Original Article

Adoption of Mobile Payment Systems during COVID-19 in India

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Abstract

The digitalization process has been increasing rapidly worldwide today. There is various technologies developed and continue developing tremendously in the world, such as mobile payment systems. Such type of emerging technologies has made a very significant transformation in people lives everywhere. Technologies such as mobile devices facilitate people to finish their work in less time and effort required usually. That is why, these innovations and advancements in technologies led people to be more inclined toward their use. Furthermore, in the current scenario, mobile payments have become an integral part of the daily lives of people due to the impact of the novel coronavirus (COVID-19) disease on society. The presence of mobile payment systems can be considered for years, but the use of mobile payment systems has increased in the current situation of the COVID-19 pandemic, which is the core basis of this research paper. However, the user's acceptance of mobile payment systems is still low due to some pros and cons of this technology which are examined in this paper by applying a hybrid machine learning model. We collected primary data through Google Form from the institute in the Meerut region and other sources from India with a total of 222 respondents. In this study, the data is processed and applied on to the machine learning models. Data analysis and findings of the research showed that the proposed ensemble of classifier algorithms outperforms other exiting machine models in terms of accuracy, precision, recall and F1-score. The research and findings will help the organizations have a clear and correct analysis of the scenario of the adoption of mobile payments in India and also design better mobile payment systems to curb the situation like the COVID-19 pandemic.

Keywords: COVID-19, Adoption, Mobile Payment Systems, PCA, K-mean, Voting.

1. INTRODUCTION

The payment system is deeply connected to people and their daily routine life. Early people used to avail goods and services and then used to pay by different means, most probably with valuable things. It is the system established since the time of its inception. In the modern world, unlike early, people have started to pay with money. In the 21st century, this system has also begun to change due to the inception of the digital payment system. The new system is very helpful, specifically in times of emergency when there is less or no availability of cash. But the situation slide dramatically due to the spread of COVID-19[18-20] worldwide; people were suffering from this infectious disease named novel coronavirus, which spread through air and touch, people were instructed to keep on mask and not to touch anything without sanitised to keep themselves safe from the virus. In the last of, 2019, this virus was first discovered in the city of China named Wuhan. As per the world health organization (WHO) [1], It is an infectious disease caused by the SARS-CoV-2 respiratory illness, which can formulate in to several ailments and can lend to individual's loss of life too. So the situation is declared as a pandemic, on March 11, 2020 [2]. The disease is also witnessed in India too, along with the world, and the first COVID-19 case was found in Kerala, the city Indian state of Kerala, India, on 30 Jan 2020. Since that time, the people of India were reluctant to touch anything to keep themselves safe from this deadly disease, and also looking for alternative options for the essentials such as payments and daily routine; they even hesitated to use digital terminals along with cash payments to pay for their goods and services as there is some sort of touch involved in it and paper money is not safe during the pandemic like situation due to its highly infectious nature. In that time, mobile payment systems took a boom in increasing the number of users due to their contactless feature, which harnessed the situation to a great extent.

The structure of this research paper is as Section 2 covers the earlier studies and facts which considered in developing research papers. Also, summarize the proposed model constructs and their hypothesized relationships. Section 3 draws the research methodology process, including data collection technique and instrumentation to validate the proposed model. Sections 4 draw the data analysis results that follow the adoption of mobile payment systems. Lastly, Section 5 conclude the paper with the scope of future study.

2. RELATED WORK

Sreekrishna M et al. (2021) discussed that the major aspect of the pandemic circumstance, such as the COVID-19 pandemic, was to maintain social distancing and avoid the interchange of tickets and money. An approach was presented to convert the paper-based ticketing system into an application-oriented ticketing procedure to avoid the exchange of money and the ticket. The RFID card or scanning QR codes was included in this procedure to make the ticket payment. Consequently, travelling by bus became more comfortable in the pandemic situation. Machine Learning was deployed to analyze the dynamic count of passengers in the bus on the basis of source and destination after the entry of a passenger inside the bus. This assisted in predicting the congestion inside the bus for planning the travel [5].

Hartatik et al. (2021) presented a cashless payment system in the formulated smart village model. This work emphasized building a framework to promote tourism and marketing on the basis of the smart village application known as Go-Payment to pay all the transactions without cash in order to fulfil the demands of the village. Initially, the actual instances were collected from the village in a survey and the possible attributes were extracted for the design of this framework. The outcomes of surveys were also utilized. In the end, a smart village application having a cashless payment system was constructed in accordance with the model [6].

Ram Murti Rawat et al. (2021) established a contactless food ordering system which was a mobile application planned on the basis of a voice assistant. This application assisted the client in scanning the restaurant menu and viewing different food categories and items so that their order was placed. The user was able to modify and confirm its order, and the payment was done easily using this application. The established approach focused on mitigating the point of contact during the COVID-19 pandemic and automating the ordering and billing procedure using which the work was simplified. Hence, the established system was proved a computerized, automatic and scalable system to order food and efficiently for the business as it diminished the workload and offered superior management and smooth operation [7].

R. Thirupathieswaran et al. (2021) introduced a zero queue management system (ZQR4S). This system assisted people in booking an appointment with the doctor, according to the availability of the doctor. The introduced system was effective for the users for making the online payment for their visit and cancelling the appointment in case their plans were changed. The earlier visits of patients, as well as their medical records, were maintained using this system so that their accessibility became easy. This mobile application also provided a waiting list option for enrolling the name on the waiting list for intimating other patients if they cancelled the appointment with their doctor [8].

Romi Hadiyan Aji Witjaksono et al. (2021) developed a mobile technology acceptance model M-TAM-based framework along with quantitative techniques. This approach utilized data in which 1.271 responses were included. The covariance-based structural equation modelling (CB-SEM) technique was implemented to analyze this data using AMOS 24 application. The results revealed that the deployment of QR codes on digital wallet applications influenced due to the insight of transaction convenience, speed, easy mobile utilization, security and behavioural intentions in Indonesia. This research also provides insights into the service providers of QR Code payment to enhance the payment services [9].

Erwin Halim et al. (2021) suggested partial least squares structural equation modelling (PLS-SEM) as study research in which judgment sampling technique was implemented to extract data and Smart-PLS version 3.0 was deployed as a statistical tool. The security was integrated with trust as an extended variable to build the suggested model based on ECM and TAM. There were 400 respondents, who made the deployment of non-bank mobile payment in the Jabodetabek area of the city of Indonesia, were considered to analyze the result. Purposive sampling was employed to gather the data. Smart PLS was implemented as a tool for the research structural equation modeling (SEM) model. All 5 variables had affected the continuance intention variable via trust. The usefulness variable was significantly influenced by the Ease of Use variable compared to others [10].

3. HYPOTHESIS DEVELOPMENT AND PROPOSED HYBRID RESEARCH MODEL

HYPOTHESIS DEVELOPMENT

This section explains hypothesis development and its relation with other hypotheses, which is presented in Figure 1.

A. SYSTEM SPECIFICATION

H1: Information Extraction: Information extraction means collecting the required information to make decisions to query further, which gives updated, well-defined, appropriate and flexible information that can be used to improve the user-friendliness and flexibility of the product.

a) H1: Information extraction positively influence the Intention of use.

b) H1: Information extraction positively influence the Ease of use.

c) H1: Information extraction positively influence the trust and security

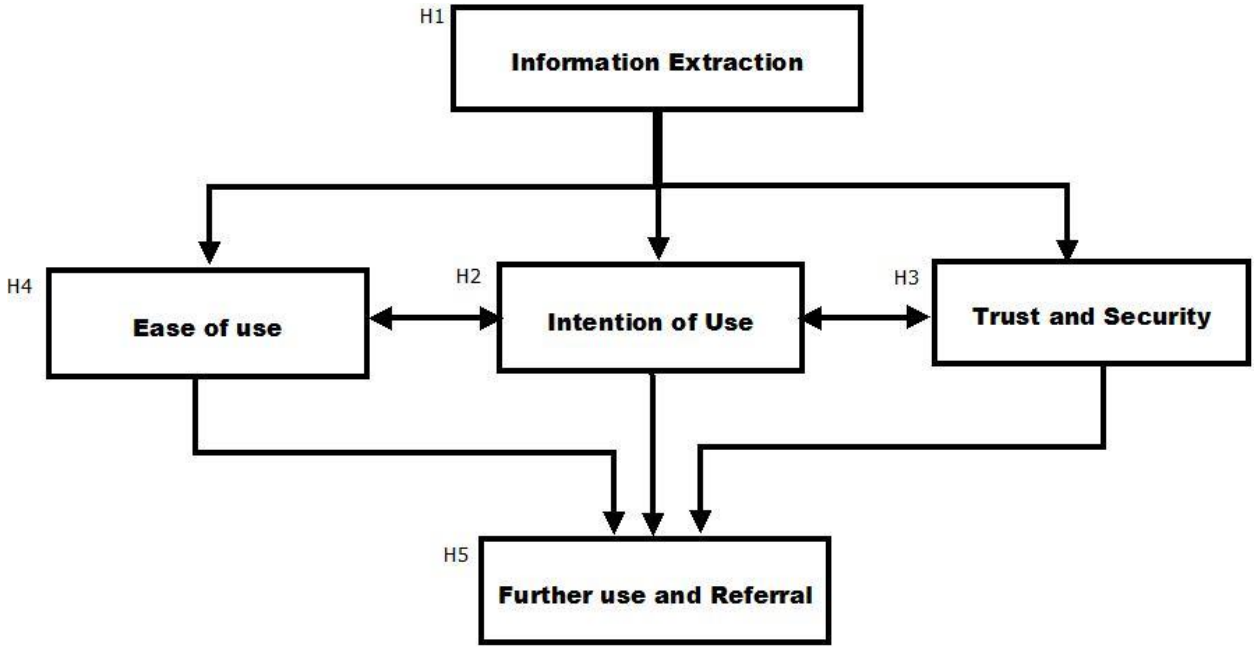

Figure 1. Proposed Hybrid Research Model

B. USER ACCEPTANCE

H2: Intention of Use: Intention of use refers to the actual want of the user to accept changes in the environment, such as acceptance of new technology. Intention to use reflects a user's desire to use the technology, which can be forwarded by a government agency, authorized entity or some other entity.

a) H2: Intention of use positively influence the Trust and Security

b) H2: Intention of use positively influence Ease of use

c) H2: Intention of use positively influence the Further use and Referral

H3: Trust and Security: It is an essential entity of any product, the state of being protected and safe from harm is the key component of establishing trust in a system. For the successful implementation of any technology into the real world to foster end users' beliefs, security and trust is the essential element, which means that integrity, confidentiality, availability and accountability requirements must be satisfied at the ground level.

a) H3: Trust and security positively influence the further use and referral

b) H3: Trust and security positively influence the intention to use

H4: Ease of Use: Mobile payment systems are a natural extension of all the daily tasks that users demand from a mobile device. That system should be full of functionality, easiness, reliability, accessibility, user friendly interface design and acknowledgement [12].

a) H4: Ease of use positively influence the intention of use

b) H4: Ease of use positively influence further use and referral

C. USER BELIEF

H5: Further use and Referral: It simply means if a user is satisfied with the product, whether the user will use it further above regulation, along with the user will refer it to friends and family.

Table1. Instrument constructs and measures

Construct	**Measures**
H1: Information Extraction	(i) What is your age? (ii) What is your education level?

	(iii) Please specify your gender?
H2: Intention of Use	(i) How often do you use mobile payment systems? (ii) What are the main reason behind shifting to use mobile payment systems? (iii) Which is mobile payment method do you use? (iv) The corona-virus pandemic caused you use mobile payment systems? (v) The corona-virus pandemic caused that you expect to be able to pay cashless in every shop? (vi) The corona-virus pandemic caused you are starting to believe that contact-less payments protect you against the virus? (vii) The corona-virus pandemic caused you see the general usefulness of new technologies?
H3: Trust and Security	(i) You feel safe using mobile payment systems? (ii) You trust the banking company to share data over the internet? (iii) Use of mobile banking services make you feel safe and protected from the COVID-19 pandemic? (iv) Mobile payment systems is a very easy and safe way of the transaction? (v) Mobile payment systems help in maintaining social distancing during the COVID-19 pandemic. (vi) Do you trust the security of online banking services? (vii) You feel safe while providing personal information for mobile payments over the internet?
H4: Ease of Use	(i) Mobile payment systems save your time and money? (ii) Mobile payment systems are better than cash payments? (iii) Mobile payment systems can be easily understood and readily adopted? (iv) Mobile payment systems save you time and money in term of discount, cash back etc. (v) Mobile payment systems are easy to use anytime, anywhere?

H5: Further use and Referral	(i) You will continue using mobile payment systems even after the COVID-19 pandemic? (ii) You will recommend mobile payment systems to your friends and family by giving a benefits overview? (iii) Your overall view of using mobile payment systems in the COVID-19 pandemic?

METHODOLOGY:

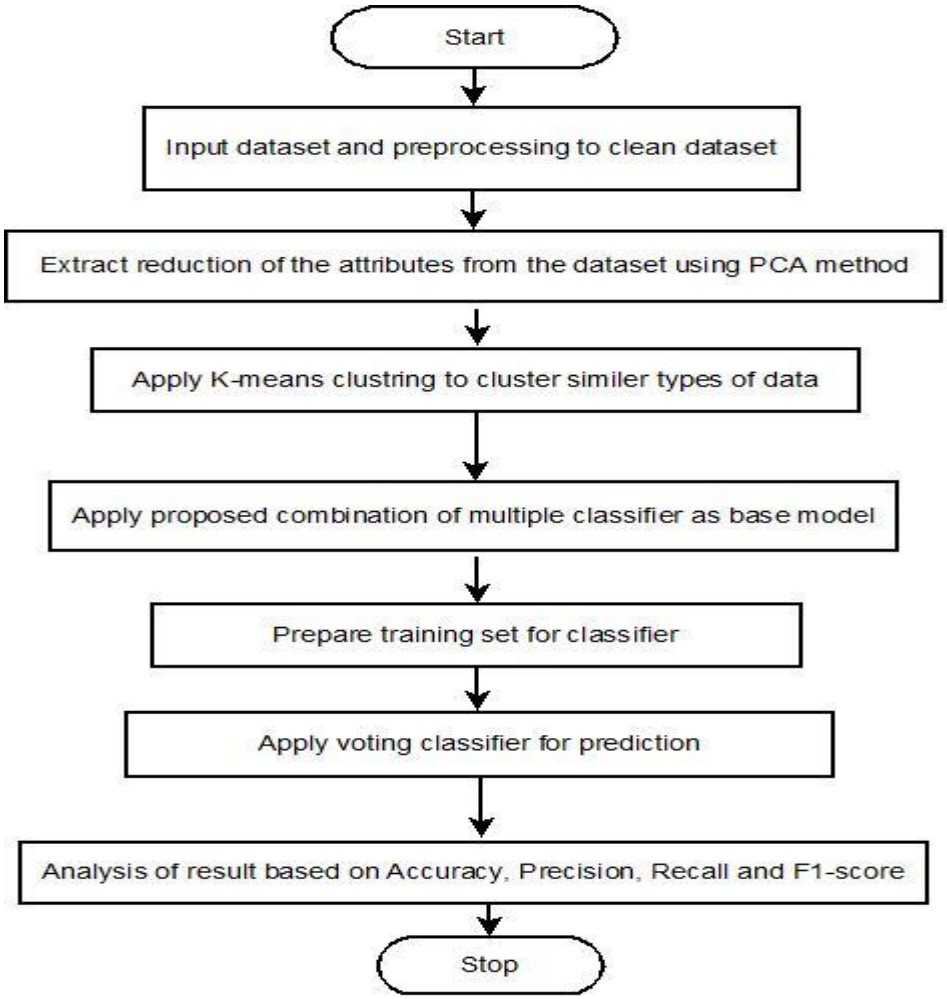

Figure 2. Proposed Methodology

According to Figure 2 several phases have applied to the hypothesized model using the dataset to get accurate results are as follows[13].

Phase-1 Dataset input and preprocessing: In this phase, dataset input and preprocessing have been processed. It is a process of preparing the raw data and making it suitable for a machine learning model. It is the first and crucial step while creating a machine learning model.

Phase-2 Extraction of reduction of the attributes from the dataset using PCA: In this phase, attributes have been extracted from the dataset using the principle component analysis (PCA) algorithm. PCA is an unsupervised machine learning algorithm that attempts to reduce the dimensionality of the number of features within a dataset while retaining as much information as possible.

Phase-3 K-means clustering to cluster similar types of data: In this phase, K-Means clustering has processed to cluster similar data types. It is an iterative supervised machine learning algorithm that divides the unlabeled dataset into k different clusters in such a way that each dataset belongs to only one group that has similar properties[14].

Phase-4 Ensemble of classifiers as a base model: In this phase combination of multiple classifiers is used. A combination of ensemble of classifiers is a set of classifiers whose individual decisions are combined to classify new example. These classifiers are often much more accurate than the individual classifiers that make them up.

Phase-5 Preparation of the training set for the classifier: In this phase,, a training set is prepared for the classifier. The training set is a portion of a data set used to fit (train) a model for the prediction or classification of values that are known in the training set.

Phase-6 Application of voting classifier for the prediction: In this successive phase, a voting classifier is applied for the prediction of an ensemble of the model. The voting classifier is a machine learning estimator that trains various base models and predicts based on aggregate findings of each base estimator [15].

Collection of Data and Participants

Considering various factors and focused on understanding people perceptions towards the adoption of mobile payment systems during the COVID-19 pandemic in India, online questionnaires have been disseminated among people, and the employed online questionnaire prepared for the research is the sole method to collect the data specified in times of COVID-19 peak. The collected data is participated by some students of a college in the Meerut region, working professionals of other regions, and some other people of society from the parts of India only. Hence a total of 222 people responses have been recorded through an online Google-form, incomplete answers have been avoided successfully, and this research is directed to collect primary data from people living inside the Indian region only [16].

Instrumentation

The quantitative technique is employed for the research. The questionnaire items have been prepared by considering various previous researches, with some other additional points by considering the scenario, pros and cons of the situation of the pandemic. The scale used to gather data is a three-point Likert type that ranges from disagreeing, agree and neutral as a measuring scale. Dataset input and pre-processing have been done, feature extraction and outlier removal have also executed, feature reduction and Classification have carried out using PCA, K-means clustering is applied, multiple of classification algorithms also used as base model and In the last the voting classification approach is employed in this research.

4. RESULTS AND FINDINGS

4.1 Data Analysis

To analyze the dataset and validation of proposed model, several machine learning algorithms are employed in this study. Machine learning is a field which focuses on the use of data and algorithms and helps to predict events effectively. Application of machine learning algorithms provides solutions to composite problems, and build predictive model via training classifier and testing on the dataset to produce effective results. This research work predicts the hypothesized value of adoption of mobile payment systems during the COVID-19 pandemic in India. Thus supervised learning classification algorithms of machine learning have been employed in this research work by using a python programming language.

4.2 Results of Theoretical Research Model and Validation

This research work is based on the adoption of mobile payment systems during the COVID-19 pandemic in India. The dataset is collected through Google forms. The performance of the proposed model is analyzed based upon the hypothesis proposed, i.e. Information extraction, Intention of use, Trust and Security, Ease of use, and Further use and Referral in terms of accuracy, precision, recall and F1-score[17].

As shown in Table 2 and Figure 3. The proposed model is improved in Accuracy, Precision, Recall and F1 score, for the adoption of mobile payment systems during the COVID-19 pandemic in India.

Table 2. Comparison Analysis of Machine Learning Models

Model Name	**Accuracy**	**Precision**	**Recall**	**F1-Score**
Random forest	91.13	0.92	0.99	0.95
KNN	87.34	0.87	1.00	0.93
Decision Tree	79.74	0.92	0.84	0.88
SVM	86.07	0.86	1.00	0.93
Proposed	97.46	0.75	0.75	0.75

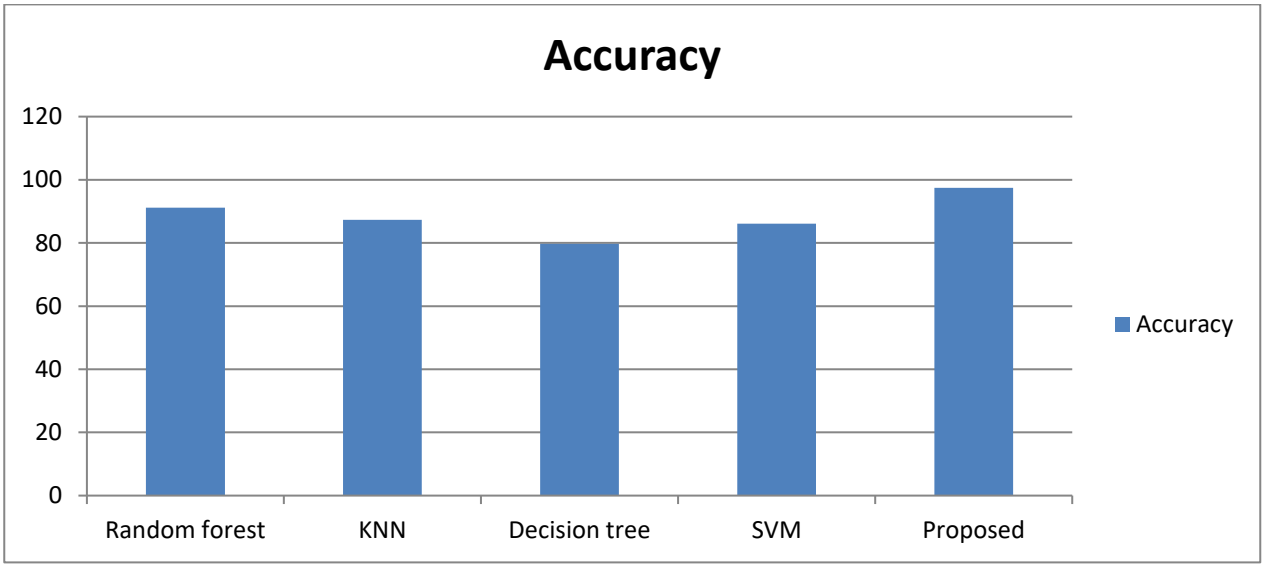

Figure 3. Accuracy Analysis

As shown in Figure 3, the performance of SVM, KNN, Decision tree, and Random forest is compared with the proposed hybrid model that combines multiple classifiers. It is analyzed that the proposed model achieves accuracy up to 97.46 which is a greater value than other classifier algorithms, for the adoption of mobile payment systems during the COVID-19 pandemic in India.

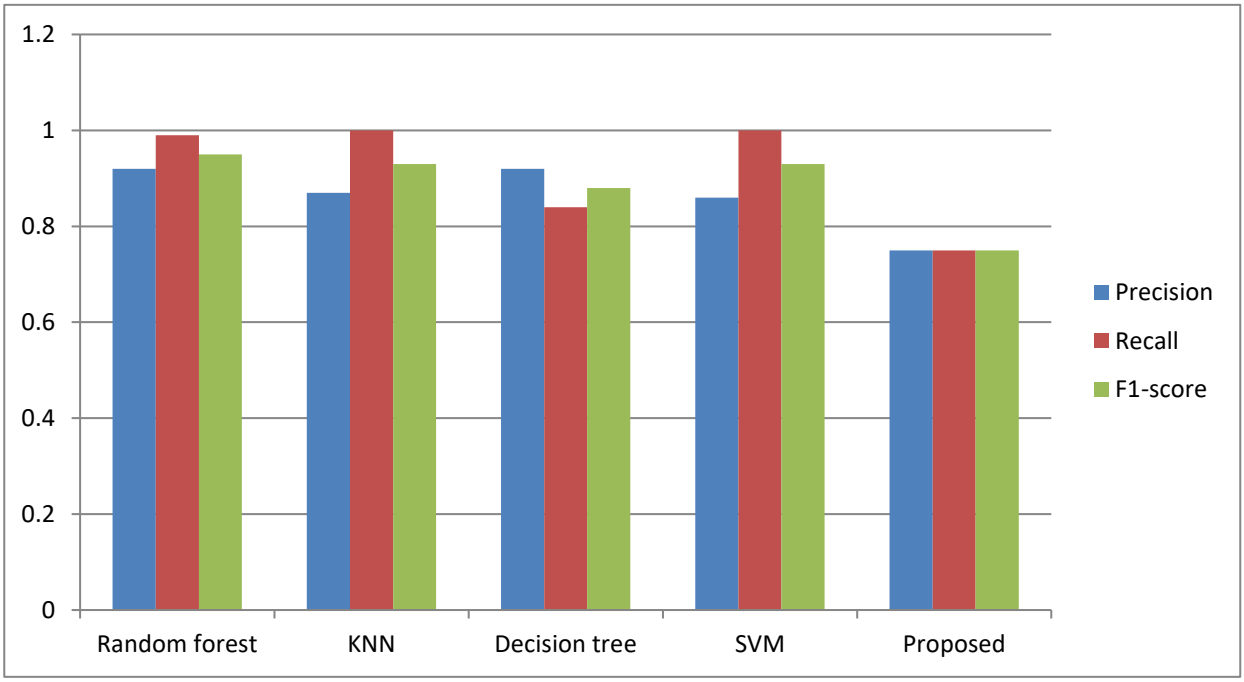

Figure 4. Precision, Recall, F1-score Analysis

As shown in Figure 4, precision, recall, and F1-score values of the proposed model is higher as compared with the SVM, KNN, Random Forest and Decision tree algorithms.

5. CONCLUSION AND RECOMMENDATIONS

This study proposes a hybrid research model based upon the evaluated hypothesis for the prediction of the adoption of mobile payment systems during the COVID-19 pandemic in India. The proposed framework has various phases viz., pre-processing of data, the input dataset is pre-processed in which missing and redundant dataset is removed using techniques of under sampling or over sampling, Second phase is feature extraction from the dataset using PCA method, third phase K-mean clustering is applied which is used to cluster similar type of information, fourth phase is about using a combination of multiple

classifier i.e. Naive baye's, KNN, Random forest and SVM as base model which is proposed model and in the last phase, voting classification method is used for the prediction. The proposed model is compared with some important machine learning models viz., SVM, KNN, Random forest and Decision tree. Our model achieved resulted an accuracy up to 97.46 accurately, which clearly shows that the adoption of mobile payment systems during COVID-19 pandemic has increased and people found this technology helpful during pandemic situation.

Recommendations for Further Studies: This study's findings include data from an institute of Meerut region and other sources of the Indian region only. Thus this research candid a scope for other countries as well, as the increased adoption of mobile payment systems in the scenario of COVID-19 pandemic depend upon the country to country. This research aims to understand the facts related to the adoption of mobile payment systems during COVID-19 in India. Another it is suggested that the adoption of mobile payment systems earlier, during and after COVID-19 should be researched in the succeeding studies to present further facts of the adoption of mobile payment systems.

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REFERENCES

[1] Gupta, Pooja, Vimal Kumar, and Vikash Yadav. "Student's Perception towards Mobile learning using Interned Enabled Mobile devices during COVID-19." EAI Endorsed Transactions on Industrial Networks and Intelligent Systems 8, no. 29 (2021): e1-e1.
[2] D. Cucinotta and M. Vanelli, "WHO Declares COVID-19 a Pandemic", Acta Biomed, vol. 91, no. 1, pp. 157–160, Mar. 2020.
[3] https://en.m.wikipedia.org/wiki/Mobile_payment
[4] https://www.cooleygo.com/glossary/service-provider/
[5] Sreekrishna, M.; Gopika, G. S.; Jaeyalakshmi, M.; Suresh, A.; Vinothini, A.; Ieee.
5th International Conference on IoT in Social, Mobile, Analytics and Cloud (I-SMAC) ; : 538-541, 2021.Artigo em Inglês | Web of Science | ID: covidwho-1779071
[6] Hartatik, N. Firdaus and A. Aziz, "Go-Payment: Towards Cashless Payment System for Smart Village Application in Indonesia," 2021 3rd International Conference on Cybernetics and Intelligent System (ICORIS), 2021, pp. 1-6, doi: 10.1109/ICORIS52787.2021.9649644.
[7] R. M. Rawat, A. Rana, A. J. Toppo and A. Beck, "AI based Impact of COVID 19 on food industry and technological approach to mitigate," 2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS), 2021, pp. 1743-1748, doi: 10.1109/ICICCS51141.2021.9432152.
[8] Thirupathieswaran, R. & Prakash, C.R.T & .R, Santhana & Narayanan, Lakshmi & Kumar, Ashok & Robinson, Y.. (2021). Zero Queue Maintenance System using Smart Medi Care Application for Covid-19 Pandemic Situation. 1068-1075. 10.1109/ICICV50876.2021.9388454.
[9] R. H. A. Witjaksono, P. W. Handayani, F. P. Sunarso and M. Hilman, "Quick Response Code Acceptance on Digital Wallet Mobile Applications in Indonesia," 2021 International Conference on Advanced Computer Science and Information Systems (ICACSIS), 2021, pp. 1-6, doi: 10.1109/ICACSIS53237.2021.9631354.
[10] Halim, Erwin & Januardin, Reynaldo & Hebrard, Marylise. (2020). The Impacts of E-Payment System and Impulsive Buying to Purchase Intention in E-commerce. 847-852. 10.1109/ICIMTech50083.2020.9211154.
[11] de Luna, Iviane Ramos, Francisco Liébana-Cabanillas, Juan Sánchez-Fernández, and Francisco Muñoz-Leiva. "Mobile payment is not all the same: The adoption of mobile payment systems depending on the technology applied." Technological Forecasting and Social Change 146 (2019): 931-944.
[12] Park, Seong-Taek, Hyuk Im, and Kyoo-Sung Noh. "A study on factors affecting the adoption of LTE mobile communication service: The case of South Korea." Wireless Personal Communications 86, no. 1 (2016): 217-237.
[13] Narayan, Vipul, and A. K. Daniel. "Multi-tier cluster based smart farming using wireless sensor network." 2020 5th International Conference on Computing, Communication and Security (ICCCS). IEEE, 2020.
[14] Choudhary, Shubham, et al. "Fuzzy Approach-Based Stable Energy-Efficient AODV Routing Protocol in Mobile Ad hoc Networks." Software Defined Networking for Ad Hoc Networks. Springer, Cham, 2022. 125-139.
[15] Narayan, Vipul, and A. K. Daniel. "CHHP: coverage optimization and hole healing protocol using sleep and wake-up concept for wireless sensor network." International Journal of System Assurance Engineering and Management 13.1 (2022): 546-556.
[16] Narayan, Vipul, and A. K. Daniel. "IOT based sensor monitoring system for smart complex and shopping malls." International Conference on Mobile Networks and Management. Springer, Cham, 2021.
[17] Narayan, Vipul, A. K. Daniel, and Ashok Kumar Rai. "Energy efficient two tier cluster based protocol for wireless sensor network." 2020 international conference on electrical and electronics engineering (ICE3). IEEE, 2020.
[18] Deshwal, Vaishali, and Vimal Kumar. "Study of Coronavirus Disease (COVID-19) Outbreak in India." The Open Nursing Journal 15, no. 1 (2021).
[19] Gupta, Mansi, and Vimal Kumar. "Revealing the demonstration of blockchain and implementing scope in covid-19 outbreak." EAI Endorsed Transactions on Scalable Information Systems 8, no. 29 (2021): e2.
[20] Gupta, Mansi, Vimal Kumar, Vikash Yadav, Rajesh Kumar Singh, and Mohd Sadim. "Proposed framework for dealing COVID-19 pandemic using blockchain technology." (2021).