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Machine Learning-Based Mobile Payment System for Empowering Low-Income Earners in India

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Abstract

In the contemporary era, mobile phones have become indispensable, serving as communication devices and offering myriad applications. Among these applications, mobile payment systems hold great potential in driving the transition to a cashless economy. However, India's current mobile payment landscape is limited by its dependency on bank accounts. This poses a significant challenge for low-income earners who lack access to banking services or perceive minimal benefits in owning an account due to their limited financial resources. As a result, they are unable to leverage existing mobile payment systems. Despite bank branches in approximately 40,000 out of 600,000 Indian villages, a staggering 80% of households possess mobile phones. The heavy reliance on cash-based transactions leaves India's economy susceptible to disruptions. To address this, the proposed research project aims to develop a user-friendly and secure mobile payment system that operates independently of bank accounts, ensuring inclusivity for all individuals, irrespective of their banking status.

Moreover, the system will be compatible with any mobile phone and will not require an internet connection. By implementing such an innovative system, India can make significant strides towards achieving a truly cashless economy. Additionally, integrating machine learning techniques in the system can enhance security, fraud detection, and user personalization, further optimizing the user experience and driving the adoption of mobile payments.

Keywords: communication, payment system, machine learning, user experience of mobile payments

1. INTRODUCTION

Mobile communications technology has quickly become the world's most common way of transmitting voice, data, and services in the developing world. They carry the potential to be the best media for the dissemination of information because mobile services are widely available and inexpensive [1]. Mobile phones have been proven to provide reliable access to information for people in low- and mid-income countries, where other forms of communication perform poorly. As a result of the widespread adoption of mobile phones, there has been an increase in the number of Mobile Applications (M-Services) used as a tool for disseminating different types of information to people [2].

Mobile payment is using mobile devices, such as mobile phones, to facilitate payment transactions. Mobile devices can be used for both proximity and remote payments. Mobile payment systems have

increased significantly, to the point where a cashless world is possible, including in India. According to a source, worldwide mobile commerce revenues amounted to 96.34 billion U.S. dollars in 2015 and are set to surpass 693 billion U.S. dollars in 2019 [3][4]. This vast increase in mobile commerce revenues demonstrates the global adaptation to mobile-related services.

Mobile payment systems incorporate a combination of technological innovations developed throughout mobile evolution. These innovations include messaging-based payment services, such as short message (SMS) and multimedia message (MMS)-initiated payments, stored value-based payment services like mobile wallets and accounts, and mobile identification and authorization-based payment services that utilize secure wireless identification modules (SWIM/WIM) along with wireless public key infrastructure (WPKI/PKI) or other identification and authorization schemes for digital signatures and certificates in high-value payment transactions [5].

Looking at a worldwide perspective, mobile applications and services have increased, providing payment solutions for real-time payments, such as in restaurants, shops, vending machines, ticketing, the purchase of mobile services, mobile commerce (applications, software, mobile games), electronic banking, online banking, and peer-to-peer transfers [6].

Several mobile payment systems currently exist, utilizing different financial payment methods, including cryptocurrencies like Bitcoin, direct debit, credit cards, and payment against service bills [7].

The cash crisis in India has been a significant issue since the demonetization of old currency notes, leading to a cash shortage and impacting the economy and daily transactions. This problem particularly affects low-income earners relying heavily on cash-based transactions for their livelihoods, including informal businesses like vendors, rickshaw owners, and farmers. Many individuals lack access to bank accounts, especially in rural areas where banks and ATMs are scarce. The limited penetration of banking services in villages exacerbates the cash crisis, with a shortage of ATMs and entire villages lacking banking facilities [8].

To address these challenges, integrating machine learning (ML) technologies can offer potential solutions. ML algorithms can help analyse transaction patterns and user behaviour to develop models that optimize cash flow, predict demand, and manage supply. Such models can aid in ensuring the availability of cash at ATMs, reducing instances of dry ATMs and providing greater access to cash for low-income earners. Additionally, ML can identify areas with higher cash demands and optimize the deployment of ATMs or other cash dispensing services to meet the population's needs.

Furthermore, ML algorithms can contribute to developing mobile payment systems that cater to low-income earners without bank accounts. These systems can leverage alternative authentication methods, such as biometrics or unique identification numbers, to enable secure and inclusive mobile payment transactions. ML-based fraud detection techniques can also enhance the security of these systems, mitigating risks associated with digital transactions [9].

By integrating ML technologies into cash management and mobile payment systems, the challenges faced by low-income earners in accessing and utilizing cash can be addressed more effectively. These advancements can potentially contribute to India's more inclusive and resilient financial ecosystem.

2. LITERATURE REVIEW

Mobile payment systems have gained significant attention in recent years, revolutionizing how people transact. With the proliferation of smartphones and technological advancements, mobile payment systems have become an integral part of our daily lives. This part aims to provide a comprehensive overview of the existing research and developments in mobile payment systems. It focuses on their impact on low-income earners in India and the integration of machine learning (ML) techniques.

Mobile Payment Systems and Financial Inclusion:

Mobile payment systems can potentially address financial inclusion challenges faced by low-income earners in India. Research by [10] highlights the significance of mobile phones in providing reliable access to financial services in low and middle-income countries. By leveraging mobile payment systems,

individuals without bank accounts can still participate in the digital economy, making transactions and accessing financial services more easily.

Challenges Faced by Low-Income Earners:

Low-income earners in India often encounter difficulties accessing traditional banking services due to limited infrastructure and low bank penetration in rural areas. According to the World Bank, access to banking services remains challenging for millions in India. These challenges hinder financial inclusion and limit the ability of low-income earners to engage in digital payment systems.

Machine Learning in Mobile Payment Systems:

Integrating machine learning techniques in mobile payment systems offers numerous opportunities for improving security, personalization, and fraud detection. ML algorithms can analyze transaction patterns, detect anomalies, and accurately identify fraudulent activities. For example, [11] explore using ML and user behaviour analysis to enhance mobile payment security and detect suspicious activities in real-time.

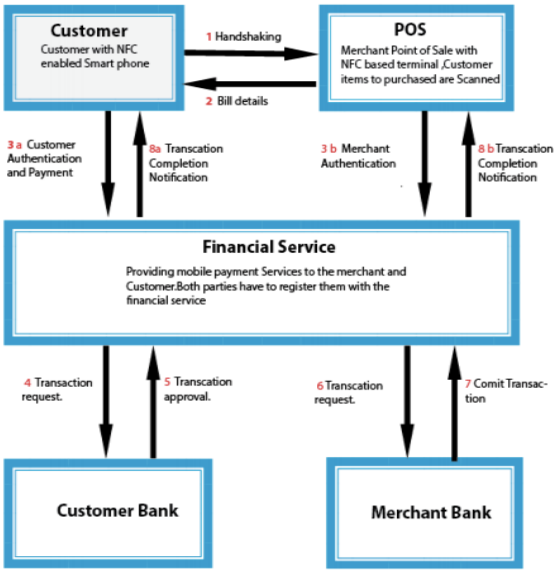

Figure 2.1 NFC Mobile Payment System

Adoption and Acceptance of Mobile Payment Systems:

The widespread adoption and acceptance of mobile payment systems are essential for their success. Several factors influence user adoption, including trust, convenience, security, and perceived usefulness. A study by [12] highlights the importance of user trust and security concerns in influencing adoption behaviour. Ensuring the security and privacy of user data is crucial in building trust among low-income earners and encouraging their adoption of mobile payment systems.

User Experience and Design Considerations:

The user experience plays a vital role in the success of mobile payment systems. A user-friendly interface, simple design, and ease of use are critical factors for encouraging adoption among low-income earners. Studies by [14] emphasize the need for intuitive interfaces and seamless user experiences to enhance the acceptance and usability of mobile payment systems.

The literature reviewed demonstrates the significant potential of mobile payment systems in promoting financial inclusion among low-income earners in India. Integrating machine learning techniques in mobile payment systems can enhance security, detect fraud, and improve user experience. However, challenges such as limited infrastructure, trust, and security concerns must be addressed to ensure low-income earners' successful adoption and usage of mobile payment systems. Future research should focus on developing innovative solutions that address these challenges and promote the widespread adoption of mobile payment systems among underserved populations.

3. METHODOLOGY AND SYSTEM STRUCTURE

The proposed mobile payment system aims to leverage machine learning (ML) techniques to create a simple and secure solution that can be used with any type of mobile phone without requiring an internet connection. The system will utilize USSD technology for communication. It will not be directly connected to the customer's bank account, making it accessible to holders and non-account holders.

One key aspect of the proposed system is integrating digital services with payment-on-site terminals at grocery shops and fuel stations. This feature eliminates the need for physical wallets and loose currency, providing convenience to users.

Additionally, the system will enable person-to-person money transfers. The primary focus is to assist low-income earners in their daily transactions, but the system can be used by anyone, regardless of income level, location, or mobile device type.

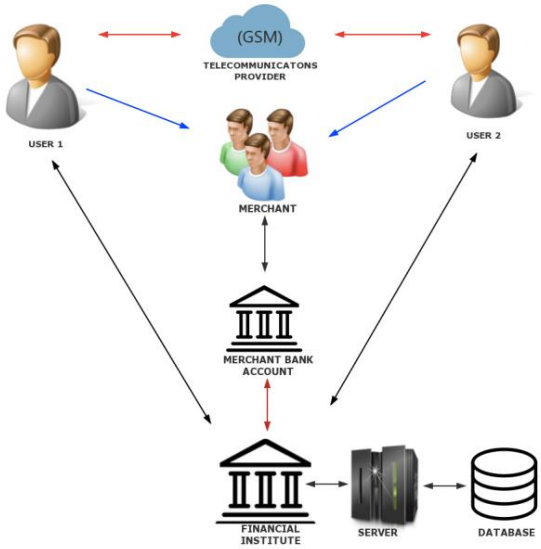

Figure 2. System Architecture

The project's objectives include designing a user-friendly mobile payment system that requires no prior training and is compatible with any mobile phone or tablet. The system should prioritize speed and efficiency to eliminate queues and delays during transactions, ensuring user satisfaction. Security is paramount, with robust measures implemented to protect user information and prevent unauthorized access.

Moreover, the system aims to be highly accessible, allowing users to make payments anytime and anywhere. Unlike traditional banks with limited operating hours, the mobile payment system will be available 24/7. It should also seamlessly integrate with various payment terminals, enabling transactions in diverse settings such as shops, malls, supermarkets, hotels, restaurants, and public transportation.

Lastly, the system emphasizes safety, reliability, and error prevention. The ML techniques incorporated will enhance the system's capabilities in detecting and preventing fraudulent activities, ensuring user trust and confidence.

GSM (Global System for Mobile Communications, originally Groupe Spécial Mobile) is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation (2G) digital cellular networks used by mobile phones, first deployed in Finland in July 1991. GSM is a circuit-switched system that divides each 200 kHz channel into eight 25 kHz timeslots. GSM operates on the mobile communication bands 900 MHz and 1800 MHz in most parts of the world. In the US, GSM operates in the bands 850 MHz and 1900 MHz.

GSM makes use of narrowband Time Division Multiple Access (TDMA) technique for transmitting signals. GSM was developed using digital technology. It has the ability to carry 64 kbps to 120 Mbps of data rates. Despite the ongoing development of 5G, the already existing third generation (3G) UMTS standards developed by the 3GPP and fourth-generation (4G) LTE advanced standards; GSM technology is still the backbone of mobile communications. Since 2014 it has over 90% of its market share, operating in over 219 countries and territories with more than one billion users.

The proposed mobile payment system architecture described above comprises four modules: cash in, cash out, person-to-person, and customer-to-merchant.

The architecture includes the following components:

Users/Customers: Users must register with their mobile numbers to access the mobile wallet. They can transfer funds between users via USSD codes over the GSM network. Users can also make payments at merchants' shops using their mobile phones.

GSM (Global System for Mobile Communications): This project works with GSM-supported mobiles and integrates with all mobile types through USSD (Unstructured Supplementary Service Data), a communication protocol used for sending text messages between a mobile phone and an application server.

Merchant: Merchants, including shop owners and business owners, can receive user payments through the mobile payment system. The funds received by merchants are automatically deposited into their bank accounts.

Merchant Bank Account: The merchant bank account holds the funds received from users when they

purchase goods and services from merchants through the mobile payment system.

Financial Institution: A financial institution is responsible for storing and managing users' funds, eliminating the need for users to have a traditional bank account. The financial institution securely holds the users' money.

Web Server: The web server hosts the system's databases, which store and manage users' account information. The financial institution uses the webserver to handle user accounts and transactions.

Database: The database is an organized collection of data that supports storing and retrieving information. In the mobile payment system, it stores schemas, tables, queries, reports, and other objects related to user accounts and transaction data.

The system enables users to utilize the mobile payment system using GSM-supported mobiles associated with mobile numbers linked to SIM cards. Users can transfer funds using USSD, compatible with any mobile phone. User accounts are password protected. Merchants receive payments through the mobile payment system, and the funds are directly deposited into their bank accounts.

4. DISCUSSION

Mobile payment systems have been in existence in India for some time now, with numerous systems currently being utilized. These systems represent a significant step towards achieving a cashless economy in India. However, the existing mobile payment systems are all linked to bank accounts, making them inaccessible to individuals who do not possess a bank account. In India, there is a substantial population residing in rural areas where banking facilities are scarce. Many villages lack banks altogether, while others have only a single bank branch and a shared ATM serving a population of over 100,000 people [15]. As a result, a significant portion of the rural population does not utilize formal banking services.

According to the Global Findex survey, 43% of Indian bank account holders have inactive accounts, while others maintain zero balances. These statistics hinder the growth of mobile payment systems in India, as they demonstrate the limited adoption and utilization of banking services among the population.

To address these challenges and promote the growth of mobile payments, this project aims to develop a mobile payment system that accommodates low-income earners without access to traditional banking services. The system is designed to be compatible with any type of mobile device, whether it is a smartphone or a basic feature phone, using USSD (Unstructured Supplementary Service Data) technology. It enables fund transfers between individuals and facilitates payments at various establishments such as shops, supermarkets, malls, and cinemas. Moreover, the system has the capability to integrate with existing registered systems, ensuring widespread acceptance and interoperability. By eliminating the need for physical cash transactions, the system helps alleviate the impact of cash shortages on the economy.

5. CONCLUSION

The proposed mobile payment system for low-income earners in India combines mobile technology with machine learning techniques to create a simple and secure solution for everyday transactions. By leveraging machine learning algorithms, the system enhances security, detects fraudulent activities, and personalizes user experiences. With compatibility across any mobile device and USSD technology, the system ensures accessibility without requiring an internet connection.

This innovative approach addresses the challenges individuals face without access to traditional banking services, promoting financial inclusion and contributing to the advancement of a cashless economy. Future enhancements can extend the system's capabilities, such as enabling online shopping, facilitating international fund transfers, and providing personalized user recommendations.

Successful implementation of the mobile payment system relies on collaboration among businesses, merchants, and consumers, along with establishing a robust regulatory framework and widely accepted standards. By leveraging the transformative potential of machine learning, this system has the capacity to revolutionize financial practices and drive economic development in India.

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