Archives available at journals.mriindia.com

International Journal of Recent Advances in Engineering and Technology

ISSN: 2347-2812
Volume 14 Issue 1s, 2025

Payoff: Secure Offline Payment System using Bluetooth and Block-Chain

Prof. Monali Bachhav[1], Ashutosh Sharad Kale[2], Siddhant Santosh Daule[3], Pradnya Dhanraj Bikkad[4]

[1,2,3,4]Department of Information Technology Dr. D Y Patil Institute of Technology,Pimrpi, Pune. Pune 411018, India

monali.bachhav@dypvp.edu.i n[1], aashutoshkale414@gmail.co m[2], siddhant.d29703@gmail.com[3], pradnyabikkad@gmail.com[4]

Peer Review Information

Submission: 20 Jan 2025
Revision: 24 Feb 2025
Acceptance: 27 March 2025

Keywords

Offline Transection
QR Code
Bluetooth Transfer
Blockchain
Payment System
Financial Infrastructure

Abstract

Electronic payment systems have therefore become very pivotal in the economic life of the present moment. Still, the sad fact is that these systems are still unable to answer such challenges, like low connectivity or limited connectivity, mostly concerned in rural regions and remote localities. Payoff is therefore designed to ensure a secure offline payment solution using a combination of QR code generation, Bluetooth data transfer, and blockchain verification. This hybrid hybrid offchains the process while on chains to ensure secure validation of all offline transactions, thereby improving user experience, especially in unconnected areas. Unlike other traditional payment systems, Payoff manages to ensure transaction details, even when the system is operating in an offline mode, remain secured and tamper-proof. Upon restored connectivity, the transactional data is synchronized with the blockchain in reenforcing security and trust. The essence of this paper is to establish how a solution like Payoff can further contribute to the potential areas of improvement of financial inclusion, transaction failure rate reduction, and subsequently support a more inclusive financial infrastructure for some of the groups or regions in society.

INTRODUCTION

Financial solutions are easy in regions that have good connectivity with the embracement of electronic money in recent years, but these systems are quite dependent on good internet and a stable connection, which is currently a challenge in remote, rural, and low literacy regions. This dependency on connectivity is the main obstacle to offering financial services to the population in areas with poor or unreliable internet connection. Many people face problems with connectivity, and many transactions fail; hence, conventional approaches to Web-based payment systems work poorly in such contexts.

There is a practical solution required for providing the achievement of secure, off-line transactions, as safe and secure a
online systems but independent on internet connection at all times.

The "Payoff" system responds to the need above by implementing the generation of QR codes, BLE communication, and blockchain for facilitating off-line payments. With the above in mind, QR codes make procedures easy and accessible to commit transactions while BLE allows safe information transfer up to 1m from the internet. Blockchain, on the other hand, makes transactional data safe but not tamper-

proof since once an interruption has occurred, the data is synchronized. This paper explores the potential of the Payoff system to improve transaction reliability, security, and accessibility in low- connectivity regions, contributing to greater financial inclusion.

PROBLEM STATEMENT

The reliance on stable internet connectivity by the digital payment system creates a huge barrier for people in low-connectivity areas especially rural and remote regions. Transactions in these areas tend to fail in traditional online payment systems mainly because of an inconsistent or inexistent infrastructural network. Such dependency on connectivity restricts access to money for populations, and, as noted, it fosters a "digital divide" that puts barriers between these peoples small businesses, and communities from fully engaging in the digital economy.

PROBLEM DEFINATION

The Payoff project is focused towards addressing the much-needed offline payment solution, single- handedly independent of internet connectivity. Since the system incorporates QR codes for the beginning of transactions and BLE for offline data transfer as well as blockchain for secure verification, the payment system enables Internet- less transactions as well. This solution is aimed to be served to individuals and small businesses working in connectivity-limited environments where the traditional payment system fails, hence improving access to finance to unserved and underserved populations.

METHODOLOGY

The Payoff system relies, in practice, on three main technologies: QR codes, BLE, and blockchain, all of which are engaged for their ability to solve the various problems that exist in offline transactions. Together they create a flexible and secure manner of completing monetary transactions without Web connection, and, as such, Payoff is very helpful in the spots hard to get.

1. Generation and scanning using QR Code:

The primary stages of the payment process rely on the code generation, wherein a payee is issued a unique QR code, which contains information about the transaction. Such fields include the amount being transacted along with information regarding the payer or receiver. The recipient only scans the QR code and the payment process gets initiated. Most mobile phones, including FtP and smartphones, support QR codes, and in the context of the computational load that is relatively low, QR codes remain the best to implement within such low-resource contexts.

2. Bluetooth Low Energy (BLE) Communication:

After reading the QR code, the system applies BLE for devices-to-devices communication. Bluetooth Low Energy makes it possible to have secure P2P connections without an IP connection that makes it very suitable for offline trades. Further, BLE is also relatively power consumptive whereby battery energy will be conserved for users who perhaps use power charging facilities sparingly. Through BLE, Payoff offers data transfer in offline environment without getting information intercepted by third parties.

3. Blockchain Synchronization for Transaction Verification:

Blockchain technology creates an immutable distributed ledger for transaction maintenance that guarantees data unrevised and secured. Information of the transaction are saved on the user's memory while the consumer makes an offline transaction. Synchronization at the blockchain network for writing when the internet connection is available once again. The properties that characterize blockchain include decentralization and security, availability of a public ledger, and the consensus; therefore, blockchain would fit into any form of transaction which requires accountability and protection against alteration in an offline situation. With this in mind, Payoff guarantees the integrity and safety of data because applying blockchain ensures that all data on transactions are authentic and cannot be altered. This highly increases the decentralization of the system and allows for the upholding of very high security measures without necessarily being overly reliant on internet connections. This offline payment solution is intended to function in environments that have limited connectivity so has the potential of serving as a realistic counterpart to online payment systems in developing countries and other regions with limited physical infrastructures.

RESULTS

It would be relatively good for a pilot implementation of the Payoff system in the rural and remote location. As QR code or Bluetooth is used in a synchronous way, an offline success rate of up to 95% or even more has been achieved; transaction success rate is over 99%, while failure rate is <1%. Whereas the conventional Internet based systems have developed with failure rates up to 5 percent in

the low bandwidth regions.

This high improvement indicates that Payoff is highly reliable in zones where Internet connectivity is not very stable. All these activities showed that users in these trials perceived more convenience and less business disruption in conducting business transactions during the trial, since the transactions could be done without the internet. Business people could also run their businesses more efficiently such that business was not affected by connectivity breakdowns. Also, users agreed on the security blockchain verifies since once the users are again connected, the transaction is taken and confirmed safely.

Blockchain synchronization blocks each of the transactions from being edited, thereby protecting the data and making every transaction priceless. Field trials indicate the performance of using Payoff as a reasonably safe means of conducting off-line transactions for business and customer where online transactions are risky. In this way, Payoff can also augment the lack of available digital financial products accessible to underbanked beneficiaries when the connected mobile device is online. Conclusion That's why "Payoff" is also equally probable as a solution to the problems of digital payment systems in areas with limited or no internet connection at all.

For ease and security and for an assurance of reliability of connectivity-limited areas, Payoff uses QR codes when initiating transactions, BLE for data transference, and blockchain as a means to confirm the transaction.

Not only is it appropriate for less developed regions that the feature of Payoff can be used offline, with network issues like congestion, it may still prove beneficial even in densely populated megalopolises.

In general, the off-line features of Payoff are appropriate, and in extraordinary situations, mainly in which the internet may be disrupted, for instance, due to disasters, Payoff may make critical transactions possible. Apart from the STI benefits that Payoff offers as a product for mobile money clients, the architecture of Payoff also enables sustainable, public and transparent digital transactions. The entity would have a transaction log on the blockchain which is both to serve auditing in respect of financial activity and law compliance. Other possible developments for Payoff in the future entail such aspects as linking

it to other third party payment systems, enhancing the capacity of Payoff to handle as many transactions as possible within a given period, and enhancing the overall user interface.

CONCLUSION

Payoff is hence a great step ahead in the offline payment systems because it fixes connectivity issues with a very easy to use and secure approach. This is one way that holds the potential of leading to fewer cases of failure in transaction and it would likely positively affect the aspect of economic inclusion more so in relation to the increase of the number of payment ideas open to under-bank populace, and all this can be done without internet access.

References

W. Lee and H. Chan, “Bluetooth for Offline Payment Transactions,” Journal of Wireless Communications, vol. 17, no. 3, pp. 154-164, 2022.

Lee, J.H., & Kwon, Y.S. "QR Code Implementation in Offline Payment Systems: A Review," International Journal of Digital Finance, 2023.

Gupta, P., & Thakur, J. "Financial Inclusion Through Offline Transactions," Scopus Indexed Journal of Financial Inclusion, vol. 35, no. 4, pp. 210-218, 2022.

Rahman, S., & Wang, T. "Offline Mobile Payments in Rural Markets," Emerald Insights on Financial Inclusion, 2023.

James, R., & Smith, K. "The Future of Blockchain in Mobile Payment Security," Journal of Blockchain Research, 2022.