CAREER POINT INTERNATIONAL JOURNAL OF RESEARCH
Career Point International Journal of Research(CPIJR)
©2022 CPIJR | Volume 4 | Issue 1 | ISSN : 2583-1895

Electronic Payment Systems: Architecture, Elements,Challenges and Security Concepts: An Overview

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Abstract- In this paper, the major aim is to investigate the heightened awareness regarding various electronic payment systems-related concepts in terms of their advantages, problems, and security issues. The payment processing system providers use software as a service (SaaS) model and with this model, they form a single payment channel to numerous payment methods for their clients. Users often give away their personal information such as names, card details, and so on whenever they go online to make any firm of payment. An online payment system is referred to a system that facilitates electronic money exchange. This form of payment typically involves the deployment of the Internet, computer networks, and other digital stored value systems. Collecting any form of payment over the internet implies that the user has accepted an online payment and must have shared some confidential information with the service provider. This paper embarks on a thorough review of all aspects of online/electronic payment with emphasis on the analysis of numerous studies on electronic payment systems. The latest studies have been explored to gain insight on the electronicpayments systems.

Keywords: Electronic Payment, Information Hiding, Steganography, Cryptography.

I. INTRODUCTION

The exchange of goods and services between 2 persons start before the advent of written history; but as the exchange of goods become more difficult between per- sons, they began to represented values in an abstract manner, starting with the barter system to the use of cer- tified notes, payment orders, cards (debit or credit), and recently the electronic or e-payment systems [1]. The cus- tomary payment methods are well-known to have cer- tain issues such as false signatures, cash falsification, and bounced cheques. However, a well-planned e-payment sys- tem can address these security issues and provide an added advantage of usage pliability [2, 3]. E-payment systems have received much recommendation due to their ease of money exchange, security, and faster access to capi- tal resources [4–6]. The conventional cash payment sys- tems have become more expensive compared to the recent strategies due to the recent impacts gained by minor finan- cial transactions in most economies. Furthermore, interne cash processing can

have less value compared to the small- est cash estimation in the manual world [7]. As the web keeps impacting our daily lives, people are getting used to online transactions when buying or selling products [8]. However, the increased dependence on web-based trans- actions for cash-related activities has come with issues that cannot viably be solved by the traditional payment methods. For this reason, financial experts have begun to investigate different e-payment systems with emphasis on the issues associated with digitalized and e-payment sys- tems [3]. Each online transaction is processed through payment gateways which serve as a point for access- ing different financial organizations. The payment details between different parties and financial institutions are val- idated through these payment gateways [8]. In this paper, a detailed description of the increased awareness on elec- tronic payment systems (EPS) was provided. This paper is arranged as follows: Section 2 provides various defini- tions and aspects of EPS while Section 3 and Section 4 cover the advantages and popularity of EPS. In section [6], the problems associated with payment system is provided while the important security issues of EPS are presented in section [7]. A review of the related works to EPS is pre- sented in section [8] while section 8 concludes the paper.

II. LITERATURE REVIEW

ELECTRONIC PAYMENT SYSTEM (EPS) With the increase in the exchange of goods among dif- ferent business partners over the Internet, the conventional cash-based payment system has been gradually rele- gated [9] as most people prefer an electronic payment sys- tem to the cash-based method. These e-payment systems are considered as a method of making payments for ser- vices over the Internet [10, 11]. An EPS can be described as a form of inter-organizational information system (IOS) dedicated for making money-related transactions between customers and different organizations. There may be a need for complex interactions between technologies, the environment, and the partners to ensure an effective EPS. The specific features of EPS/IOS also makes it techno- logically, organizationally, and relationally different from the traditional internal-based information systems [12–14]. This highlights the need for the cooperation among differ- ent technologies to make an effective system [15]. Over the years, there has been an increase in the global annual non-cash transactions facilitated through mobile and e-payment systems except for the year 2012 when there was a decline in the annual growth rate from 8.6% in 2011 to 7.7% in 2012 [16]. However, the year 2014 witnessed an increase in the global electronic payment to 8.9%, reaching 387.3 billion, representing the most signif- icant increase since the World Payments Report was first published. This increase was mainly due to the quickened development in newly emerging financial markets. A pro- jected higher worldwide development of 10.1% was antic- ipated for the year 2015 and predicted to take the global non-paper exchange volume to 426,300,000,000 [17]. Indi- viduals and groups use e-

payment systems as a convenient and secure way of making cash payments over the inter- net and consider the channel as the gateway to techno- logical advancement in global economy [18]. It has also become the major facilitator of e-commerce on which success in electronic business depends upon. E-payment systems have also reduced resourcefulness ad fraud rate in the global payment system [11, 19].

History of EPSs

Historically, e-payment dates to 1918 when the United States (U.S.) Federal Reserve Bank first moved currency via telegraph. However, this technology was not widely adopted in the US until the incorporation of their Auto- mated Clearing House (ACH) in 1972. Since then, the popularity of the system became high, enabling the U.S. commercial banks and its central treasury to introduce it as an alternative to the conventional cheques payment [11].

The advent of credit cards also date to 1914 when cus- tomers were issued with cards by department stores, oil companies, Western Union and hotels to facilitate payment for goods and services. Forty years later, credit cards are being widely used and have become more acceptable as a payment option. Before the 1990s, credit cards were issued as paper-based payment options but later, they were trans- formed to electronic systems. The increase in the rate of credit card usage has led to a rapid growth in the industry and has ushered in the introduction of a debit card system. Both credit and debit cards are currently used globally for the payment for goods and services [10, 20].

Definitions of EPS

The EPS is a complex term that portrays various meth- ods of electronic payment delivery. Its multipurpose nature provides and increased imprecision of e-payment char- acterization in the literature. In terms of capabilities, e-payment can be considered as e-banking, e-cash, inter- net banking, m-payment, online banking, and so on. All things considered, researchers have recently strived to pro- vide a comprehensive definition of e-payment [5]. The EPS is described by Ref. [9] as a form of financial com- mitment which brought a customer and a seller to the same platform via electronic means. Furthermore, Ref. [15] con- sidered e-payment as a form of inter- relation between peo- ple and associations powered by institutions that provides electronic financial transactions [12–18].

According to Ref. [21], e-payment is any form of internet-based money exchange. Similarly, Ref. [22] stated that an e-payment system is an electronic way of mak- ing payments for web- based services. In another explana- tion, e-payment is any form of payments/exchange made electronically [23]. Another researcher [24] considered e-payment as an online monetary exchange between two persons. Additionally, Ref. [25] defined e-payment as money-related exchanges facilitated via electronic means. Another definition of e-payment is any form of

payment that involves exchange of electronic information such as credit and debit card detail other than payment with cash or cheque [26].

As per Ref. [27], e-payment is a fiscal claim exchange by a payer on a worthy and useful party. According to Ref. [28], e-payment involves payments made through electronic transfers, an automated clearing house, or through a commercial card system. E-payment was defined by Ref. [29] as any form of money exchange via any elec- tronic channel. Another definition of e-payment according to Ref. [30] is payments made through electronic signals linked to credit or debit bank accounts. E-payment, as per Ref. [31], is any form of non-money payment with the exception of a paper cheque. E-payment is defined by Ref. [32] as any electronic exchange that could be consid- ered as a form of payment for goods and services made via e-payment channels that gives clients a remote access to their financial accounts via electronic systems. Generally, EPS can be defined as any form of monetary exchange between buyers and sellers via online platforms with the help of a digital financial instrument [33].

III. METHODOLOGY

A. HOW BLOCKCHAIN WORKS?

Blockchain, the name is adapted from the way it works – blocks connected to form a chain. The transaction recorded in a block contains a hash (digital signature), hash of previous block and the ledger of all valid transactions. The hash links the block one after another and strengthens the verification of the previous block. Thus, an immutable blockchain is formed.

1. A node of the network starts a transaction by creating,then digitally signing with its private key.
2. The transaction is represented as a block.
3. The block is broadcast to every participant in the P2P network.
4. The transaction is propagated by using Gossip protocol, to participants to validate the transaction based on data and history of transaction. More than 50% of nodes are required to verify the transaction.
5. When the transaction is verified and validated, a block can be added to the blockchain.
6. Newly created block now becomes a part of the ledger and money (cryptography like bitcoin) moves to the other party.

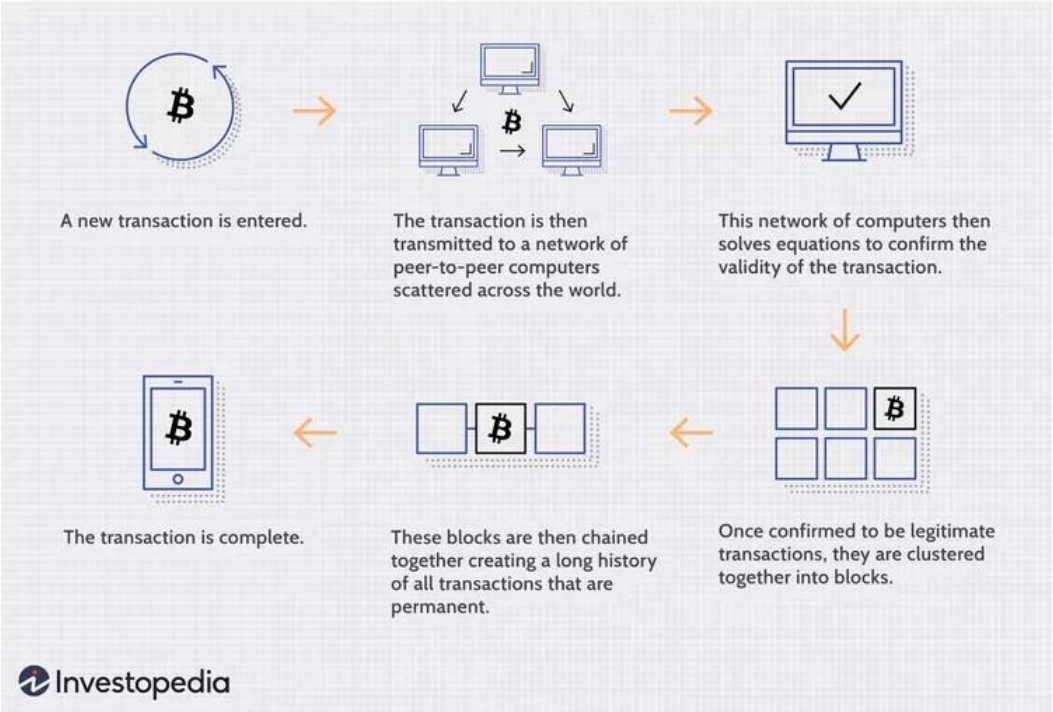

Figure 1: How a Blockchain works

1) Public Blockchain - This provides an open platform for people from various financial organizations like banks and backgrounds to join, transact and mine by decentralized consensus mechanisms. There are no restrictions. So they are called 'Permission less' blockchains. Blockchain is specific to the user without specific validator nodes. All the participants have power to write and read transactions, and perform auditing and view transactions of the blockchain.

2) Private Blockchain - These systems facilitate exchange of data and private sharing among a group of individuals or selected people or multiple organizations controlled by selective individuals or one organization. These blockchain systems are called permissioned Blockchain. Therefore unauthorized access can't do, without any special permission. Each and every node maintains a copy of the ledger to reach a consensus, but unlike public blockchain the writes are restricted.

3) Consortium Blockchain - This blockchain system can be considered as a partially private and permissioned blockchain, not a single organization or person but a set of predetermined nodes that are responsible for consensus and block validation. Nodes decide who can join the network and mine data. . This is not a fully centralized system, but it has the ability to control some selected validator participants or peers. There are some limited abilities to read and write transactions. These nodes do not guarantee immutability and irreversibility.

B. BLOCKCHAIN ARCHITECTURE

The Blockchain architecture consists of four concepts as decentralization, digital signature, data mining and data integrity.

1) Decentralization: Blockchain distributed control among all the participants or peers in the chain and creating a shared infrastructure.

2) Digital signature: An exchange of transactional value using public keys by the mechanism of a unique digital sign enabled by Blockchain. All the participants in the network know the code for decryption. Private keys known only to the owner to create ownership.

3) Mining: Every user in the system mines and digs data which is evaluated according to the cryptographic rules. This also acknowledges miners for confirmation and verification of the transactions.

4) Data integrity: Algorithms and agreements among participants ensure that the transaction data, once agreed, cannot be tampered [1]. Data stored in the system act as a one version for all parties while reducing risk of fraud.

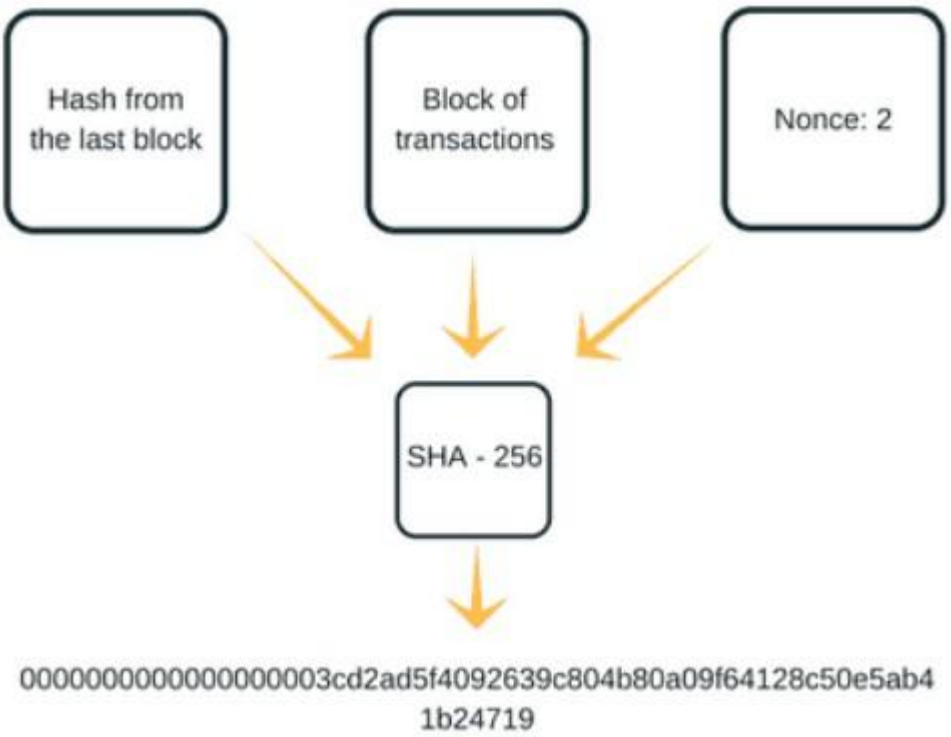

Figure 2: How the hash value create for each block

C. BLOCKCHAIN TRANSFORMATION OF BANKING SERVICES

Blockchain technology promises a huge opportunity to recover the challenges in the banking industry. There are several use cases with advantages and limitations with blockchain technology.

1. **Payments** : These are the important use case of any financial and banking systems. Both commercial and central banks are going to use this blockchain technology for the payment process. These are important for cross border payments, without third party payments can be done very quickly. Some problems related to the cryptocurrency exchange to the local money can happen because of changes in exchange rates.

2. **Digital verification**: This can be done by removing all traditional verification systems like identity, face checking and proof of client intention by using blockchain. Blockchain provides ways to choose users who can identify them and others who like to share their identity without repeating registration for each banking service. Because of the shared ledger system, any participant can access information without permission. Therefore private information should not be added to the blockchain.

3. **Lending**: Traditional banks provide different kinds of loans. But it takes a long time. Blockchain can be used for this lending system with superfast transactions in a transparent way. Banks provide loans, KYC (Know Your Customer) and BSA (Bank Secrecy Act) and link all of them to a single consumer block. This system helps to save money and time for waiting the traditional long process.

4. **Bookkeeping**, Accounting and Auditing: Most of the traditional banks still depend on paperwork like double entry transactions and after a long process they digitize the details slowly. Banks can directly enter their transaction details into the shared ledger system . All the records are transparent and irreversible when using blockchain. This system has a feature of smart contracts which can pay invoices automatically. People who work in banks should have prior knowledge about blockchain is a considerable limitation.

5. **Crowdfunding**: This is an online raise funding mechanism by involving large numbers of people with small amounts of money. Initial Coin Offerings (ICOs) have the ability to sell

their tokens via the internet, with the decentralization advantage by using blockchain technology. This has a risk because of the legal issues in ICOs.

6. **Smart contracts**: Smart contracts are a set of code which is stored in Blockchain. These programs execute automatically when conditions are met. They perform cryptographic transactions, transparency without intermediaries because of the decentralized ledger in blockchain.

7. **KYC (Know Your Customer)**: Traditional KYC processes use a lot of time to perform individually in all banks and other financial institutions. Using Blockchain, independent verification of each customer of one bank can be accessible for other banks. This process helps to eliminate duplication, reduce administrative effort and save time.

D. LIMITATIONS OF BLOCKCHAIN TECHNOLOGY

1. High initial cost: Blockchain saves transaction cost and time but it needs high initial capital cost.
2. Complexity: This technology involves entirely new vocabulary. Participants should have specialized knowledge about the technology.
3. Network size: Blockchain requires a large network of participants. If it is not a widely distributed grid of networks, it becomes more difficult to achieve the benefits.
4. Transaction cost: Transaction cost for the first few years is free. But after that there is a rising transaction cost in the network.
5. Limited scalability and storage issues: Blockchain has a consensus mechanism to verify the transactions. This limits the number of transactions that can be made in a given time period. Blockchain has an immutable distributed chain of blocks that grows at a very rapid space, then this can course for storage issues.
6. Unavoidable security flaw: If more than half of participant nodes to service the network are a lie, it will become a truth.
7. Energy and resource consumption: A blockchain network consumes heavy resources. When the blockchain network grows, miners need to validate the blocks. So it increased heavy energy consumption

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E. FUTURE IMPROVEMENTS OF BLOCKCHAIN TECHNOLOGY

1. Blockchain and bitcoin are really hard to those who are not working with technology and software development. So one of the future improvements is to build tools to make the transactions easier.
2. Storing data in the Blockchain is quite expensive so make a solution to store the data off the chain and send them to the blockchain periodically.
3. Making laws to adopt blockchain technology for the industry is necessary for the revolution of the banking industry.
4. Blockchain will hope to reduce their prices and improve their quality of services with new features in near future.

IV. CONCLUSION

Blockchain is a decentralized digital ledger which cannot achieve hacker's objectives. Therefore Security wise, it is a very important technology to adopt in Sri Lankan Financial industries like banks. This also helps to enhance the efficiency of the banking industry. There are a lot of opportunities with Blockchain technology with immeasurable values. This provides a unique way to establish cryptography transactions, by enabling simplification of money in the world. Giants in the banking industry started to search possible new use cases to expand their services by using Blockchain. This technology revolutionized the underlying sectors in credit information systems, payment clearing, lending systems, digital verification, audit keeping systems, crowdfunding, smart contract and KYC in banking. PBFT is the best consensus algorithm for payments and transactions. Banks used POW for digital verification because it is the best algorithm which provides better security. PBFT or BFT is mostly used for syndicated lending in the banking industry. Both PoW, Pos and DPoS are used for crowdfunding in the banking sector. Based on the type of cryptocurrency algorithms will change in smart contracts. If the cryptocurrency is Bitcoin for smart contracts most of the time we use POW. If the cryptocurrency is Ethereum for smart contracts most of the time we use POS. Most of the banks used PoW for KYC. Prospect of this technology into the banking industry will occur in the near future. When using Blockchain, there are some challenges. To solve these challenges we should provide facilities to reduce initial cost to adopt blockchain in the banking sector. System usage complexity is high. Therefore developers should reduce complexity and give prior knowledge for the users. Then we can minimize adoption and usage problems related to blockchain technology. Blockchain should develop for small scale

networks as well in future. According to the consensus algorithm power consumption can be changed. Therefore we should select the best algorithm for relevant banking service. Developers should reduce unwanted security flows and make them simpler to use. This paper gives a comprehensive review of the blockchain revolution in the banking industry. Blockchain is the next best invention after the internet. Therefore my opinion is that blockchain is a great disruptive technology which will revolutionize the banking sector in a better way in the near future.

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