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An IoT-Based Framework of Digital Payment in Electronic Health Record System -DP-EHR

Yogita Chauhan[1], Dr. Kavita[2]

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Abstract: Objective- The objective presented this research is to develop the reliable digital payment system from centralized Electronic Health Record (EHR) system that utilizes the blockchain technology to address the challenges of interoperability in the healthcare sector specially for payment.
Method- The research introduced the idea on digital payment in the healthcare sector and observed that payment can be facilitated using a Digital payment system and patient history can be centralized using supporting mobile apps and API's. Additionally the use of an IoT-based approach for payment using digital paper and pen, makes the payment cost-effective. A comprehensive analysis is conducted of existing literature regarding the adoption of blockchain technology in healthcare systems, with a focus on its implementation within Electronic Health Record (EHR) systems. During analysis it is found that the system provide a boom in acceptance of Digital payments, provides Health education and awareness, increase the trend of telemedicine integration.
Result- The comprehensive analysis of the literature is based on the adoption of blockchain technology in healthcare systems for digital payments. The research focuses on its implementation within Digital Payment (DP) and Electronic Health Records (EHR).

Keywords: *Digital payment, Digital paper, Smart gadgets, IoT, Blockchain, QR codes, Static QR code, Dynamic QR code, UPI, Electronic health records.*

Introduction:

Digital payments have become an integral part of daily life, with over 90% of the current generation opting to use digital payment methods when making online transactions. In response, banks have launched a high-profile campaign to raise awareness of the benefits of digital payments, including convenience and enhanced security.

The objective of this research is to centralize the healthcare data based on IoT and some smart equipment like digital paper with a digital touchpad. By using these IoT devices the medical history of any patient can be stored on a central repository in the cloud, which can be accessible by healthcare industries like hospitals, insurance providers, digital payment gateways, and some connected health apps.

In the current landscape, healthcare data is dispersed across diverse stakeholders. Capitalizing on the inherent capabilities of Blockchain's DLT (Distributed Ledger Technology) infrastructure could potentially surpass the capabilities of prevailing centralized systems. Blockchain's decentralized architecture holds the potential to enhance data accessibility, expansion, and security. Furthermore, decentralized systems have the potential to optimize costs, truncate transaction durations, and foster efficiency by avoiding excessive overhead and intermediaries.

Healthcare providers employ a combination of open standards and proprietary formats for organizing health records, which find utility within internal applications and manifest in diverse formats. In earlier iterations, Electronic Health Records (EHRs) were not tailored to manage lifelong, multi-institutional medical records. The progression of life events leads patients to traverse across different organizations, resulting in their health data being dispersed across distinct silos. Consequently, the ease of accessing historical data diminishes, as primary custodianship usually rests with providers rather than patients.

Background: An Electronic Health Record (EHR) constitutes a digital repository encompassing a patient's health information, perpetually curated throughout their life. Traditionally, this data is disseminated and preserved across various healthcare facilities, including hospitals and clinics. Primary access to these records usually rests with the healthcare providers, limiting patient access to historical data. In instances where patients gain access to their health records, the interaction tends to be fragmented, mirroring the inherent management approach of these records[1].

Offering a potential avenue for data sharing and trust-building, Blockchain emerges as a prospective solution to

[1]*School of computing science and engineering, Galgotias University, Delhi, NCR, India. Email: yogitachauhan8@gmail.com*
[2]*School of computing science and engineering, Galgotias University, Delhi, NCR India. Email: kavitasaini_2000@yahoo.com*

address this issue. This technology holds the promise of facilitating collaborative clinical decision-making within telemedicine and precision medicine domains. The presented research's principal contribution lies in a methodical literature review that spotlights prior investigations relating to the amalgamation of EHRs and Blockchain. In the presented research, the utilization of Blockchain architecture in healthcare, particularly in the realms of Electronic Health Record (EHR) Storage and access management.

In DP-EHR Blockchain stands as a distributed ledger protocol to secure the digital payment data and medical data over the cloud. The blockchain concept can be extended to furnish a versatile framework for decentralized computing resources, even within the complex healthcare system. To better understand the EHR as a blockchain taxonomy the best reference is the paper [2] author used the best way to represent the taxonomy which is Figure 2 in the paper.

Challenges in adapting Blockchain technology in EHR: Blockchain technology helps to increase the interoperability, privacy, and security of Electronic Health record systems, in recent decades (2008-2018),In the absence of interoperable data standards—such as HL7 FHIR or Open EHR—clinical data can adopt formats and structures that pose challenges in interpretation and integration with alternative systems. Thus, an architecture grounded in standards emerges as indispensable for facilitating integration with prevailing telemedicine systems. Such integration nurtures authenticated and adaptable clinical data sharing, thereby enhancing collaborative decision support.[2]

The challenges related to EHR in blockchain are-

- The existence of interoperability challenges amidst provider and hospital systems creates additional obstacles to seamless data sharing.
- This absence of synchronized data management and exchange results in fragmented health records, lacking the clarity needed for effective utilization.
- Security and privacy are major challenges in this as data is stored in the cloud.

The important principles behind blockchain in DP-EHR is transparency decentralized, security, and immutability. A comprehensive transaction log is maintained, detailing the particulars of each interaction. This ledger encompasses data such as transaction dates, times, participants, and quantities. Each node in the network retains a complete copy of the Blockchain. These principles additionally guarantee that network nodes consistently and automatically concur on the ledger's prevailing status, as well as each transaction contained therein. If any attempt is made to tamper with a transaction, a consensus is unattainable among the nodes, leading to the rejection of the transaction's integration into the Blockchain[3].

Technical requirements are –

Network-based- Digital payment methods, especially when using cloud-based systems or accessing online services, are network-dependent. This means that they rely on a stable and reliable internet or data network connection to function properly. While network dependency is a characteristic of digital payment systems, efforts are made to ensure a seamless user experience even in low or intermittent network conditions. Some mobile payment apps may offer offline payment capabilities, which store the payment details and transmit the transaction once a stable network connection is available. It's important for users to be aware of the network dependency when relying on digital payment methods and ensure they have a reliable internet connection, especially for critical transactions. Additionally, users should take necessary security measures and follow best practices to protect their financial data when using digital payment systems online.

User-Based - Overall, being tech-friendly and knowledgeable about digital payments empowers users to navigate the modern financial landscape, take advantage of various payment options, and make secure transactions. It also helps individuals adapt to the ongoing digital transformation of the financial industry and stay ahead in an increasingly interconnected world.

Other Supporting requirements- Payment app, Smart IoT equipment Digital paper, and touch pen.

Integration of EHR (Electronics Health Records) and Blockchain-

A practical paradigm of utilizing blockchain for EHR management involves addressing the issue of patients lacking access to their medical records when transitioning between hospitals. The application of blockchain in this scenario facilitates primary patient care data by ensuring seamless access to essential medical information across different healthcare institutions. The data stored with the help of an IoT device i.e digital pen and digital paper, touchpad, medical practitioner gives inputs with the help of IoT and input will be considered as a medical record. The input data (including personal details, illness or disease symptoms, Payment details, etc) will be stored on the cloud and secured by Blockchain technology[4,5].

The study conducted a comprehensive analysis of sharing Electronic Health Record (EHR) data utilizing blockchain technology, introducing an innovative framework designed for the effective management and sharing of data, particularly in the context of critical illness patient care. The researcher emphasizes that EHRs, being

electronic in nature, possess inherent potential for sharing across various healthcare entities, including, insurance companies, pharmacies, patients, and other healthcare service providers.

Materials and methods –

Centralized system flow – The primary contributors of Electronic Health Records (EHR) data are predominantly hospitals, where patients visit and furnish their health-related information. Following closely in the spectrum of stakeholders are the medical practitioners, particularly doctors, who maintain direct communication with the patients. Specialists play a pivotal role in organizing and upholding the patient's health data, thereby ensuring the delivery of high-quality treatment that is both accurate and accessible. The emphasis lies on safeguarding the security of this information.

Doctors in hospitals shall use the touch pen and digital paper which are connected to some health app that is responsible for storing and securing accurate data on central repository system, also some contactless payment gateways are interconnected with the health apps to make the payment system quick and authenticate.

Furthermore, within the healthcare ecosystem, patients themselves are vital contributors to EHR data. Notably, patient-generated data and behavioural information encompassing vital signs, dietary habits, physical activity levels, real-time alcohol, and tobacco consumption, and more have not been extensively integrated into prevailing EHR platforms.

The relationship between stakeholders extends beyond providers and patients. Patients avail of healthcare services extended by service providers, and in return, they cover costs such as insurance premiums, co-payments, deductibles, and direct out-of-pocket expenses related to medical care.

Pharmacies bear the responsibility of effectively managing medication inventories and ensuring adherence to prescriptions provided by healthcare providers. Their role encompasses the meticulous dispensing of medications and remedies, while also aligning with regulatory requirements. Additionally, pharmacies have expanded their role to include serving as auxiliary medical clinics catering to immediate care requirements.

In the broader healthcare landscape, researchers assume a pivotal role in propelling scientific and medical progress. Through their commitment to exploration and experimentation, researchers contribute significantly to the advancement of knowledge in the fields of science and medicine [4,5].

The data has the potential to be stored within a centralized repository, with the option of utilizing a cloud-based infrastructure. Where all data resources are like patient data. Stakeholders (Doctors, pharmacists, insurance issuers), and some other government records (birth, any accident, and injury during the govt. service, death details, etc) and further recommendations, if someone has taken further recommendations for other countries, are interconnected.

The data from all stakeholders and other resources is displayed in Figure 1.

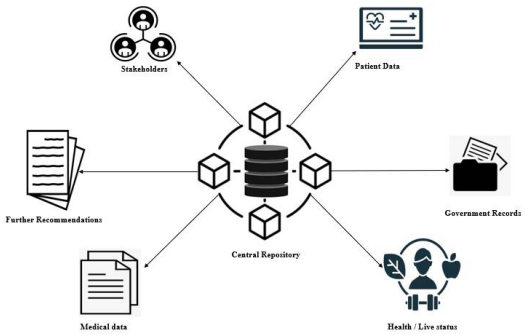

Fig 1: Central repository system.

Payment flow - Payment flow refers to the sequence of steps involved in processing a payment transaction. It outlines the journey of funds from the payer (the person making the payment) to the payee (the person or business receiving the payment). The payment flow can vary depending on the payment method and the parties involved, but generally, it follows a series of standardized steps are explained below-

- Initiation- The payment process begins when the payer initiates the transaction. This can be done through various channels, such as in-person at a store, online on a website, or using a mobile app.
- Authorization - After the initiation, the payment must be authorized to ensure that the payer has sufficient funds or credit to cover the transaction. Depending on the payment method, this can involve inputting a PIN, providing a signature, or using biometric authentication.
- Processing -Once the payment is authorized, the transaction enters the processing phase. During this step, the payment details are transmitted securely to the payment processor, who then communicates with the respective financial institutions involved.
- Clearing- In the clearing stage, the payment processor routes the transaction to the payer's bank or card issuer for validation and verification. The bank checks the payer's account for sufficient funds and confirms the transaction's legitimacy.
- Settlement-: After clearing, the funds are transferred from the payer's account to the

payee's account. The settlement can occur instantly for most of payment methods.

- Notification - Both the payer and payee receive notifications of the completed transaction. This can be in the form of a receipt, an email, or an alert on their respective payment platforms.
- Reconciliation- The payment is reconciled on both the payer's and payee's end, ensuring that the transaction is accurately recorded in their respective financial records.

It's important to note that payment flows can differ depending on the payment method used. For example, credit card payments involve additional steps like credit card authorization and chargebacks, while digital wallets might have their own unique steps like user authentication, for funding and processing transactions. The pay modes generally used in digital payments are listed as follows-

Steps Involved in online payments-

1. Patient (User) choose any doctor or diagnose lab form the health application (Merchant) and create his order for the doctor consultation or some other medical help.
2. User enters his/her mobile number to the cashier to make payment using merchant POS.
3. Merchant server in network validation the details entered by user and send API and User mobile number to the payment gateway.
4. Payment gateway sends a SMS of payment Link to the user registered mobile.
5. User opens link in his mobile device and select the payment methos as per his choice, this can be , UPI, Wallet, Postpaid, Credit card, Debit Card, Net banking, EMI etc.
6. User enter other authentication details further like (Name, card numbers etc).
7. Merchant server receive the transaction confirmation.
8. Merchant POS system close the order/bill and shares payment response (Success/failure) with customer.

Apart from this QR code is another contactless pay mode which is very quick and secure.

QR codes are divided in two primary categories-

Dynamic QR Codes: Dynamic QR codes are produced by merchants using their Billing POS/System for particular orders or bills. To generate a dynamic QR code, merchants incorporate order-specific details such as Order ID and Order Amount. Customers then scan this QR code to initiate the payment process. Merchants can monitor transaction status through the Payment gateway using the Order ID, enabling them to oversee and finalize the respective order or bill.

Static QR Codes: In contrast, static QR codes are exhibited by different merchants as an identification mechanism. Unlike dynamic QR codes, static codes lack particulars specific to payments. When utilizing a UPI app for payment, customers manually input the payment amount relevant to the transaction. The dynamic QR code empowers merchants with greater control over the payment sum executed via the QR code.

Benefits of Dynamic QR Codes:

Every QR code generated by a merchant is distinct, bolstering security.

Merchants possess the option to print the dynamic QR code on their bills or receipts.

Merchants wield authority over the order amount, curbing user modification during scanning.

Displaying the dynamic QR code on a mobile device is straightforward.

It supports payments through a wide range of UPI apps.

The process of integrating dynamic QR codes for online payments on the merchant's end encompasses various stages:

Merchant Authentication: Merchants acquire a unique Merchant ID and merchant key from the payment gateway to ensure authentication.

Creation of Dynamic QR Codes: Merchants generate dynamic QR codes within their systems. Online resources offer libraries capable of transforming QR Code IDs or UPI QR Data strings into QR code images.

Customer Scanning and Payment Initiation: Customers scan the dynamic QR code using their UPI app. This action directs them to the final payment page hosted by the Payment gateway.

Confirmation of Transaction Status: Verification of transaction status transpires between the merchant's server and the payment gateway's server. This communication guarantees accurate monitoring of transaction progression[7].

To summarize, dynamic QR codes furnish a secure and convenient avenue for merchants to receive payments pertinent to specific orders or bills. This methodology empowers merchants with authority over payment sums and streamlines transactions across diverse UPI apps. The integration procedure involves authentication, the generation of dynamic QR codes, customer scanning, and verification of transaction status, culminating in a seamless online payment experience.

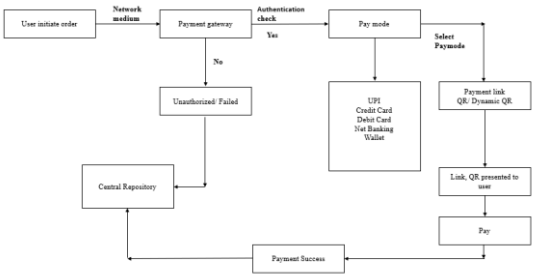

Fig 2: Payment Flow.

Methodology:

This research consists of three primary components: the IoT-enabled smart pen, the Secure Healthcare Solution application, and the cloud storage system. Healthcare providers utilize the smart pen on specially designed paper to prescribe medication. Equipped with sensors, the smart pen captures handwritten information, converts it into a digital format, and transmits it to the patient's mobile device through the application. The application securely stores the digital prescription on the cloud server using SHA-256-bit encryption, associated with the patient's unique ID. The cloud storage system ensures encrypted and secure storage of each patient's medical history, accessible only to authorized individuals and potentially lockable with biometric features for enhanced privacy[6].

Beyond digital prescriptions, our system incorporates payment link/Dynamic QR/ digital payment, linked to a payment gateway's API. This pay mode includes relevant payment details, such as payment type, amount due, and billing information. When asked at the billing desk, user can opt for payment using their mobile devices to initiate a reliable and contactless payment process, offering multiple payment options like UPI and credit cards. This feature enhances payment efficiency, reduces the risk of disease transmission, and adds convenience for patients.

Moreover, the unique patient ID can be globally accessed by medical practitioners, facilitating comprehensive diagnostics and treatment. In emergencies, biometrics provide vital information, including medical history and insurance plans, to doctors and emergency responders, ensuring immediate and life-saving interventions.

Utilizing expertise and artificial intelligence, our system predicts future illnesses, enabling advanced treatment and preventive measures. The unique ID acts as a global data collection point for insurance companies, allowing them to tailor custom insurance quotes and plans for users, preventing future difficulties.

Our invention unifies disparate systems, creating a functional ecosystem by integrating IoT and encryption in healthcare. It securely manages diverse records and maximizes utility for all users.

Result:

In this research, the development is already done in EHR with a blockchain framework. Our focus is on making EHR, IoT-based which will provide transparency in the patient history, using the digital paper and the Touch Pen. These can be offered by some health applications as the system is turned to digital. The function takes place when Dr. prescribes something to the patient and it is automatically recorded in the system of the health application.

These health applications relate to central repositories where data can be stored centrally on the cloud. The method also focused on the digital payments system supporting all pay modes like Credit cards. Debit card. UPI, Net banking, wallets. The integration can be done between the health application and the payment gateway provider to receive payments and settle them to the merchant (Health application) and the Doctors and Labs as per the requirements. The payment system is more secure having multi-level security of Merchant. Bank and the security from payment gateway.

Discussion: This study is worthwhile for a marketing perspective as well. Most of the modules are available in different sectors like digital payments systems in the E-commerce market, Health applications and some connected stake holder in the health sector, the idea is to integrate all the modules in a platform to make the system interconnected, authenticate, and reliable. The organization that provides a payment gateway can earn a good revenue by offering the payment gateway to the good enterprise's merchants, and also the connected health apps and labs can earn a good revenue by offering the payment gateway to the good enterprise's merchants.

Conclusion-

This research concludes that there is a strong case for advocating the integration of blockchain technology within Electronic Health Record (EHR) systems in the healthcare sector. It takes innovation in the healthcare sector like telemedicine Integration, Appointment scheduling and reminders, Health education awareness, and Interoperability with other healthcare service providers. Integrate telemedicine capabilities into the platform, allowing patients to consult with healthcare providers remotely. This will improve access to healthcare services, particularly for patients in rural areas or those with limited mobility. Provide health education and awareness resources within the platform, empowering patients to make informed decisions about their healthcare and promoting preventive care The increasing adoption rates of blockchain in healthcare indicate a growing interest in its potential benefits. However, this research has also highlighted the presence of several critical

challenges that must be overcome to ensure the successful and effective implementation of blockchain technology in EHR systems and The trend of digital payment in the medical sector

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