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# The Influence of Blockchain Technology on the Use of Electronic Drug Prescription Based on Cultural Safety Sociotechnical Framework

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**ABSTRACT**

Electronic drug prescription (e-DP) is embraced in many countries due to the numerous benefits, but the drawbacks commonly experienced include security concerns, privacy violations, data manipulation, and patient mortality. Therefore, this qualitative study aimed to review blockchain technology as a solution for e-DP based on Cultural Security Sociotechnical Framework (CSSF). The analysis conducted from 2015 to 2023 showed a twelvefold rise, while progressive growth was detected in 2023. A total of 13 main variables associated with CSSF were identified, and blockchain technology was found to be dependable and transparent, as well as capable of enhancing rapid information repository, patient safety, and security. The accuracy and tamper-resistance of blockchain data promote user confidence, which is further strengthened by the provenance function of this technology through data tracking and verification. Blockchain anonymizes and guards system data, but a new governance structure is needed to fully implement technology for digital prescription issuing. The results of this study are important for the development of science and general human welfare.

## 1. INTRODUCTION

Electronic drug prescription (e-DP) is widely used across several countries. Despite this adoption, numerous issues persist as reported in previous studies, particularly concerning patient data security [1-10] and privacy [11-14]. The potential negative consequences of data manipulation and excessive usage of electronic health record systems should be considered, as these factors can cause harm to patients [1, 15-17]. Another investigation suggests a need for enhanced governance in e-DP publishing [12, 18, 19]. Implementation of efficient procedures is required to ensure the appropriate use of e-DP systems and compliance with all the elements stipulated in medical rules and regulations, such as those outlined by CSSF. Blockchain technology application for e-DP is currently in the early stages, even though it is believed to hold an opportunity for resolving the issues experienced [20]. This is supported by the increasing investigations on the stated topic, with a twelvefold rise observed between 2015 and 2022 as well as progressive exploration extending into 2023. Therefore, this study aimed to comprehensively examine the application of blockchain technology in facilitating e-DP implementation, particularly considering the impact on CSSF. The most important concerns to be addressed relate to the potential of blockchain technology to deal with the challenges associated with e-DP. The question "What is the common impact of blockchain technology on CSSF?" needs to be answered.

The current study applied a qualitative method, specifically using a systematic literature review (SLR). Furthermore, a total of 218 articles released between 2015 and 2023 were examined, and the search process was facilitated by the Publish or Perish application [21]. The search was conducted across multiple sources, including one database index (Scopus) and eight publishers (Sciencedirect.com, ACM.org, IEEExplore.IEEE.org, MDPI.com, tandfonline.com, onlinelibrary.wiley.com, journals.plos.org, links.springer.com). Subsequently, 31 articles focusing on the application of blockchain technology for e-DP were identified. These were carefully examined to determine the factors contributing to development and evaluate the impact on CSSF. The abstract data in the articles were analyzed using the VosViewer application to identify new trends in blockchain technology exploration for e-DP. This study detected 13 significant factors related to development, which directly influenced CSSF consisting of three primary dimensions, namely culture, process, and technology. The results provided evidence regarding the direct positive impact of blockchain technology on critical success factors influencing CSSF. These factors included enhancing information reliability, ensuring data security and privacy, promoting transparency, facilitating distributed data management, improving efficiency, ensuring data provenance, enhancing safety measures, enabling information traceability, and establishing verifiability and trustworthiness.

This study tends to provide valuable insights, particularly for industries planning to implement blockchain technology for processing e-DP issuance. Significant contributions will be made to the advancement of scientific knowledge in the fields

of blockchain technology and CSSF. However, the development of governance requirements in Smart Contracts presents a novel challenge, as it necessitates the adaptation of efficient procedures to accommodate blockchain technology application. The process of writing an article starts with an introductory section that explains the contextual framework of the study, novel aspects, the topics addressed, the methodology used, and the results derived.

## 2. LITERATURE REVIEW

### 2.1 SLR

In this study, SLR was used to comprehensively examine articles regarding the application of blockchain technology for e-DP. SLR is a prevalent method often applied in the area of quantitative investigations. Furthermore, it is widely recognized as highly effective for conducting an in-depth exploration of a specific topic. This process incorporates four key phases, including preparation, searching, data processing, and report generation. Phase 1 comprises the setting of objectives, development of study questions, and identification of relevant keywords. Phase 2 requires performing a comprehensive search for articles, starting with an initial search based on the titles. This is followed by a careful evaluation of the abstracts to refine the selection. The process concludes with a thorough examination of the complete contents of the selected articles to determine the suitability. Phase 3 includes the processing of data corresponding with the objectives and addresses the study questions, while the final phase features report creation [22].

### 2.2 Culture safety sociotechnical framework (CSSF)

The initial development of CSSF can be related to the radioactive disaster that occurred at Chernobyl. The use of this framework is prevalent due to the significant efficacy in enhancing patient safety [23]. CSSF can be categorized into three primary groups, namely culture, process, and technology. Culture plays a substantial role in shaping the behavior of an individual toward safety, particularly regarding this study which focuses on patient safety. In this context, process refers to the application of technology as well as the accessibility of information to promote prompt and precise decision-making. The introduction of technology has caused a significant development in the capacity to record and monitor safety and quality concerns in a system. The velocity of reporting can facilitate the preservation of patient safety and security. The application of advanced technology enhances the effective recording and reporting of potential risks.

### 2.3 Blockchain for e-DP based on CSSF

This study aimed to visualize and explore the influence of factors, including culture, process, and technology, identified from the literature concerning blockchain adoption for e-DP based on CSSF. The visualization results would provide insights into the influence of blockchain on e-DP to promote the implementation of this technology by businesses.

## 3. METHODOLOGY

An overview of the method used to conduct the current study is provided in this section.

Figure 1 discusses the sequential phases of the conducted study, starting with the identification of keywords for article retrieval, specifically related to the domains of blockchain and prescription. The subsequent phase included conducting a literature search using the SLR method [22].

### 3.1 Literature identification

The literature search was performed on the Scopus database using the Publish or Perish application. Additionally, eight publishers were consulted for relevant articles, namely sciencedirect.com, ACM.org, Ieeexploere.ieee.org, MDPI.com, tandfonline.com, onlinelibrary.wiley.com, journals.plos.org, and link.springer.com. The search query applied the keywords comprising "blockchain" and "prescription" as well as “blockchain” and “drug”.

### 3.2 Literature search

The inclusion criteria consisted of articles written in English between 2014 and 2023. In January 2024, a comprehensive search was conducted, from which a total of 212 articles were retrieved. The abstract of each paper was reviewed, resulting in the selection of 85 articles as potential candidates. A comprehensive reading of the entire content of these articles led to the selection of 31 suitable for further data processing. Various factors contributed to the exclusion or non-use of articles, such as duplication and inaccessibility.

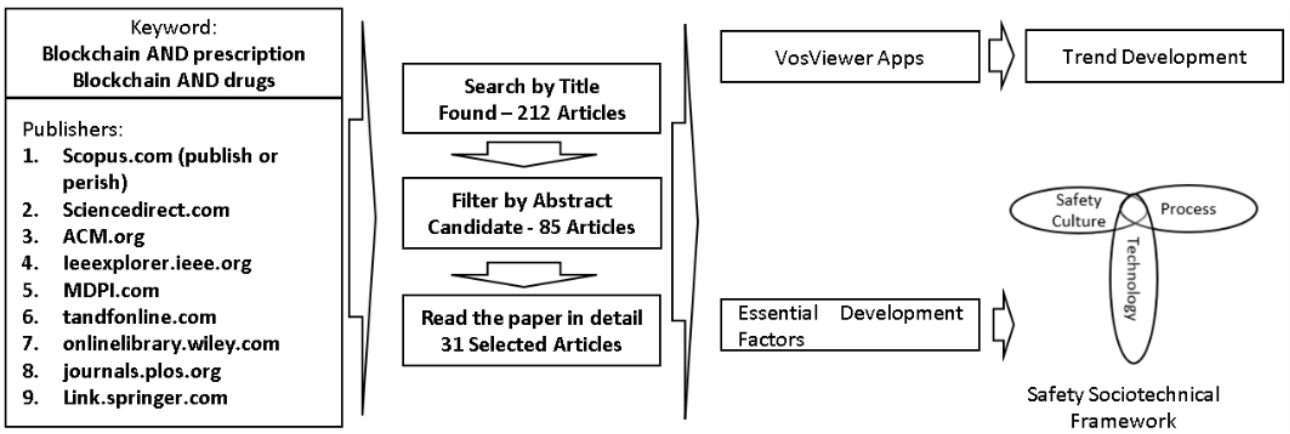


**Figure 1.** Study phases

### 3.3 Data extraction and analysis

After selecting 31 articles, data processing was conducted using the VosViewer application [24]. Data extraction and analysis produced an image which will be explained in the following session.

## 4. RESULT AND DISCUSSION

The session will present the data collected for this study, as well as the results of data processed using the VosViewer application and an in-depth analysis of the article. The analysis of the results is conducted towards the conclusion of this session.

Table 1 shows the resources selected for this study, which includes a journal article found in 2015, signifying the onset of an investigation into the use of blockchain technology for e-DP. Further investigation was found in 2017 in the form of a conference, followed by a journal and a conference in 2019. A journal, three conferences, and another source were identified in 2020, with an increase of 2.5 times compared to the previous year. Five journals were detected in 2021, as well as six newspapers and six conferences in 2022, then four articles and one conference were obtained in 2023.

**Table 1.** Data source

| Years | Journals | Conferences | Others | Total (%) |
|---|---|---|---|---|
| 2015 | [25] | | | *1 (3.2%)* |
| 2017 | | [20] | | *1 (3.2%)* |
| 2019 | [16] | [17] | | *2 (6.6%)* |
| 2020 | [1] | [11, 18] [26] | [2] | *5 (16.1%)* |
| 2021 | [4, 5, 27-29] | | | *5 (16.1%)* |
| 2022 | [3, 7, 15, 30-32] | [6, 8, 12] [14, 19, 33] | | *12 (38.7%)* |
| 2023 | [9, 13, 34, 35] | [10] | | *5(16.1 %)* |
| | | | Total | *31 (100%)* |

An increase of twelvefold in the number of publications relating to the subject matter was observed. Based on the provided information, it can be inferred that blockchain technology application to record electronic prescription for pharmaceuticals is a contemporary subject.

Figure 2 further shows the same phenomenon as presented in Table 1. This signifies that the trends of publications related to blockchain technology application for e-DP remain relatively recent.

The results presented in Figure 3, shows that this study remained in a state of continual development, and obtained from using the VosViewer software for data processing [24]. These signified the continual development of e-DP systems, as shown by the inclusion of the year 2022 highlighted in yellow. The issue of medical prescription mistakes, including incidents of false drug administration, persists in contemporary healthcare settings [16]. Therefore, privacy and security concerns remain a subject of interest, particularly regarding the exchange of data among prescribing doctors, patients with prescription, and pharmacies where drugs are purchased. Smart contracts are a viable solution applied in the context of blockchain technology to address prevailing challenges.

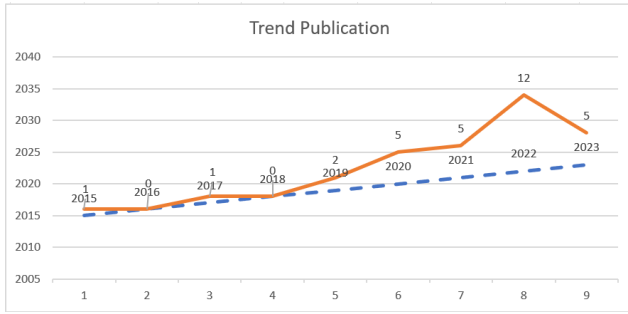


**Figure 2.** Publication trends

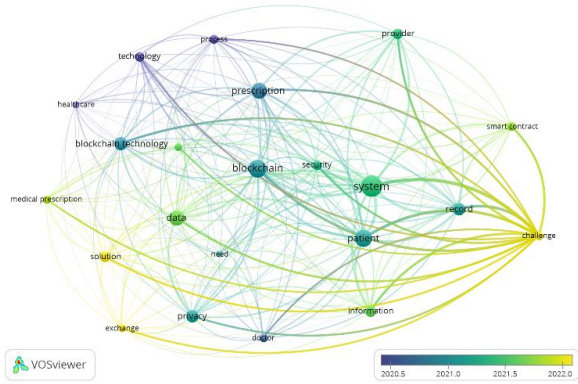


**Figure 3.** Study development trends and challenges

Through article reading, additional factors were identified as obstacles to the application of e-DP. These included Wrong Medication [16], Costly Infrastructure [16, 34], Time Consumption [3, 16], Data Privacy [12, 15-17], Data Security [13, 15, 16, 20], Financial lost (Fraud) [15], Complexity (Invisibility) [17], Unreliable System (Lack of Trust) [20, 27], Overdoses Prescription [5], and Tracking issues [5].

**Table 2.** Data source

| Essential Factors | Citation | Culture | Process | Technology |
|---|---|---|---|---|
| Efficiency | [4, 5, 25, 35] | | x | x |
| Decentralized | [1, 13, 15, 32, 35] | | x | x |
| Distributed | [6] | X | | |
| Governance | [12, 18, 19] | X | x | x |
| Privacy | [2, 3, 7, 8, 10-15, 32] | | | |
| Provenance | [7, 12, 29, 32] | | x | |
| Reliable | [1, 5, 10, 29, 33] | X | x | x |
| Secure | [1-10, 15, 32] | X | x | x |
| Safety | [25] | x | | |
| Traceability | [5, 7, 8, 14, 15, 33, 35] | | x | x |
| Transparency | [3, 8-10, 28, 29, 32, 35] | | x | x |
| Trustworthy | [3, 7, 9] | x | x | x |
| Verifiable | [4, 13, 19] | x | x | x |
| | Total | 6 | 11 | 9 |

Table 2 presents the article review results, showing important factors identified in this study and the influence mapped onto CSSF factors, which are explained subsequently. The efficiency factor has a direct influence on the process regarding the application of blockchain technology in producing e-DP, which offers real-time information to all parties including medical doctors, patients, hospitals, and drug stores. This can significantly facilitate decision-making, leading to enhanced speed, as well as impact the procedure for documenting reports (e-DP) through blockchain featuring immutable and unchangeable data. The efficiency factor significantly contributes to the effectiveness of CSSF.

The decentralization aspect of blockchain is closely associated with the process and technology, as it prevents any point of failure in e-DP system, thereby enabling uninterrupted operation. This feature also helps to facilitate decision-making and enhance the reporting procedure. The distributed factor refers to information accessibility to all parties in the same network, while still upholding the importance of data privacy by implementing pseudonyms in e-DP. The concept of distribution is closely associated with the dissemination of information that promotes the direct observation of patient safety culture. Governance contributes to the three dimensions of CSSF and is an essential consideration because it has implications for the adaptation of existing procedures to effectively leverage blockchain technology. The adoption of governance manifests through the setting up of smart contracts, representing a business process that operates continuously until completion, ranging from doctors issuing electronic prescription to using prescription at drugstore. The creation of contracts depends on the consensus of all included parties, thereby ensuring effective governance. The privacy aspect of blockchain technology is attributed to the pseudonym feature, which ensures the preservation of data privacy through the inability to read patient names directly. This attribute directly impacts decision-making, leading to enhanced objectivity in terms of selecting the right patient, medical doctor, and drugs. The advantage of blockchain exists in the provenance factor because this technology creates a continuous link/chain of data. In principle, incorporating the provenance feature in the decision-making process can lead to increased efficiency, as information reliability can be traced back to the origin. This comprises an e-DP source, which is the medical doctor, and the usage of prescription at drugstore.

Blockchain is characterized by reliability, which develops from fundamental properties such as immutable and tamper-proof data. This attribute ensures that e-DP data stored on blockchain remains unchanged and permanently available, promoting the reliability of information about patient safety, process, and technology. The secure factor applies to a characteristic mainly associated with blockchain technology, which uses the hashing encryption feature and the Merkle-tree method to prevent data modifications. This feature has the potential to significantly impact the three dimensions of CSSF. Enhancing the security of data stored through several hashing can promote decision-making and improve report-processing capabilities. Safety originates from the inherent capabilities of blockchain, including the ability to ensure reliable data and maintain privacy. Consequently, the application of this technology has the potential to enhance patient safety. Traceability enables the linking of data in sequence, thereby facilitating the identification of the source and enabling easy tracing of information including the medical doctor who provided an e-DP, drugstore location, and recommended drugs. This is closely connected to the process of decision-making and report documentation. Transparency is ensured by the decentralized nature of blockchain technology, enabling all parties to have access to shared information. This does not compromise the security (multiple hashing) and privacy of data, hence, integrating the feature will significantly enhance decision-making and documentation efficiency. The trustworthy factor refers to the enduring existence of all inherent characteristics in blockchain technology, which remain unchangeable. This ensures the reliability of both the system and the data of e-DP. The presence of accessible information and the ability to verify the authenticity through the transparent nature of blockchain technology significantly influence the three dimensions of CSSF. The final factor identified from the development of blockchain technology is the capacity for verification through features such as provenance and data chains. This enables the seamless verification of information, thereby aiding CSSF dimensions.

The study of important elements in CSSF promotes the belief that using blockchain technology to generate e-DP will improve health services and patient safety. This improvement is achieved through faster and more secure record-keeping resulting from more efficient and consistent administration of services. Additionally, the use of e-DP provides reliable data because the source of prescription and drug purchases can be easily tracked, leading to enhanced safety. Medical professionals, patients, hospitals, pharmacy stores, and other parties experience openness all through the process of developing and applying e-DP. Blockchain technology application increases patient confidence, governance efficiency, and safety by resolving existing problems, such as the manipulation of e-DP data.

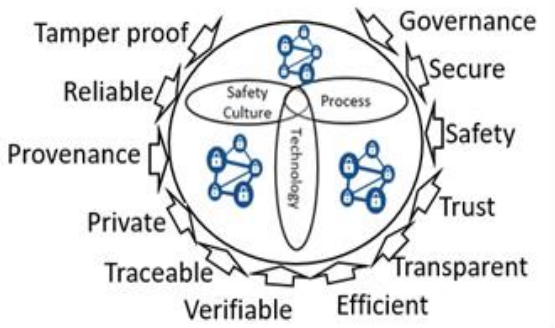


**Figure 4.** CSSF integration with blockchain

Figure 4 shows the direct implications of integrating blockchain to resolve inherent issues present in e-DP system, specifically focusing on CSSF. The implementation of this technology for electronic health record issuance offers a novel method that enhances data security and safety as well as the service rendered to patients.


**Figure 5.** An e-DP without blockchain

Figure 5 presents the shortage of a connection between parties in an e-DP system lacking blockchain technology. The depicted scenario showcases the medical doctor generating an e-DP for a patient, who subsequently uses it to procure drugs. The lack of connectivity in the system poses a significant challenge, constituting the primary drawback experienced. Without blockchain, the provenance of drugs is compromised due to the difficulty of tracking the use of e-DP.

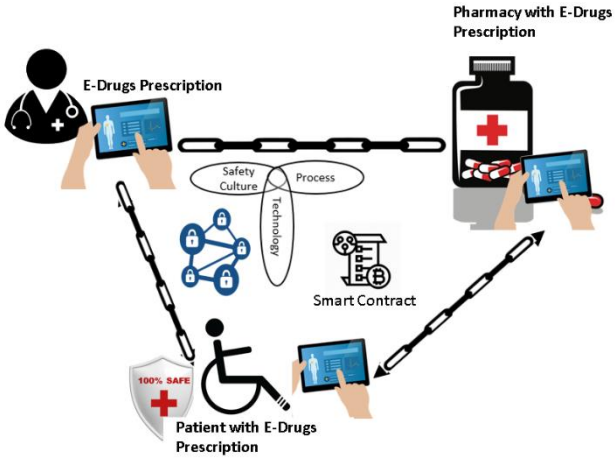


**Figure 6.** Blockchain application for e-DP

Figure 6 shows the adherence of an e-DP system using blockchain to CSSF regulations. Through technology application, an e-DP incorporating smart contracts will remain interconnected, starting from e-DP provision until prescription fulfillment. This has the potential to enhance patient safety by ensuring that access to data is transparent, validated, reliable, and secure, thereby eliminating manipulation tendencies.

The use of blockchain as a foundation for creating e-DP helps to improve the entire process, ranging from prescription publishing to execution in pharmacy outlets. However, data manipulation does not resolve the contemporary issue nor sufficiently regulate drug sales. Blockchain technology benefits patients by facilitating rapid governance and decision-making procedures capable of ensuring safety through transparent and traceable information that can be validated. Therefore, blockchain technology application is expected to guarantee the correct matching of medical specialists, acceptable drugs, and suitable patients or individuals.

## 5. CONCLUSION

In conclusion, the results showed that blockchain application could enhance patient safety due to possessing unchangeable, immutable, transparent, reliable, secure, traceable, and verifiable characteristics. The implementation of e-DP using this technology should provide significant benefits to healthcare professionals and pharmacies dispensing drugs. Blockchain was found to streamline the process of authenticating drugs and the information contained in an originally issued e-DP. This technology would promote faster and more reliable service delivery by healthcare providers to patients, thereby enhancing performance.

Important aspects concerning governance in the context of e-DP issuing and blockchain technology through the use of smart contracts were identified. To promote effective accommodation of this new business process, existing procedures would need modifications. The impact of blockchain application in e-DP tended to contribute to the desired harmony in SCCF implementation. This could ensure an accurate distribution of medical doctors, appropriate drugs, and suitable patients, with safety and security being the primary objectives.

This study exclusively examined e-DP implementation in the context of CSSF to enhance patient safety. Clearer insights were provided into blockchain technology application in the healthcare sector along with a comprehensive assessment of the effects produced on both the industry and patients. However, future investigations could be conducted using alternative frameworks, including the Occupational Safety and Health Administration (OSHA) guidelines, as well as the domain of electronic medical records.

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