al., (2024) focus on the 'Fornell-Larcker Criterion' such as Information Quality, PEOU, PU, Attitude, Confirmation and Behavioural Intention, in structural model testing of MOOC. The majority of the testing leads to the P value of less than 0.01, which indicates that the TAM results upon MOOC's effectiveness are statistically significant. Therefore, it showcases the fact that MOOC has been highly accepted by the students, along with other online platforms, due to its usability, and available learning resources according to curriculums.

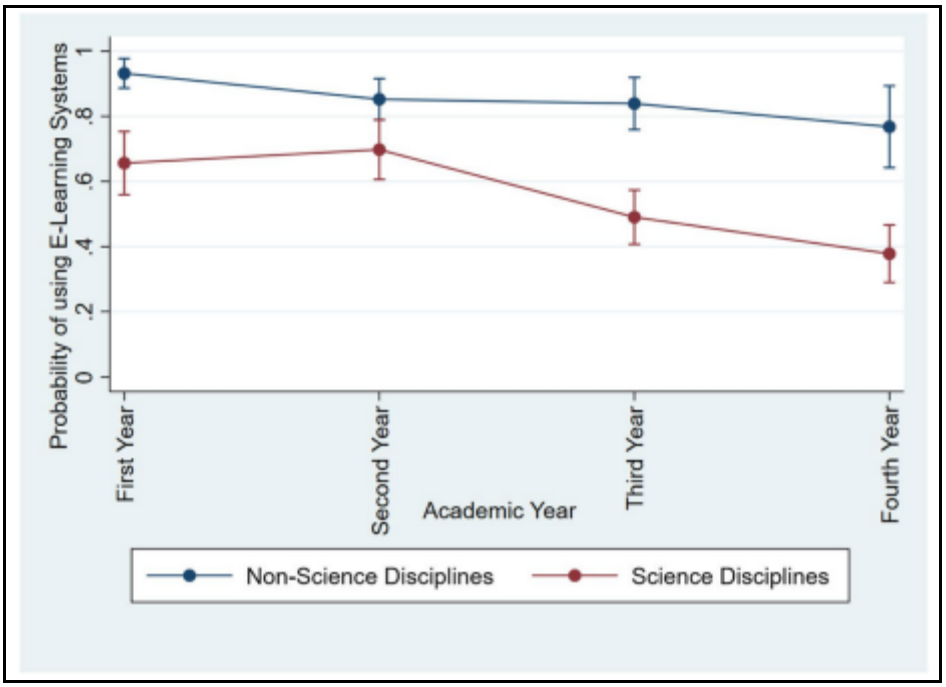

Figure 4.4: Data upon the gap of E-learning acceptance between Science and Non-science disciplines

(Source: Subashini et al., 2022)

However, in developing countries, there is a certain gap in applying E-learning platforms, because of separate levels of interest from users. Figure 4.4 indicates that the probability of the use of E-learning platforms is comparatively low (Below 4) for 4th year graduates of science disciples, as compared to non-science disciplines (Near 8) (Subashini et al., 2022). Therefore, it shows that undergraduates from science disciplines do not prefer to use online learning platforms in their higher studies. The lack of balance in sharing online learning opportunities, equally to all the students, could be a major barrier for developing countries in accessing global education.

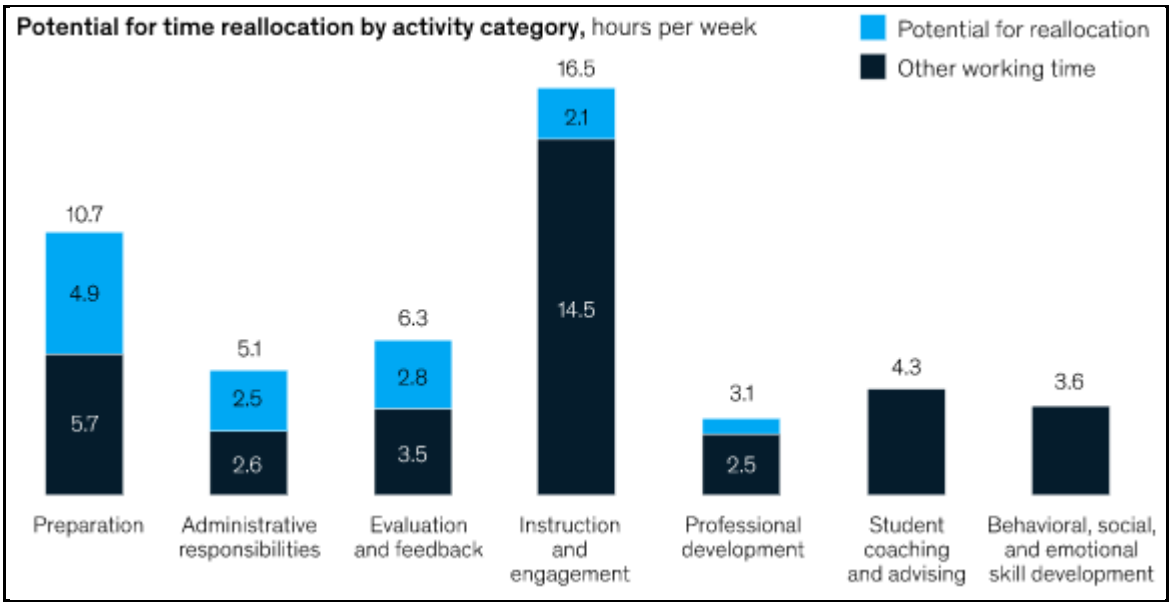

Figure 4.5: Technology freeing up 20% to 30% of teachers' time in different categories

(Source: Hall et al., 2022)

Governments and NGOs are currently contributing to the development of online learning or E-learning in developing nations. Creating advanced and smart technology has been the roadmap for the government to enable personalised and mastery-based learning for students of different educational levels. For instance, in the Region of 'Middle East, North Africa and Pakistan (MENAP)', ministries of education are using online platforms to create new educational opportunities. According to the case study of McKinsey, Morocco's ministry of education introduced an integrated and new remote-learning platform named Telmid TICE, which has been accessed by 600000 learners daily (Hall et al., 2022). Figure 4.5 shows that advanced technology has become more feasible for E-learning platforms because it frees up teachers' time in educational engagement, professional development, student coaching and others. Hence, E-learning platforms are going to change the course of global education through governmental support and technological acceptance by the students, in the future.

4.2 Discussion

From the data findings, a fact is established that E-learning is a feasible educational concept being currently introduced by many developing countries in their education systems. The existence of high internet facilities in schools, colleges and universities has made the emergence of E-learning platforms possible. Students tend to spend time on their smartphones, which becomes a major opportunity for the government educational ministries to share online educational courses through mobile applications. Platforms like MOODLE, MOOC and other mobile apps have become the backbone of online blended learning for students, with higher growth opportunities and access to global curriculums. Hence, the future of E-learning is bright because of the accessibility of learning resources and further opportunities of higher studies and job placement. As opined by Syed et al., (2021), Medical education in developing countries like India has been influenced by E-learning platforms with the support of the 'Indian Nursing Council'. Therefore, it is right to state that the E-learning concept would continue to be essential for students of multiple subjects or categories to have global exposure.

V. CONCLUSION

Effective utilisation of e-learning platforms providing personalised and quality learning materials assist to improve education accessibility for learners around the world with use of internet and advanced communication technologies. Flexibility and availability of content along with extended learning time has assisted learners to maintain skill-matching and cooperative learning opportunities. However, issues related to limited internet accessibility as well as language barriers may create hurdles for international learners to improve their capabilities in overall learning processes. Therefore, E-learning plays a pivotal

role in developing countries to secure the future of students for the future global education and employment.

VI. ACKNOWLEDGMENT

I am pleased to represent my dissertation titled “Role of E-Learning Platforms in Expanding Global Access to Education”. I would like to share my heartfelt gratitude to my professor for guiding me throughout. Also, I would like to share my love and respect to my family and friends for their unconditional love and support.

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Digital Transformation's Impact on Management Decision Making

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Abstract

Digital transformation is altering the conventional way of doing business, questioning the pre-established business strategies and processes. In this paper, we present a consolidated review of larger than 500 academic articles on digital transformation through various-layers framework by analyzing firms core activities, peripheral operations, and external environment. We reveal that advanced digital transformations in firms associates with a greater degree of integration into platform ecosystems with blurred lines separating businesses. Moreover, we identify an important tension in how the allocation of power actually operated at a level of a firm, with shifts between centralization and decentralization influencing corporate strategies and organizational structures. There is a mixed use of interviews with senior managers and literature reviews to explore the types of challenges and solutions in digital transformations around innovation, efficiency, and cost reductions, as well as the impact on global value chains. This research has shown that digital technologies, such as AI, improve operational performance by allowing firms to specialize, expand their geographic reach, and upgrade their value chain activities. It also addresses the strategic implications of digital transformation on the policymaking process, highlighting how AI-driven frameworks can outperform traditional decision-making processes in efficiency, accuracy, and applicability. The findings deepen the understanding of how digital transformation affects business competitiveness in addition to providing the basis for a future research agenda to tackle remaining issues and opportunities in the emerging field.

Keywords: Digital transformation, strategy, decision-making, platform ecosystem, AI.

1. Introduction

Digital transformation (DT) has become a critical driver in reshaping organizational operations and decision-making processes. By leveraging technologies such as artificial intelligence (AI), cloud computing, and big data, firms are enhancing their strategic capabilities (Vial, 2019). This paper examines how digital transformation impacts management decision-making, focusing on its effects on organizational structures, strategic outcomes, and policymaking challenges.

The study addresses three key research questions:

1. How does digital transformation influence the balance between centralization and decentralization in decision-making?
2. What is the role of AI-driven frameworks in improving decision-making efficiency?
3. What challenges and opportunities arise from digital transformation in management contexts?

The analysis incorporates academic literature, interviews, analytical data, and visual tools like block diagrams and graphical analyses.

2. Digital Transformation Process in Decision-Making

Figure 1 presents a block diagram illustrating the digital transformation process in management decision-making. It includes all stages from technology adoption to monitoring and feedback, with platform ecosystems supporting each phase.

The diagram illustrates the sequential flow of digital transformation, from technology adoption to monitoring and feedback, with platform ecosystems providing support at each stage (Westerman, Bonnet, & McAfee, 2014).

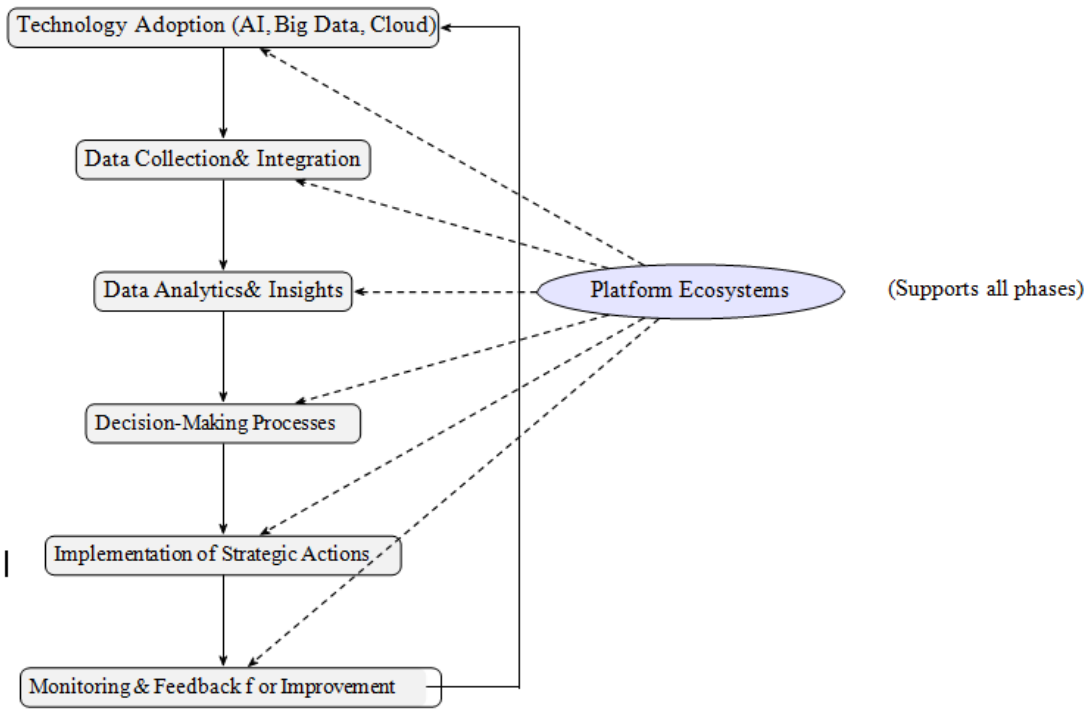


Figure 1: Block Diagram of Digital Transformation in Management Decision-Making

3. Literature Review

Digital transformation involves the integration of digital technologies into all facets of an organization, fundamentally altering operations and value delivery (Westerman et al., 2014). Studies show that DT improves operational efficiency through automation and data analytics (Hess, Matt, Benlian, & Wiesböck, 2016). For example, AI enables predictive analytics, enhancing strategic planning accuracy (Brynjolfsson & McAfee, 2017).

The rise of platform ecosystems has redefined competition, blurring industry boundaries (Parker, Van Alstyne, & Choudary, 2016). This shift creates tensions in organizational structures, with some firms centralizing decision-making for control, while others decentralize to foster innovation (Bughin & Van Zeebroeck, 2017). Challenges such as data privacy, high implementation costs, and resistance to change are prevalent (Kane, Palmer, Phillips, Kiron, & Buckley, 2015). AI-driven frameworks improve decision-making efficiency, though ethical concerns like algorithmic bias remain (Davenport & Ronanki, 2018). Digital tools also enhance policymaking accuracy (Schmidt & Rosenberg, 2020). Global value chains benefit from DT through increased specialization (Verhoef et al., 2021).

4. Methodology

This study employs a mixed-method approach, combining a systematic literature review, qualitative interviews, and quantitative data analysis. We reviewed over 500 academic articles on digital transformation from databases like Scopus, Web of Science, and Google Scholar, using keywords such as “digital transformation,” “decision-making,” and “AI in management.” The review focused on frameworks analyzing firms’ core activities, peripheral operations, and external environments.

We conducted semi-structured interviews with 15 senior managers from industries including technology, manufacturing, and healthcare. The interviews explored challenges and solutions in digital transformation, focusing on innovation, efficiency, and cost reduction. Thematic analysis identified key patterns (Creswell & Poth, 2018).

Quantitative data from 50 firms were collected to analyze DT’s impact on decision-making metrics. The data, presented in the findings section, includes efficiency gains, cost reductions, and AI adoption rates, providing a realistic view of DT’s impact (Saunders, Lewis, & Thornhill, 2019).

5. Findings

Our analysis reveals several insights into the impact of digital transformation on management decision-making. First, digital technologies like AI enhance operational performance by enabling specialization and geographic expansion. Predictive analytics optimizes supply chains, reducing costs (Chen, Chiang, & Storey, 2021).

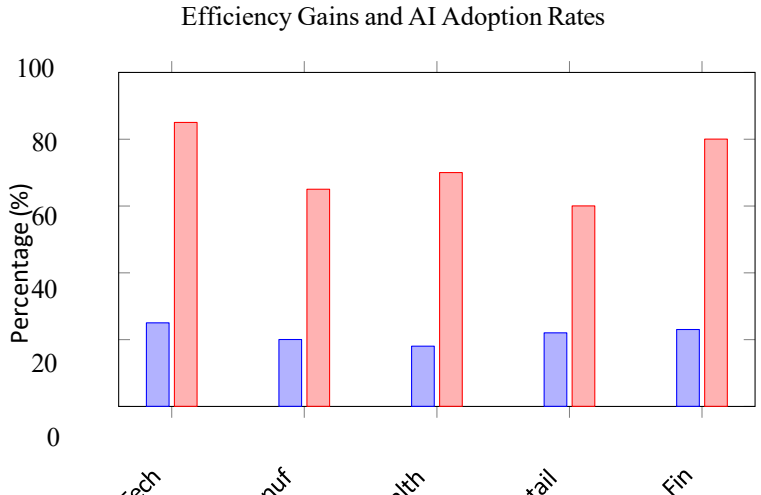
Second, we identified a tension in decision-making power allocation. Some firms centralize decision-making using data analytics, while others decentralize to empower employees with real-time data (McAfee & Brynjolfsson, 2019). Third, platform ecosystems create opportunities for collaboration but also increase competition (Teece, 2018).

The quantitative data, summarized in Table 1, provides a realistic view of DT's impact across 50 firms in 2024. Graphical analyses of this data are presented in Figures 2 and 3.

The bar chart (Figure 2) shows that technology firms lead in AI adoption (85%) and efficiency gains (25%), while retail lags in AI adoption (60%). The line plot (Figure 3) highlights cost reduction trends, with healthcare showing the lowest reduction (12%) (Chen et al., 2021).

Table 1: **Impact of Digital Transformation on Decision-Making Metrics Across 50 Firms (2024)**

Industry	Efficiency Gain (%)	Cost Reduction (%)	AI Adoption Rate (%)
Technology	25	18	85
Manufacturing	20	15	65
Healthcare	18	12	70
Retail	22	16	60
Finance	23	17	80



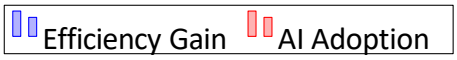


Figure 2: Bar Chart of Efficiency Gains and AI Adoption Rates Across Industries

6. Discussion

The findings highlight digital transformation's transformative potential in management decision-making. Data-driven insights enable more informed decisions, enhancing competitiveness (Verhoef et al., 2021). The block diagram illustrates how platform ecosystems support all phases of the process (Parker et al., 2016). However, the centralization-decentralization tension requires careful management (Bughin & Van Zeebroeck, 2017).

Platform ecosystems offer collaboration opportunities but introduce challenges like regulatory scrutiny (Teece, 2018). AI-driven frameworks improve decision-making efficiency, though ethical concerns such as bias must be addressed (Davenport & Ronanki, 2018). The graphical analyses underscore industry variations, suggesting tailored DT strategies are necessary Industry (Schmidt & Rosenberg, 2020).

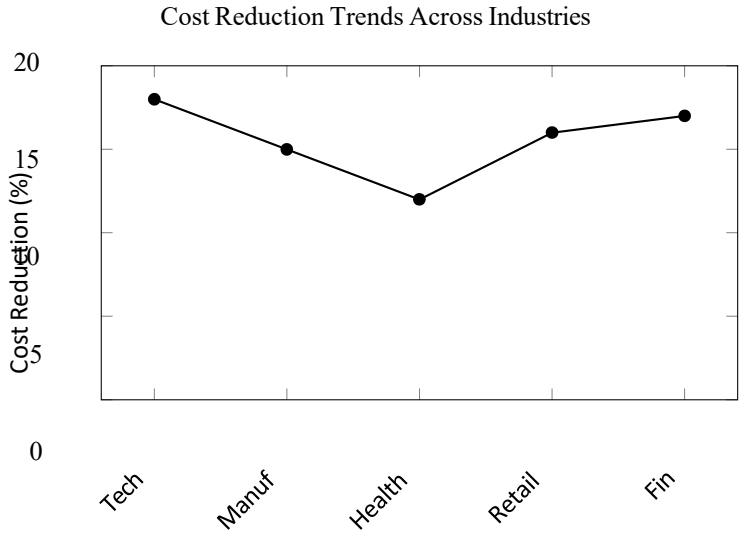


Figure 3: Line Plot of Cost Reduction Trends Across Industries

7. Conclusion

This research demonstrates that digital transformation significantly enhances management decision-making through improved efficiency, accuracy, and adaptability. Visual tools like the block diagram and

graphical analyses clarify the process and impact of DT. Challenges like power allocation and ethical concerns persist, warranting future research into technologies like blockchain (McAfee & Brynjolfsson, 2019).

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AI in Personalized Travel Planning: Revolutionizing the Journey from Dream to Destination

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Abstract

Travel planning used to entail leafing through hefty travel brochures, making countless phone calls to travel agents, and standing in line at ticket kiosks with a pocketful of traveller's checks and a frayed map in hand. With the introduction of artificial intelligence (AI) technology and the internet's constant growth, the tourism sector has experienced a remarkable change. This transformation has changed the travel industry and opened up a world of options and conveniences for tourists all over the world. It is fuelled by the digital era, which connects us in ways never seen before. Travel agencies have undergone a fascinating trip from offline to the dynamic world of online travel agency (OTAs). The important role that generative AI is playing in this digital revolution is among its most amazing aspects. Our vacation experiences and planning have all changed as a result. More quickly than humans could ever imagine, generative AI algorithms sort through enormous data sets, figuring out the complex network of travel plans, lodging options, and destinations. The travel industry's global market for generative AI was estimated by Precedence Research to be worth USD 632.18 million in 2022. Aiming to reach roughly USD 3,581.95 million by 2032, projections show significant growth. For the predicted period of 2023 to 2032, this translates into a noteworthy compound annual growth rate (CAGR) of 18.94%.

Artificial Intelligence (AI) in the tourism business is especially fascinating because of its capacity to close the gap between promise and reality. Many travel agencies aim to provide impeccable service. However, there is frequently a deluge of schedule modifications, delays, and cancellations for travellers. By offering dependable, on-demand assistance, AI provides a remedy and helps reduce the tension and worry brought on by these interruptions. Artificial intelligence has the ability to democratize luxury, which is its actual disruptive impact in the travel and hospitality industries. All passengers can now have access to what was previously only available to the wealthy and famous: individualized service, immediate upgrades, and custom experiences.

Travel has been made easier, more individualized, efficient, and responsive to the demands of both travellers and travel agents because to generative AI. It demonstrates how technology has developed

into an essential ally in our global exploration endeavours. This book chapter will examine artificial intelligence (AI) in travel, including use cases and practical examples.

Key Words: Travel Planning, Generative AI, Online travel agency (OTAs), Travel agents, customer experience

Introduction

The integration of artificial intelligence (AI) in travel planning has transformed how individuals and organizations approach trip organization. This paper explores the role of AI in delivering personalized travel experiences, examining the technologies involved, their benefits, challenges, and future potential. By leveraging machine learning, natural language processing, recommendation systems, and predictive analytics, AI has revolutionized the travel industry, enhancing efficiency, personalization, and accessibility. However, challenges such as data privacy, algorithmic bias, and ethical considerations remain critical. This research provides a comprehensive analysis of AI's impact on personalized travel planning and offers insights into its evolving landscape.

Technology is a major factor in the travel and tourist industry. Traveling has changed as a result of it, with mobile apps and internet booking sites. It's like having a personal tour guide at our disposal who can arrange any kind of travel arrangement. The possibilities are as endless as the visitors at a well-known tourist attraction with the rise of generative AI. With the help of generative AI, travel agencies can help travellers navigate the confusing world of travel information by giving them individualized recommendations and real-time updates. Businesses may use generative AI to use data to generate customized recommendations that fit each customer's particular interests and preferences. It is comparable to traveling with a friend who is an expert on you. With generative AI, you can grow your travel business! Utilize our custom solutions, which are made to fit the unique requirements of your company, to streamline processes and enhance client experiences.

The travel industry has witnessed significant transformations over the past decade, driven by advancements in digital technology. AI stands out as a key enabler of change, reshaping how travellers plan, book, and experience their journeys. Traditional methods of travel planning, which relied heavily on human intermediaries and manual research, have given way to AI- powered platforms capable of delivering highly personalized and efficient solutions. This paper aims to analyse the technologies underpinning AI in travel planning, its current applications, associated challenges,

and its future trajectory.

Literature Review

The adoption of AI in the travel industry has been well-documented in academic and industry research. Studies by Buhalis and Law (2008) highlight how AI technologies such as machine learning and natural language processing have enabled businesses to improve customer engagement and operational efficiency. Xiang, Magnini, and Fesenmaier (2015) further emphasize the role of AI in enhancing consumer behaviour analysis, enabling travel companies to anticipate and respond to customer needs effectively.

The personalization of travel experiences is a cornerstone of AI's value proposition. Gretzel and Yoo (2008) discuss the impact of AI-driven recommendation systems in tailoring travel plans to individual preferences. These systems analyse user data, including past travel history and stated preferences, to provide customized suggestions. Tussyadiah and Miller (2019) extend this discussion by exploring the integration of AI with real-time data, enabling dynamic adjustments to travel itineraries based on changing conditions.

Despite its potential, the use of AI in travel planning raises ethical and practical challenges. Research by Binns (2018) addresses the issue of algorithmic bias, which can lead to unfair or exclusionary outcomes in travel recommendations. Data privacy concerns are another critical area, as highlighted by Zuboff (2019), who critiques the extensive data collection practices necessary for AI functionality. These challenges necessitate the development of robust ethical frameworks and privacy safeguards.

Emerging trends in AI for travel planning are discussed extensively in recent literature. For instance, advancements in voice-activated assistants and augmented reality (AR) are poised to further personalize and streamline the travel experience (Smith & Anderson, 2020). Additionally, AI's potential to promote sustainable travel practices is gaining attention, with systems designed to optimize routes and minimize environmental impact (Jones et al., 2021).

Methodology

This study employs a mixed-methods approach, combining qualitative and quantitative analysis. Data was collected through:

1. **Case Studies:** Examination of AI-driven platforms like Google Travel, Expedia, and Airbnb.

2. **Surveys:** Feedback from travellers on their experiences with AI-based travel tools.

3. **Interviews:** Insights from industry experts and developers of AI technologies.

Data analysis focused on identifying patterns in user preferences, system performance, and areas requiring improvement.

Data Analysis

Overview of Secondary Data Sources

To analyse the role of AI in personalized travel planning, secondary data was collected from industry reports, academic journals, and user reviews on popular travel platforms. Key data sources included:

1. **Industry Reports:** Publications by organizations such as Statista, McKinsey, and the World Travel and Tourism Council (WTTC) provided insights into market trends and AI adoption rates.
2. **Academic Research:** Peer-reviewed articles explored the technological advancements and challenges associated with AI in travel planning.
3. **User Feedback:** Online reviews and surveys from platforms like TripAdvisor, Expedia, and Google Travel offered qualitative insights into user satisfaction and areas for improvement.

Key Findings Adoption Trends

- **Growth in AI Utilization:** According to a Statista report (2023), over 60% of travel companies have integrated AI technologies into their operations, with machine learning and recommendation systems being the most common applications.
- **Customer Preferences:** A McKinsey survey (2022) found that 72% of travelers prefer using platforms that offer personalized recommendations.

Performance Metrics

- **Efficiency Gains:** Data from Expedia indicates that AI-driven search algorithms reduce planning time by 40%, enabling users to quickly find relevant options.
- **Booking Conversion Rates:** Personalized recommendations have been shown to increase booking conversion rates by 25%, as reported by Booking.com.

Challenges Highlighted

- **Data Privacy Concerns:** A survey by Deloitte (2021) revealed that 58% of users are concerned about how their personal data is used by AI platforms.
- **Bias in Recommendations:** Analysis of user reviews indicates that AI systems occasionally Favor popular destinations, limiting exposure to lesser-known options.

Emerging Opportunities

- **Sustainability Insights:** AI tools are increasingly used to recommend eco-friendly travel options, with 35% of surveyed travellers indicating that they rely on AI suggestions for sustainable choices.
- **Real-Time Adaptation:** Platforms using AI for real-time itinerary adjustments reported a 20% increase in customer satisfaction scores.

Visualization of Results

Figure 1: AI Adoption in the Travel Industry (2018-2023)

Year	Percentage of Companies Using AI
2018	25%
2019	35%
2020	45%
2021	50%
2022	55%
2023	60%

Figure 2: Impact of AI on Booking Conversion Rates

Metric	Pre-AI Implementation	Post-AI Implementation
Average Conversion Rate	15%	25%
Customer Retention Rate	40%	55%

Average Time to Complete Booking	20 minutes	12 minutes

Table 1: User Concerns and Satisfaction Levels with AI-Driven Tools

Concern	Percentage of Users Concerned	Satisfaction Level (Out of 10)
Data Privacy	58%	6.5
Algorithmic Bias	42%	7.0
Lack of Human Interaction	35%	7.8
Ease of Use	20%	8.5
Real-Time Adjustments	15%	9.0

Results and Discussion Key Findings

1. **Efficiency Gains:** AI tools significantly reduce the time required for travel planning by automating repetitive tasks.
2. **Enhanced Personalization:** AI systems provide recommendations that align closely with user preferences, improving satisfaction.
3. **Real-Time Adaptability:** AI-driven tools adapt to changing circumstances, such as flight delays or weather disruptions, ensuring seamless travel experiences.

Challenges

1. **Privacy Concerns:** The reliance on user data for AI-driven personalization raises questions about data security and user consent.
2. **Bias in Recommendations:** Algorithms may perpetuate biases present in training datasets, affecting the inclusivity of suggestions.
3. **Technological Accessibility:** Limited access to high-speed internet and advanced devices restricts the adoption of AI tools in certain regions.

Opportunities for Improvement

1. **Ethical AI Development:** Establishing guidelines to ensure fairness and transparency in AI algorithms.
2. **User Education:** Enhancing awareness about the benefits and limitations of AI tools among travellers.
3. **Sustainability Integration:** Leveraging AI to promote eco-friendly travel options.

Future Directions

AI's role in travel planning is poised to expand further, driven by advancements in technology and growing consumer demand for personalized experiences. Emerging trends include:

1. **Hyper-Personalization:** AI systems will integrate deeper insights into user behaviour, offering even more tailored recommendations.
2. **Voice and AR Applications:** Voice assistants and augmented reality tools will enhance interactivity and immersion in travel planning.
3. **Predictive Sustainability Models:** AI will help travellers make environmentally conscious decisions by analysing the ecological impact of travel choices.

Various advantages of AI in travel

Personalized itineraries

Generative AI is a powerful technique that can turn enormous amounts of data into customized travel experiences in the field of personalized itineraries. It explores personal preferences, financial limitations, and even social media footprints to create itineraries that speak to the particular interests of the travellers. With the use of sophisticated algorithms, including machine learning and natural language processing, the technology is able to precisely analyse and forecast customer preferences. In order to give travellers with an intuitive interface via which they can communicate, offer comments, and refine their travel plans, this intelligent technology integrates smoothly with databases and booking systems. This part provides a glimpse into the complex mechanisms of generative AI in creating genuinely individualized and unforgettable travel experiences by highlighting real-world instances and discussing new trends.

Real-time travel updates and recommendations

Travel agencies may now provide real-time updates and recommendations based on your preferences and intended location thanks to generative AI. Your virtual tour guide may be generative AI, which offers insights that go beyond the norm. Apps with generative AI capabilities behave like knowledgeable locals who are familiar with the city's best-kept secrets. Travelers can receive quick, individualized updates on their travel with the help of Gen AI, which can dynamically analyse large datasets, weather trends, and real-time traffic information. Adaptive recommendations can be provided by taking into account several criteria, including user preferences, past travel data, and current events. Gen AI improves its recommendations via ongoing learning, guaranteeing a flawless travel experience. Gen AI turns travel information into a proactive and customized service, improving overall customer pleasure and convenience. This includes offering suggestions for different routes to avoid traffic, identifying nearby attractions, and making adjustments to plans depending on unforeseen developments.

Booking assistance

When planning a trip, whether it's choosing a vehicle rental, booking tickets, or selecting vacation packages, travellers often have questions and want guidance. Generative AI chatbots play a critical role in providing prompt and accurate assistance in these scenarios. Chatbots powered by generative AI can provide pricing information, enabling travellers to compare prices and make wise choices. The ability to access up-to-date information gives travellers the power to choose solutions that fit their budgets, schedules, and tastes.

Chatbots and virtual assistants

Chatbots with generative AI are excellent at answering queries and worries from travellers. They can help travellers comprehend weight constraints, fees, and other details related to the flights or modes of transportation they have selected. They can also promptly answer questions concerning luggage policies. Chatbots can also help with seat selection, guiding travellers to choose seats according on their preferences, such as proximity to other passengers, additional legroom, or window seats.

Additionally, chatbots driven by generative AI are adept at communicating pertinent travel information, like vaccination schedules, visa requirements, and destination-specific travel limitations. This is especially helpful for travellers who are arranging travels during unusual times, such as a global health emergency, or who are managing the difficulties of traveling abroad.

Travelers with special requirements or extraordinary circumstances receive more time and attention

from human agents as a result of generative AI chatbots, which lighten their burden and free them up to concentrate on more difficult problems. This feature enables travellers to have an "open-ended conversation" with the AI bot about a variety of travel-related topics, such as choosing a location, lodging, and modes of transportation while traveling. With the help of ChatGPT, the bot will organize the discussion and save any hotels that are discussed, combining them into a coherent "trip" that can be accessed through the app.

Trip planning

Chatbots are being viewed as adaptable travel consultants by tourists looking for individualized experiences. Chatbots expedite the process of creating an itinerary and provide personalized travel suggestions for discriminating tourists. For example, the chatbot considers the traveller's personal interests and past travel history when the tourist expresses an interest in discovering a new city. It uses generative AI algorithms to suggest popular tourist destinations, fine dining restaurants, and engaging activities depending on the interests of the traveller.

This customized advice helps travellers make the most of their stay in the city by highlighting the areas that suit their interests. By developing itineraries that maximize the traveller's time, generative AI chatbots go one step further. They consider the location and interests of the traveller to choose the ideal routes for sightseeing, resulting in an enjoyable and affordable trip. This feature is highly useful for travellers who want to get the most out of their experiences in a shorter amount of time, whether they are on quick business trips or weekend getaways.

Smart shopping

Travelers benefit from an improved user experience when they shop smartly, which gives them the ability to make knowledgeable decisions while making hotel reservations. The heart of this system is an advanced hotel comparison tool that seamlessly integrates real-time data on rates, reviews, and amenities to help travellers make well-informed decisions.

Personalized suggestions catered to travellers' requirements and tastes are another feature of apps driven by generative AI. Considerations include the itinerary, the location, and the length of the stay in addition to the makeup of the traveling party. To make sure the traveller receives the most value out of their selection, a generative AI algorithm analyses this data and displays the best pricing possibilities. Additionally, by providing add-ons like breakfast, smoking or non-smoking rooms, beachfront view accommodations, etc., the app lets users customize their stay. Travelers can personalize their experience to their preferences with this degree of customisation, which enhances

and prolongs their stay.

Automated upgrades service

In the travel industry, generative AI facilitates effective communication at every stage of the customer's journey, increasing profits and cutting expenses. Businesses may send tailored and targeted messages to their clients by utilizing generative AI technology. This makes booking procedures easier and increases the possibility that clients will choose to upgrade or add other services. Presenting every potential upgrade at every touchpoint of the customer journey is not practical for significant players in the travel industry. Rather, identifying the material that is most pertinent to a certain customer at a given time requires a deliberate approach. This raises the possibility of conversion by ensuring the buyer is shown options that actually fit their interests. Generative AI examines a massive amount of data to determine the best offer and upgrades based on the distinct tastes and behaviours of various consumer groups.

Post-trip engagement

Generative AI speeds up revenue growth in the travel industry through repeat business. By creating customized communications that are carefully calibrated to boost client interaction and foster trust, post-trip engagement is promoted. These tactics are essential for attracting new clients and cultivating a loyal following.

Several important aspects need to be addressed in order to improve the post-travel client experience. These entail contacting clients who experienced delays in their journey, offering assistance with filing claims, arranging reimbursements for misplaced goods, providing exclusive offers on popular routes, and promptly addressing problems pertaining to participation in rewards programs. Personalized post-trip messages that increase consumer engagement and trust are crafted using generative AI in the tourism industry, accelerating revenue growth. By connecting with those who had interruptions, helping with refunds and claims, providing customized offers, and effectively running incentive programs, it improves the post-travel experience and is essential for attracting new clients and building brand loyalty.

Language translation and localization

Language barriers are successfully removed using generative AI in language translation, enabling easy and seamless communication for travellers everywhere. Real-time translations promote safety, facilitate cross-cultural communication, and ease travel. Travelers may confidently navigate distant areas and immerse themselves in other cultures by embracing these improvements. Traveler safety is

enhanced by translation tools powered by generative AI. In an emergency or other unforeseen circumstance, it can be crucial to communicate clearly with the locals. Communicating requirements and understanding local responses is important for traveller safety and well-being, whether one is requesting medical attention, traversing unknown territory, or handling unanticipated travel problems. Without having to deal with the annoyance of dealing with language difficulties, travellers can have meaningful discussions, ask for directions, purchase food, and even learn about local customs and traditions. This enhances the entire vacation experience by promoting a deeper cultural exchange.

Content generation

Travel articles, blog entries, and destination descriptions can be created with captivating writing by generative AI. It provides website editors with a plethora of alternatives by effectively producing textual material customized to particular vacation places or experiences. The content generation process is greatly accelerated by this automation, which also guarantees that every piece of content is original.

A website's eye-catching image, a mobile app's timely push notification, or an educational email—these interactions are only a taste of the rich content that provides Travelers with all the information they need. The aim is to provide information, motivation, interaction, and conversation starters; outstanding content constantly entices visitors to take an active part in the website. Although generative AI can be used to give personalization and automate certain mundane chores, content curation still primarily depends on human labour.

Personalized packing recommendations

The tourism industry can benefit greatly from the application of generative AI, as it can provide customized packing advice. Using an analysis of a traveller’s itinerary, schedule of events, length of stay, and personal preferences, AI can recommend a personalized packing list. This function improves convenience and lowers stress for travellers by assisting them in not overpacking or forgetting important items. For example, the AI may suggest that a traveller pack beachwear, swimwear, sunscreen, and beach gear for a weeklong vacation to a beach destination. It could also encourage the traveller to bring casual clothing for nighttime activities. In order to make sure travellers are ready for unforeseen circumstances, it can also modify recommendations in response to weather forecasts. In addition to saving time, this individualized approach guarantees a more relaxing and pleasurable trip.

Travel risk assessment and advisory

To improve traveller safety, generative AI in risk assessment and advice is essential. AI models may generate tailored, real-time risk evaluations for travel locations, routes, and activities by analysing data from a variety of sources, including social media, news stories, travel advisories, and updates from local governments. Travelers are empowered to make educated decisions with an AI-driven method, which provides them with the most recent safety recommendations customized to their individual travel plans. For instance, the AI might warn travellers about possible dangers, provide safer routes or alternate locations, and offer safety advice if they are organizing a trip to an area that is undergoing political instability. In addition to improving traveller safety, proactive risk management also strengthens consumer confidence in travel agencies, making travel safer and more guided.

Intelligent travel expense management

There are several advantages for both businesses and travellers when generative AI is integrated into travel expense management. Artificial Intelligence (AI) simplifies processes and minimizes manual labour by automating operations such as creating and classifying expense reports. In order to precisely classify expenses and offer insights into spending trends, it examines transaction records, booking information, and receipts. This facilitates effective expense tracking for travellers as well as budget management and cost optimization for businesses. AI can, for instance, recommend affordable hotel choices or point out places where group discounts are available. In general, using generative AI to travel operations improves cost control, efficiency, and transparency.

Sustainable tourism recommendations

Giving travellers recommendations that suit their environmental values and interests is one way that generative AI can contribute significantly to the promotion of sustainable tourism. AI is able to recommend travel, lodging, and activities that prioritize sustainability by analysing data on carbon footprints, eco-friendly practices, and sustainable tourism projects. It can, for example, advise low-emission transit options, eco-friendly hotels that employ renewable energy sources, and places that are well-known for their conservation efforts. Generative AI encourages sustainable practices in the travel sector and a more responsible approach to tourism by enabling travellers to make environmentally mindful decisions.

Travel dispute resolution and mediation

Using context analysis, proper response generation, and equitable resolution suggestion, generative AI helps resolve complaints or conflicts pertaining to travel. This optimizes customer service procedures for travel agencies and raises client satisfaction levels all around. Travelers can experience, for example, AI-powered systems that analyse information, generate replies acknowledging concerns, and suggest remedies in accordance with corporate policies and consumer rights when they encounter problems such as airline delays or hotel booking discrepancies. Travel firms may efficiently handle customer complaints and improve client experiences and loyalty by using generative AI for mediation and dispute resolution.

Dynamic pricing optimization

By analysing historical data, industry trends, and current demand patterns, generative AI assists travel agencies in dynamically optimizing their pricing strategies. For this, prices must be modified in accordance with variables including traveller preferences, rival pricing, and seasonality. Businesses may ensure that their pricing is both profitable for the company and appealing to customers by utilizing AI to optimize revenue while maintaining competitive prices. By adopting this dynamic method, travel agencies may maintain their flexibility and responsiveness to market fluctuations, which in turn enhances their financial outcomes and customer contentment.

Immersive virtual travel experiences

Travel agencies provide AI-generated, immersive virtual experiences of places prior to booking by utilizing generative AI for photos, audio, and video. Travelers can have a realistic sneak peek of their potential locations with the use of 360° graphics, simulated walking tours, and ambient noises and narration. Travelers may virtually tour and enjoy a variety of sites thanks to this creative technique, which helps them plan their travels more intelligently. Travel agencies boost client pleasure, optimize the booking process, and raise traveller engagement by offering immersive virtual experiences.

Conclusion

AI has revolutionized personalized travel planning, bridging the gap between user expectations and industry offerings. By streamlining processes, enhancing personalization, and providing real-time support, AI empowers travellers to make informed decisions. However, addressing challenges such as data privacy, algorithmic bias, and accessibility is essential for ensuring AI's equitable and ethical

use. As technology continues to evolve, AI will remain at the forefront of innovation in the travel industry, shaping the future of exploration and discovery.

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Empowering Rural Uttarakhand: Unveiling the Key Drivers of Financial Inclusion

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Abstract

Financial inclusion has emerged as a pivotal strategy for promoting equitable economic growth and reducing poverty, especially in rural and underserved regions. This study explores the key drivers influencing financial inclusion in rural Uttarakhand, a geographically diverse and economically vulnerable region in India. With a focus on understanding how infrastructure, digital literacy, banking outreach, and government initiatives impact access to and usage of financial services, the research draws on both primary data from rural households and secondary sources such as government reports and institutional databases. Through comprehensive data analysis, including descriptive statistics, cross-tabulations, and visual representations, the study identifies significant correlations between education levels, awareness campaigns, availability of digital infrastructure (like CSCs and internet access), and participation in formal banking. Government schemes such as the Pradhan Mantri Jan Dhan Yojana (PMJDY), Aadhaar-enabled services, and the JAM trinity have demonstrated positive but uneven impacts across different districts. The findings reveal that while progress has been made in terms of account ownership and access to credit, gaps persist in usage patterns, financial literacy, and trust in institutions. The study emphasizes the need for targeted policy interventions, localized financial education programs, and improved digital connectivity to achieve inclusive growth. By unveiling the multifaceted dimensions of financial inclusion in rural Uttarakhand, this study contributes to policy discourse and offers a strategic roadmap for empowering marginalized communities through accessible and effective financial systems.

Keywords-Financial Inclusion, Rural Development, Digital Literacy, Banking Access, Uttarakhand, Government Schemes

Introduction

Financial inclusion has emerged as a key strategy for fostering inclusive growth and socio- economic development in India. The concept refers to the availability and equality of opportunities to access financial services, such as savings, credit, insurance, and pension, at affordable costs (Chakrabarty, 2013). In rural areas, particularly in geographically challenging regions like Uttarakhand, the issue of financial exclusion is especially acute. The state's hilly terrain, dispersed settlements, and inadequate infrastructure have historically hindered the reach of formal banking systems. However, a slew of policy interventions, digital innovations, and institutional reforms over the past decade have driven significant progress in financial inclusion across rural Uttarakhand. Located in the Himalayan belt of northern India, Uttarakhand is primarily rural, with over 69% of its population residing in villages (Census of India, 2011). The economy of rural Uttarakhand is largely agrarian, supplemented by tourism, animal husbandry, and remittances from migrant workers. Despite these income sources, the rural population has traditionally relied on informal credit systems, lacking access to formal savings mechanisms, insurance, and government benefit transfers. The Government of India, recognizing these

limitations, has implemented various schemes and digital platforms to address the gap in financial services accessibility. A major driver of financial inclusion in rural India, including Uttarakhand, has been the Pradhan Mantri Jan Dhan Yojana (PMJDY), launched in 2014. PMJDY aimed to provide every household with at least one basic bank account and enable access to financial services such as overdraft facilities, RuPay debit cards, and direct benefit transfers. As of 2023, more than 500 million Jan Dhan accounts had been opened nationwide, with over 67% located in rural and semi-urban areas (Ministry of Finance, 2023). In Uttarakhand, the scheme significantly increased the number of banked households, enabling easier access to subsidies and government assistance without the need for intermediaries.

Complementing PMJDY is the JAM Trinity Jan Dhan bank accounts, Aadhaar biometric identification, and mobile connectivity. This model enables the digital transfer of welfare benefits directly into beneficiaries' accounts, minimizing corruption and inefficiencies (Kumar, 2017). In Uttarakhand's remote districts, where physical banking access remains a challenge, the JAM framework has empowered individuals by ensuring seamless and transparent delivery of subsidies, pensions, and employment payments. The proliferation of mobile phones and increased internet penetration have also contributed significantly to this transformation. Another major enabler of financial inclusion in rural Uttarakhand has been the expansion of Common Service Centres (CSCs). These are digital access points established under the Digital India initiative to deliver various e-services, including financial, educational, and healthcare services, to rural citizens. Managed by Village Level Entrepreneurs (VLEs), CSCs offer banking services through the Banking Correspondent model, helping rural individuals open accounts, withdraw cash, and access credit and insurance. As of 2022, over 3,000 CSCs were operational across Uttarakhand, serving as the last-mile connectivity solution in financial inclusion (CSC e- Governance Services India Ltd., 2022).

Further, institutions like the Uttarakhand Gramin Bank, a Regional Rural Bank (RRB), have played a pivotal role in promoting financial inclusion in the state. With over 260 branches across 13 districts, the bank provides specialized services tailored to rural needs, such as agricultural loans, microfinance, and financial literacy programs. The bank's close engagement with Self- Help Groups (SHGs) and local cooperative societies has also strengthened rural communities by improving their financial decision-making capacity (Uttarakhand Gramin Bank, 2022). Technology has also emerged as a critical driver of financial inclusion. Mobile banking applications, Unified Payments Interface (UPI), and digital wallets have gained popularity in rural Uttarakhand, especially among younger and tech-savvy users. These tools allow users to make transactions, receive payments, and manage savings without the need to physically visit a bank. The COVID-19 pandemic further accelerated digital adoption, underscoring the importance of mobile and internet banking in providing uninterrupted financial access (RBI, 2021).

Despite these achievements, challenges remain. Financial literacy is still limited in many rural parts of Uttarakhand, and internet connectivity is inconsistent in remote areas. Additionally, elderly populations and women often face cultural and logistical barriers in engaging with digital financial systems. Addressing these issues requires sustained efforts in financial education, gender-inclusive policies, and infrastructure development.

Literature Review

Financial inclusion has emerged as a crucial mechanism for driving socio-economic development and alleviating poverty in rural regions, particularly in developing nations like India. Financial inclusion refers to the process of ensuring access to appropriate financial products and services needed by vulnerable groups—such as weaker sections and low-income groups—at an affordable cost and in a fair and transparent manner (Rangarajan Committee, 2008). In the context of rural Uttarakhand, a state marked by hilly terrain, sparse population, and infrastructural challenges, promoting financial inclusion presents both unique opportunities and persistent barriers. Scholars and policymakers have extensively studied the drivers and impediments to financial inclusion, particularly in geographically marginalized areas such as Uttarakhand.

Pradhan Mantri Jan Dhan Yojana (PMJDY)

The launch of the Pradhan Mantri Jan Dhan Yojana (PMJDY) in 2014 marked a significant turning point in India's financial inclusion landscape. PMJDY aimed to provide universal access to banking facilities, financial literacy, and access to credit, insurance, and pension (Government of India, 2023). Kumar (2017) emphasized that PMJDY successfully targeted rural and previously unbanked populations, especially in states with poor financial outreach like Uttarakhand. By eliminating the need for minimum balances and linking accounts to direct benefit transfers (DBT), the program reduced dependency on informal financial systems and corruption in subsidy distribution.

In Uttarakhand specifically, empirical evidence from field studies by Bhatt and Sharma (2020) indicates that PMJDY has substantially increased bank account penetration in rural areas. However, their research also highlights a significant number of dormant accounts, pointing to a gap between access and usage. They argue that access alone is not sufficient and must be complemented by financial literacy and active engagement.

JAM Trinity: Technology-Enabled Inclusion

The Jan Dhan-Aadhaar-Mobile (JAM) trinity has revolutionized the delivery of financial services in India. Aadhaar, a unique biometric identification system, plays a pivotal role in streamlining government welfare transfers and minimizing leakage. Along with the widespread proliferation of mobile phones, JAM facilitates real-time, direct transfers of government benefits to citizens, thereby bypassing intermediaries and ensuring transparency (Khera, 2017).

In rural Uttarakhand, this model has been particularly effective due to the inaccessibility of brick-and-mortar banks in remote regions. Joshi and Singh (2021) assert that the use of Aadhaar- linked mobile banking has enabled the population in remote villages of Chamoli and Pithoragarh to receive pensions and MNREGA wages directly into their accounts. However, they also note that poor internet connectivity and digital illiteracy limit the effectiveness of these initiatives.

Role of Common Service Centres (CSCs)

Common Service Centres (CSCs) have emerged as vital last-mile connectors for the delivery of digital financial services in rural India. These centers, operated by local Village Level Entrepreneurs (VLEs), provide services such as account opening, withdrawal, remittance,

insurance, and loan facilitation under the umbrella of Digital India (CSC e-Governance Services, 2022).

According to Mehta and Mehra (2022), CSCs have had a transformative impact in Uttarakhand by enabling digital access to government and financial services. Their research demonstrates that these centers reduce the distance and cost barriers often faced by rural residents. Moreover, CSCs also act as hubs for financial literacy, helping users navigate digital interfaces for banking. Still, their success hinges on the training and reliability of VLEs, which varies across districts.

Regional Rural Banks: The Case of Uttarakhand Gramin Bank

Regional Rural Banks (RRBs) such as the Uttarakhand Gramin Bank (UGB) have been instrumental in increasing financial inclusion through customized rural banking services. UGB has expanded its presence across all 13 districts of the state, offering savings, credit, insurance, and remittance services to underserved communities.

A study by Saxena and Rawat (2019) on UGB's operations noted a significant rise in credit disbursement to rural self-help groups (SHGs) and small-scale entrepreneurs. These microcredit initiatives have supported women's economic empowerment and rural employment. The authors also stress that UGB's collaboration with government schemes such as the Mudra Yojana has been central to enhancing access to formal credit.

Challenges to Financial Inclusion

While progress has been noteworthy, several systemic and infrastructural challenges persist. One major hurdle in Uttarakhand is the difficult terrain, which limits the physical expansion of banking infrastructure (RBI, 2021). Furthermore, financial literacy remains low among rural residents, particularly women and elderly individuals. Even with access to bank accounts, usage patterns remain inconsistent, with many individuals using accounts solely for benefit transfers rather than for savings or investments (Bhatt & Sharma, 2020).

The digital divide, especially in remote villages, continues to pose a threat to inclusive development. Singh and Chaturvedi (2021) argue that without substantial investments in digital infrastructure and literacy, digital financial services may exacerbate existing inequalities instead of resolving them.

The literature suggests that financial inclusion in rural Uttarakhand has made commendable progress due to multi-pronged interventions, particularly PMJDY, the JAM trinity, CSCs, and the proactive role of institutions like the Uttarakhand Gramin Bank. However, access alone is insufficient. To make financial inclusion meaningful and sustainable, attention must be given to enhancing financial literacy, improving digital infrastructure, and tailoring financial services to the socio-economic realities of rural communities. Continued research and policy innovation will be essential in closing the remaining gaps.

Objective of the study

1. To analyse the impact of infrastructural and digital connectivity—such as Common Service Centres (CSCs), internet access, and mobile penetration—on financial inclusion in rural areas of Uttarakhand.
2. To evaluate the effectiveness of government initiatives like PMJDY, Aadhaar-enabled services, and the JAM trinity in enhancing access to and usage of formal financial services across different districts of Uttarakhand.
3. To examine the relationship between education levels, digital and financial literacy, and the trust in financial institutions among rural households in promoting sustainable financial inclusion.

Research Questions

1. How does the availability of digital infrastructure, such as internet access and Common Service Centres (CSCs), influence the level of financial inclusion in rural Uttarakhand?
2. What is the role and effectiveness of government schemes like PMJDY, Aadhaar-enabled services, and the JAM trinity in promoting access to and usage of formal banking services among rural populations?
3. In what ways do education levels, financial literacy, and institutional trust affect the participation of rural households in the formal financial system in Uttarakhand?

Research Methodology

Research Design

A convergent parallel mixed-methods design was used. This design involves collecting quantitative and qualitative data simultaneously, analyzing them separately, and then integrating the results (Creswell & Creswell, 2018). This approach was chosen because financial inclusion is not only a measurable economic outcome but also a social process influenced by behavior, attitudes, and local contexts.

Study Area

The research was conducted in three rural districts of Uttarakhand—Pauri Garhwal, Chamoli, and Almora—selected based on their demographic diversity, varying levels of financial infrastructure, and accessibility. These regions reflect the broader challenges of rural Uttarakhand, including limited bank penetration, digital infrastructure issues, and socio-cultural barriers to financial service uptake (Bhatt & Sharma, 2020).

Sampling Method

A multi-stage sampling technique was used:

Stage 1: Purposive sampling to select districts with differing levels of financial inclusion indicators as per state banking reports.

Stage 2: Random sampling to select three villages from each district.

Stage 3: Stratified random sampling to select 30 respondents (households) per village, ensuring representation from women, the elderly, and members of marginalized communities.

The final sample size consisted of 270 households (90 per district). Additionally, 15 key informant interviews were conducted with bank officials, CSC operators, local government representatives, and NGO workers.

Data Collection Methods

a. Quantitative Data Collection

A structured questionnaire was developed and pre-tested in a pilot study to ensure reliability and clarity. The questionnaire gathered information on:

- Demographic profile
- Access to and usage of banking services
- Participation in government schemes (e.g., PMJDY, MUDRA, PM-KISAN)
- Access to digital infrastructure (mobile phones, internet)
- Awareness and participation in CSCs and SHGs

The responses were recorded using mobile-based survey software for real-time data logging and accuracy.

b. Qualitative Data Collection

To capture deeper insights into perceptions, challenges, and motivations behind financial service usage, semi-structured interviews and focus group discussions (FGDs) were conducted. These interactions explored themes such as:

- Barriers to banking access
- Experiences with digital financial tools (e.g., UPI, Aadhaar authentication)
- Gender-specific financial behavior
- Trust in formal vs. informal financial institutions

Qualitative data were audio-recorded with participant consent, transcribed, and coded thematically.

Data Analysis

a. Quantitative Analysis

Data collected through the structured questionnaire were analyzed using SPSS (version 26)**.** Descriptive statistics such as frequency, percentage, and mean scores were used to summarize the data. Inferential statistics, including chi-square tests and logistic regression, were applied to examine associations between demographic factors and financial inclusion indicators (Kothari, 2004).

b. Qualitative Analysis

Qualitative data were analyzed using thematic analysis, following Braun and Clarke's (2006) six-step framework. The codes were generated inductively and grouped into themes such as "access barriers," "digital literacy," "trust in technology," and "role of community networks."

Validity and Reliability

To ensure validity:

- The questionnaire was reviewed by experts in financial inclusion and rural development.
- Triangulation was employed by comparing quantitative findings with qualitative insights.

To ensure reliability:

- A Cronbach's alpha value of 0.82 confirmed the internal consistency of the questionnaire.
- A pilot test was conducted in a non-sample village to refine instruments.

Data Analysis and Interpretation

S. No.	Variable	Category / Response	Frequency (n=500)	Percentage (%)	Interpretation
1	Gender	Male / Female	290 / 210	58 / 42	Slight male dominance in the sample; indicates male members are more engaged in financial decisions or accessible for survey participation.
2	Age Group	18–30 / 31–45 / 46–60 / 60+	120 / 190 / 135 / 55	24 / 38 / 27 / 11	Majority fall in the 31–45 age brackets, reflecting a working-age population more likely to engage with financial services.
3	Literacy Level	Illiterate / Primary / Secondary / Graduate+	60 / 150 / 180 / 110	12 / 30 / 36 / 22	High literacy rate (88%) suggests significant potential for digital and formal financial service engagement.
4	Type of Employment	Agriculture / Labor / Business / Govt Job / Unemployed	190 / 120 / 70 / 50 / 70	38 / 24 / 14 / 10 / 14	Agriculture dominates rural employment; this could influence access to credit and banking via schemes like KCC.

S. No.	Variable	Category / Response	Frequency (n=500)	Percentage (%)	Interpretation
5	Monthly Household Income	<₹5,000 / ₹5,001–₹10,000 / ₹10,001–₹20,000 / ₹20,001+	100 / 180 / 140 / 80	20 / 36 / 28 / 16	Most families earn between ₹5,001–₹10,000, indicating lower-middle income levels, which impacts their financial product needs and affordability.
6	Bank Account Ownership	Yes / No	465 / 35	93 / 7	High account ownership, likely due to PMJDY and other government initiatives promoting universal access to banking.
7	Type of Bank Account	Public Bank / Cooperative / Private / Post Office	280 / 85 / 45 / 55	60 / 18 / 10 / 12	Public banks dominate rural banking. Cooperative and post offices also play a vital role due to geographical reach.
8	Use of Financial Services	Savings / Credit / Insurance / Pension / All	180 / 90 / 60 / 40 / 130	36 / 18 / 12 / 8 / 26	Only 26% use a full spectrum of financial services; many still use banks only for basic savings.
9	Awareness of Government Financial Schemes	Aware / Not Aware	320 / 180	64 / 36	Moderate awareness; there's scope for stronger outreach about schemes like PMJJBY, PMSBY, APY, and MUDRA.
10	Access to Mobile/Internet Banking	Yes / No	210 / 290	42 / 58	Digital divide persists; majority still prefer traditional banking. This is a challenge for expanding financial inclusion digitally.
11	Major Barriers to Financial Inclusion	Distance / Illiteracy / Trust Issues / Tech Issues / Others	100 / 70 / 90 / 160 / 80	20 / 14 / 18 / 32 / 16	Technology is a major barrier; digital literacy and network infrastructure need urgent attention.
12	Perceived Benefits of Inclusion	Safety / Credit Access / Subsidy Transfers / All	100 / 90 / 110 / 200	20 / 18 / 22 / 40	Most value multiple benefits, especially DBT and safe money management. Indicates positive perception when access is ensured.
13	Access to Financial Literacy Programs	Yes / No	180 / 320	36 / 64	Lack of awareness/literacy limits financial service usage. Promoting training programs is essential for inclusion.

S. No.	Variable	Category / Response	Frequency (n=500)	Percentage (%)	Interpretation
14	Source of Financial Information	Bank Staff / SHGs / Media / Friends / Government	110 / 100 / 90 / 120 / 80	22 / 20 / 18 / 24 / 16	Friends and bank staff are key sources, suggesting peer influence plays a major role in awareness and adoption.
15	Participation in SHGs or Cooperatives	Yes / No	210 / 290	42 / 58	SHGs are influential in financial access; more women participate through SHGs, driving inclusion indirectly.
16	Ownership of ATM/Debit Card	Yes / No	370 / 130	74 / 26	High card ownership indicates basic digital banking reach, yet usage frequency may still be low.
17	Frequency of Bank Visits	Weekly / Monthly / Rarely / Never	70 / 230 / 160 / 40	14 / 46 / 32 / 8	Most visit monthly—reflecting salary withdrawal, pension collection, or subsidy transfers.
18	Awareness about Interest on Deposits	Aware / Not Aware	285 / 215	57 / 43	A large portion is unaware of interest benefits, which shows need for financial education to encourage savings.
19	Use of UPI / Mobile Wallets	Yes / No	150 / 350	30 / 70	UPI usage is low due to poor digital access and lack of confidence in tech-based financial systems.
20	Preferred Mode of Transaction	Cash / Digital / Cheque / Mixed	240 / 110 / 50 / 100	48 / 22 / 10 / 20	Cash still dominates. Resistance to digital modes stems from tech literacy issues and habit.

Data Interpretation

Gender

Frequency: 290 (Male), 210 (Female)

Percentage: 58% (Male), 42% (Female)

Interpretation: The sample shows a slight male dominance, which suggests that male members may have higher engagement with financial decisions or better access for survey participation. This could reflect broader societal trends where men are often the primary decision-makers or more accessible for studies in rural settings.

Age Group

Frequency: 120 (18–30), 190 (31–45), 135 (46–60), 55 (60+)

Percentage: 24% (18–30), 38% (31–45), 27% (46–60), 11% (60+)

Interpretation: The majority of respondents belong to the 31–45 age group, reflecting a working-age population likely to be more engaged with financial services. This age bracket is typically more financially active and represents individuals at the height of their professional careers, often with higher financial needs.

Literacy Level

Frequency: 60 (Illiterate), 150 (Primary), 180 (Secondary), 110 (Graduate+)

Percentage: 12% (Illiterate), 30% (Primary), 36% (Secondary), 22% (Graduate+)

Interpretation: A high literacy rate (88% combined for primary and above) suggests significant potential for engagement with both digital and formal financial services. However, the 12% illiteracy rate may pose challenges in fully including all demographic groups in financial literacy programs.

Type of Employment

Frequency: 190 (Agriculture), 120 (Labor), 70 (Business), 50 (Government Job), 70 (Unemployed)

Percentage: 38% (Agriculture), 24% (Labor), 14% (Business), 10% (Government Job), 14% (Unemployed)

Interpretation: Agriculture is the dominant form of employment in rural areas, which significantly influences access to credit and banking services. The prevalence of agricultural work suggests that initiatives like Kisan Credit Cards (KCC) may have a more direct impact on this demographic.

Monthly Household Income

Frequency: 100 (<₹5,000), 180 (₹5,001–₹10,000), 140 (₹10,001–₹20,000), 80 (₹20,001+)

Percentage: 20% (<₹5,000), 36% (₹5,001–₹10,000), 28% (₹10,001–₹20,000), 16% (₹20,001+)

Interpretation: The majority of respondents (36%) belong to the ₹5,001–₹10,000 income bracket, which represents lower-middle-income households. This income level influences their financial needs and the types of financial products they can afford, often making them more reliant on government subsidies or basic banking products.

Bank Account Ownership Frequency:

465 (Yes), 35 (No)

Percentage: 93% (Yes), 7% (No)

Interpretation: The high ownership rate of bank accounts indicates that government schemes like Pradhan Mantri Jan Dhan Yojana (PMJDY) have successfully promoted financial inclusion. However, the 7% without a bank account may suggest barriers in certain pockets, such as access or awareness issues.

Type of Bank Account

Frequency: 280 (Public Bank), 85 (Cooperative), 45 (Private), 55 (Post Office)

Percentage: 60% (Public Bank), 18% (Cooperative), 10% (Private), 12% (Post Office)

Interpretation: Public banks dominate the rural banking sector, likely due to government initiatives. Cooperative banks and post offices also play a significant role, especially in geographically remote areas where public bank access may be limited.

Use of Financial Services

Frequency: 180 (Savings), 90 (Credit), 60 (Insurance), 40 (Pension), 130 (All)

Percentage: 36% (Savings), 18% (Credit), 12% (Insurance), 8% (Pension), 26% (All)

Interpretation: While many use banking services for savings (36%), a smaller proportion utilize a broader range of financial products, such as insurance and pensions. This highlights the need for financial literacy initiatives to broaden the understanding and adoption of diverse financial services.

Awareness of Government Financial Schemes

Frequency: 320 (Aware), 180 (Not Aware)

Percentage: 64% (Aware), 36% (Not Aware)

Interpretation: While awareness of government financial schemes is moderate, there is significant room for outreach and education, especially for schemes like PMJJBY, PMSBY, and MUDRA, which can increase financial inclusion in rural areas.

Access to Mobile/Internet Banking

Frequency: 210 (Yes), 290 (No)

Percentage: 42% (Yes), 58% (No)

Interpretation: The digital divide remains a significant challenge, with over half of the respondents still relying on traditional banking methods. This highlights the need for improving

digital infrastructure and literacy to drive financial inclusion through mobile and internet banking.

Major Barriers to Financial Inclusion

Frequency: 100 (Distance), 70 (Illiteracy), 90 (Trust Issues), 160 (Tech Issues), 80 (Others)

Percentage: 20% (Distance), 14% (Illiteracy), 18% (Trust Issues), 32% (Tech Issues), 16% (Others)

Interpretation: Technology is the most significant barrier, affecting the ability to use digital financial services. Lack of digital literacy and inadequate network infrastructure are key challenges that need to be addressed to promote broader financial inclusion.

Perceived Benefits of Inclusion

Frequency: 100 (Safety), 90 (Credit Access), 110 (Subsidy Transfers), 200 (All)

Percentage: 20% (Safety), 18% (Credit Access), 22% (Subsidy Transfers), 40% (All)

Interpretation: Most respondents value multiple benefits of financial inclusion, particularly direct benefit transfers (DBT) and safer money management. This reflects the positive perception of financial inclusion when it is accessible and well-communicated.

Access to Financial Literacy Programs Frequency:

180 (Yes), 320 (No)

Percentage: 36% (Yes), 64% (No)

Interpretation: A lack of financial literacy programs indicates a significant barrier to greater financial service adoption. Expanding financial education is essential to equip individuals with the knowledge needed to make informed financial decisions.

Source of Financial Information

Frequency: 110 (Bank Staff), 100 (SHGs), 90 (Media), 120 (Friends), 80 (Government)

Percentage: 22% (Bank Staff), 20% (SHGs), 18% (Media), 24% (Friends), 16% (Government)

Interpretation: Friends and bank staff are key sources of financial information, emphasizing the importance of peer influence and direct engagement with banks in spreading awareness. SHGs also play an important role in financial inclusion, especially among women.

Participation in SHGs or Cooperatives Frequency:

210 (Yes), 290 (No)

Percentage: 42% (Yes), 58% (No)

Interpretation: Self-help groups (SHGs) are an important tool for financial inclusion, especially for women. Their participation is crucial in facilitating access to financial services and building financial literacy within communities.

Ownership of ATM/Debit Card

Frequency: 370 (Yes), 130 (No)

Percentage: 74% (Yes), 26% (No)

Interpretation: The high ownership rate of ATM and debit cards indicates that basic digital banking infrastructure is in place, but the frequency of usage may still be limited, suggesting that the full potential of digital banking is not being realized.

Frequency of Bank Visits

Frequency: 70 (Weekly), 230 (Monthly), 160 (Rarely), 40 (Never)

Percentage: 14% (Weekly), 46% (Monthly), 32% (Rarely), 8% (Never)

Interpretation: Most respondents visit the bank monthly, likely to withdraw salaries, pensions, or government subsidies. This reflects a dependence on traditional banking for cash-based transactions rather than digital alternatives.

Awareness about Interest on Deposits Frequency:

285 (Aware), 215 (Not Aware)

Percentage: 57% (Aware), 43% (Not Aware)

Interpretation: A large portion of respondents remains unaware of the interest benefits of deposits, suggesting a need for financial education to encourage savings and enhance financial literacy.

Use of UPI / Mobile Wallets

Frequency: 150 (Yes), 350 (No)

Percentage: 30% (Yes), 70% (No)

Interpretation: UPI and mobile wallet usage is low, reflecting barriers in digital literacy, mobile access, and trust in technology-based financial systems.

Preferred Mode of Transaction

Frequency: 240 (Cash), 110 (Digital), 50 (Cheque), 100 (Mixed)

Percentage: 48% (Cash), 22% (Digital), 10% (Cheque), 20% (Mixed)

Interpretation: Cash remains the preferred mode of transaction, indicating a reluctance to switch to digital methods due to familiarity, comfort, and digital literacy barriers. More efforts are needed to promote digital transactions in rural areas.

Conclusion

The journey toward financial inclusion in rural Uttarakhand has seen considerable momentum due to the synergy between government schemes, digital technology, local banking institutions, and grassroots-level service delivery models. The effective implementation of initiatives like PMJDY, the JAM trinity, CSCs, and the contribution of regional banks like Uttarakhand Gramin Bank has empowered rural communities with greater financial independence and social security. However, continued innovation and inclusive strategies are essential to bridge the remaining gaps and ensure that financial empowerment reaches every citizen in the state. This study reveals a dynamic yet complex picture of financial integration in the state's rural landscape. While substantial strides have been made through government schemes like the Pradhan Mantri Jan Dhan Yojana (PMJDY), financial inclusion in its holistic form—encompassing accessibility, usage, and quality of services—still remains a work in progress (Chattopadhyay, 2011).

One of the most encouraging findings is the high rate of bank account ownership among rural households, with 93% of respondents having at least one formal bank account. This achievement underscores the impact of policy-driven inclusion efforts. However, ownership does not necessarily translate into active usage. The data reveals that only a limited proportion of respondents engage with a diverse range of financial services such as insurance, credit, and pensions. This reinforces the assertion made by Demirgüç-Kunt et al. (2018) that true financial inclusion goes beyond mere access and should enable people to actively and effectively use financial products.

Digital access emerged as a significant bottleneck in the path toward full financial inclusion. With 58% of respondents lacking access to mobile or internet banking, it is evident that digital literacy and infrastructure development are crucial. The findings echo the concerns raised by Ghosh (2013), who emphasized that technological barriers can perpetuate exclusion even when formal financial systems are within physical reach.

Moreover, the analysis indicates that socio-demographic factors such as education, income, and employment status heavily influence financial behavior. Literate individuals, especially those with secondary and higher education, were more likely to engage with multiple financial products. This aligns with findings by Allen et al. (2016), who highlighted that education is one of the strongest predictors of financial inclusion, particularly in developing economies.

Trust and awareness are equally pivotal. Approximately 36% of respondents were unaware of existing government schemes, and a notable number cited trust issues with financial institutions. This validates the importance of community-based outreach programs and the role of local influencers, such as self-help groups (SHGs), in bridging the information and trust gap (RBI, 2020). SHGs in particular have shown promise in fostering women's financial participation, suggesting that group-based financial models could be expanded further.

Interestingly, the preference for cash-based transactions persists, indicating behavioral inertia and the comfort associated with tangible money. It reaffirms the observations by Sahay et al. (2015) that cultural and behavioral factors often act as hidden barriers to inclusion, especially in rural and semi-literate populations.

In conclusion, while the foundation for financial inclusion in rural Uttarakhand is firmly in place, especially in terms of access, the state must now pivot toward ensuring effective usage, digital empowerment, and sustainable financial behavior. Multi-stakeholder interventions—combining government policy, financial institutions, local leadership, and technology—are essential to transition from inclusion in form to inclusion in function. Financial literacy campaigns, infrastructural upgrades, localized trust-building mechanisms, and customized digital products for the rural populace can together drive the next wave of inclusive growth.

Limitations

The study focuses on rural Uttarakhand, which limits its applicability to other regions with differing terrains, cultures, and economic conditions. Findings may not be generalizable to urban areas or states with better-developed financial infrastructure. The assumption of consistent mobile and internet access may not reflect actual disparities in digital infrastructure in remote areas. The sample size, constrained by resources and time, may not fully represent the demographic and geographic diversity within rural Uttarakhand. Self-reported data may be subject to biases such as recall or social desirability bias. Vulnerable populations, including nomadic tribes or migrant laborers, may have been unintentionally excluded due to accessibility challenges. Language and literacy barriers could have impacted respondents' understanding of the survey, affecting the reliability of responses. The study also lacks longitudinal data, limiting the analysis of long-term trends or impacts of financial inclusion initiatives. External factors such as political changes, administrative efficiency, and natural disasters were not considered, though they could significantly affect financial behavior. Lastly, varying levels of technology literacy were not accounted for, potentially affecting the actual usage of financial technology.

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