Assessment of Blockchain Technology Application in the Improvement of Pharmaceutical Industry

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***Abstract*—Blockchain technology (BCT) has paved a way for new potentials of handling serious data privacy, integrity and security issues in healthcare. To curb the increasing challenges in healthcare industry, healthcare organizations need to apply blockchain technology to better improve patient safety and protect patients records from counterfeiting and fraud. The purpose of this research paper was to define BCT can assist in improving pharmaceutical industries in Saudi Arabia upon utilization of its application. This study adopted quantitative methods to gather the study data. Based on healthcare leaders perception and Internet connection, lack of cooperation, and economic inequality were found to be leading factors hindering the application of blockchain technology in the pharmaceutical industries, Saudi Arabia. Factors facilitating the application of blockchain technology in the pharmaceutical industries, Saudi Arabia were found as system robustness of BCT, increased data safety and decentralization, need for enhanced supply chain management and interoperability, and government laws and policies. Adopting interventions that are targeted to specific patient population medications, effective delivery systems, transit provider reimbursement far from intensity and volume of services towards value and quality was found to compromise the pre-existent challenges and real capacity in healthcare system. Although the relationship between implementation of blockchain technology and cost spending is negative in the short-term, in the long run, the relationship is positive Blockchain helps in managing multiple levels in a more secure way, reduces paper work and amplifies verification inefficiency.**

***Index Terms*—assessment, blockchain technology, pharmaceutical, Saudi Arabia, patient safety, data integrity**

I. INTRODUCTION

The increased uptake of digitization in the healthcare industry has resulted in the development of massive electronic records of patients. The development of blockchain technology has paved a way for new potentials of handling serious data privacy, integrity and security issues in healthcare. There are numerous challenges experienced in healthcare industry such as the pharmaceutical industries. They include lack of transparency, increased transaction costs and interoperability. Strategies to aid in solving the problem need to be formulated. Blockchain technology serves as the most appropriate technology in solving these challenges hence it was chosen to be discussed in this paper. The technology has attracted considerable focus from industry in academics over the previous years. Definitely, the applications of the new blockchain and research studies advance each day. Blockchain technology is acknowledged as a distributed ledger innovation for peer network digital data transactions that may be privately or publicly to all users, enabling the patients data to be stored in a verifiable and reliable way. Blockchain technology has led to the advancement of many smart contract applications in some regions such as energy resources, voting, and healthcare and energy resources.

II. METHODS

A. Participants and sampling procedure

The participants included 14 healthcare leaders in the field of pharmaceutical industries in Saudi Arabia. All participants were able to read and respond to the questionnaire in English, and they have had previous experience in a managerial position for a period of not less than a year (i.e., pharmaceutical industries). Ethics approval was obtained before participants recruitment. Healthcare leaders in the field of the pharmaceutical industries in Saudi Arabia were invited to participate. The study was advertised via emails sent to healthcare-wide mailing lists. Subject of this study were thanked for their time and participation.

B. Data collection and analysis

The data in this research paper was collected from participants using self-administered questionnaires. A questionnaire is a research instrument comprising of a series of questions created with the aim of gathering information from the participants. Cronbach's alpha and reliability test in SPSS were conducted for each item. Cronbach's Alpha ranged between 0.847 to 0.734 which was at an acceptable level for reliability. Questionnaires were created based on the research questions and issued to the participants to be answered. The data collected was analyzed through descriptive statistics which entailed measuring the central tendency and dispersion. The study was guided by the following research questions:

- What are the factors that hinder the application of BCT in the pharmaceutical industries?
- What are the factors that foster the application of BCT in the pharmaceutical industries?
- What are the ways that compromise between the pre-existent challenges and the capacity of healthcare system?

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- Is there a relationship between the application of blockchain technology and the cost of spending on short term and long term basis?

III. RESULTS

Out of the 14 questionnaires distributed, 11 were completed and received back. From the data collected, the study recorded the following results as per the research questions of the research paper.

A. Factors that hinder the application of blockchain technology

In formulation of the self-administered questionnaires, four factors were considered to determine the extent to which they hinder the application of BCT in the pharmaceutical industry. These factors include; healthcare leaders perception about the importance of BCT application (4-item), internet connection (3-item), lack of cooperation from other health sectors (3-item), and medical supplies inequality (2-item). The respondents were asked to rate the factors using 5-Point Likert Scale, ranging from 1 being strongly disagree to 5 being strongly agree, depending on their perception and influence in blocking the application of BCT in healthcare organizations (i.e., pharmaceutical industries). Table I shows a summary of the results from the respondents in descending order.

TABLE I
FACTORS HINDERING THE APPLICATION OF BCT

Factor	***Mean***	***SD***	***N(%)***
Healthcare leaders perception	4.01	1.51	11(78%)
Internet connection	3.78	1.28	13(92%)
Lack of cooperation among health sectors	3.56	1.06	13(92%)
Economic inequality	2.94	0.44	12(85%)

B. Factors that facilitate the application of blockchain technology

Similarly, in formulation of the self-administered questionnaires, five factors that facilitate the application of BCT in pharmaceutical industries were considered. The participants were requested to rate the factors using 5-Point Likert Scale, ranging from 1 being strongly disagree to 5 being strongly agree, depending on the extent to which they think each factor influences the easiness of the blockchain technology adoption. These factors included overall performance of BCT (4-item), system robustness (2-item), government policies and laws (3-item), need for enhanced supply chain management and interoperability(3-item), and increased need for data safety and decentralization (3-item). Table II summarizes the results obtained from the respondents in a descending order.

C. Ways to compromise between the pre-existent challenges and the current capacity of healthcare system in relation to the pharmaceutical industries

Three ways were suggested in formulation of the self-administered questionnaires to help in determining ways of compromising between the pre-existing challenges and the real capacity assuming that healthcare industry is not that good enough. The participants were requested to rate the factors based on the importance of these three ways using five point- Likert scale, ranging from 1 being strongly disagree to 5 being strongly agree. These ways include; adopting interventions that are targeted to specific patient population (3-item), adopting effective delivery systems (2-item), transit provider reimbursement far from intensity and volume of services towards value and quality (4-item). Table III shows respondents rate regarding the importance of the three ways.

TABLE II
FACTORS FACILITATE THE APPLICATION OF BCT

Factor	***Mean***	***SD***	***N(%)***
System robustness	3.86	1.36	13(92%)
Overall performance	3.45	0.95	12(85%)
Need for data safety and decentralization	2.98	0.48	11(78%)
Need for enhanced supply chain management and interoperability	2.78	0.28	11(78%)
Gernment laws and policies	2.56	0.06	13(92%)

TABLE III
WAYS TO COMPROMISE BETWEEN THE PRE-EXISTENT CHALLENGES AND THE CURRENT CAPACITY OF HEALTHCARE SYSTEM

Factor	***Mean***	***SD***	***N(%)***
Adopting effective delivery systems	4.18	1.68	12(85%)
Adopting interventions targeting a specific patient population	3.75	1.25	12(85%)
Low reimbursement comparing to value and quality	2.78	0.28	13(92%)

D. Determination of the relationship between the application of BCT and cost spending in the short term and long-term

In establishment of the relationship between the application of BCT and the cost of spending in short-term and long-term, the respondents were asked to denote the type of the relationship between the two variables. Pearson correlation coefficient was used to measure the strength of the relationship between these two variables and their association with each other. Negative linear relationship were found between the application of BCT and the cost of spending in short-term, as the greater investment in building a system that is designed to use BCT in the health sectors the more spending will be and vice versa. On the other hand, positive linear relationship were found between the application of BCT and the cost of spending in long-term, whenever there is available robust system that utilizes the BCT in the healthcare sectors (i.e., pharmaceutical industries) the more likely the cost saving increases and vice versa.

IV. DISCUSSION

In the application of blockchain [1] technology, several blocks exist. The finding of the study revealed that the healthcare leaders as the leading factor in hindering application of BCT. The study [2] found that the lack of knowledge

among healthcare leaders hinders the application of blockchain technology. Blockchain being comparatively new technology is perceived with skepticism by numerous health leaders [3]. Most of the health leaders are not sophisticated enough to embrace the advantage of technology in the healthcare arena and specifically in [4] the pharmaceutical industries . Network was found as the second leading hindering factor. Blockchain technology cannot be applied in the absence of a network. A remote location characterized by a slow internet connection creates a challenge in applying blockchain technology. The thirds factor which the researcher found to be influencing the application of BCT was lack of cooperation.

The application of blockchain technology in the pharmaceutical industry demands strong cooperation among other domestic and international health sectors. As revealed by [5], lack of cooperation hinders the effective functioning of the technology. There are two main reasons as to why cooperation is critical in applications of blockchain technology. One, blockchain has the potential to eliminate the desire for the trusted intermediaries, some of which are deeply entrenched within the present systems as well as processes and are key in regulator fabric [6]. Varying this demands technology vision, willingness to allow and make regulatory modifications and the incentive to support the accomplishment of these variations from the market. Two, the technology provides great value when multiple parties across trust boundaries engage in a blockchain network, supporting possibilities not though before [6]. Enhanced cooperation is required for the successful application of blockchain technology. The finding of the study also acknowledged inequality in the contiguous support of medical supplies as it is hindering the application of blockchain technology. Giving blockchain technology much priority benefits only the educated people in society hence fosters inequality.

Regarding the factors fostering the application of Blockchain technology in pharmaceutical industries, system robustness stemming from the system has was found to have facilitated application of BCT a lot. System robustness entails transparency, removal of intermediaries, trustworthy system, security and handling of double speed issues in healthcare organizations [7]. Transparency in information flow brought by the technology has encouraged the stability of the data depicting that once data is stored cannot be deleted or changed, peer to peer transactions in absence of the third party is possible, all which have made encouraged the application of blockchain technology [8]. The second factor which was found to have encouraged the adoption of technology is its overall performance. Blockchain technology leads to increased efficiency, speed, and effectiveness in accomplishing tasks in pharmaceutical industries, all these encourage the application of technology. The technology has also increased the safety of data and decentralization in the pharmaceutical industries [4]. These make most people wish to apply it mainly to increase the safety of their information and medicine supply chain management [3].

Increased need for enhanced supply [9] chain management was found to have a certain influence in application of BCT in healthcare industry. The study [6] found that the increased demand for improved supply chain management has motivated the application of blockchain technology. The blockchain-based contrast tends to help healthcare institutions to successfully monitor the supply-demand cycles within its entire lifecycle. Moreover, interoperability, the very blockchain chain has encouraged BCT adoption in most organizations [10]. With blockchain network being shared successfully by the authorized providers in securing manner eliminates the burden and cost involved in data reconciliation.

Government laws and policies have also encouraged the application of blockchain technology in the pharmaceutical industries as per the research findings. The fact that the technology makes things less complicated, [11] is less time-consuming, is more transparency, checks corruption within government health organizations and has the capacity to recognize any scam in an organization has made the government to continuously encourage the application of the technology in all healthcare organizations [1].

Adoption of delivery system reforms serves as the effective approach of compromising the pre-existent challenges and the capacity in healthcare system (i.e., pharmaceutical industries). In the study [12], the authors found that their application supports provision of tools, incentives and resources required to achieve better patient outcomes and reduces pre-existing challenges. Varying provider reimbursement which details moving away from focus on intensity and volume of the services availed and towards responsibility of the general cost as well as quality is significant in underpinning integrated delivery system reforms. In the study [5], predictors for instance, improved utilization, complexity conditions or other personal and clinical features tend to enhance delivery system investment returns. To fully support integrated delivery reforms through provider payment as well as benefit reforms should be mixed with broad healthcare coverage to compromise the pre-existing challenges especially the spread of Covid-19 is a feasible and sustainable way [13].

Application of BCT in the pharmaceutical industries especially during this critical time when most of the healthcare system is suffering from Covid-19 will benefit a lot. Firstly, BCT helps in managing multiple levels in a more secure way, something which allows monitoring of the whole system at once without breach [14]. Secondly, blockchain technology helps in reducing the outbreak of coronavirus by completely doing away with paper processes and the need for back and forth documents delivery to clinics. The sharing of physical documents tends to spread Covid-19. Reducing the amount of paper through the application of BCT benefits not only the pharmaceutical industries but the entire healthcare system. Thirdly, the blockchain technology enabled tracker features aids in [15] capturing recent tweets concerning Covid-19 [16]. This benefits the healthcare system as it offers a map and figures grounded on publicly available data. In the study [7], the negative impacts of the present pain points in the healthcare industry such as lack of information sharing, the challenge

in timely supervision and verification inefficiency during the spread of coronavirus are amplified. The cross-border, blockchain technology platform helps the healthcare system in improving the convenience and efficiency of acquiring export trade financing as well as other financial credit support. Most of the research institutes are committed to searching for Covid-19 treatment. BCT is beneficial in this research among all healthcare systems as it a decentralized approach that manages authorization, permissions, immutable audit trail and offers secure and rapid access to longitudinal research information [17]. Besides, it enhances the advancement of drugs, medical devices and reduces the generation of counterfeit medicine as well as clinical trials through a reduction of the amount presently utilized in confirmation by the third party.

From managing data of the patients to tracking the drugs through the supply chain, blockchain technology in the healthcare industry solves numerous health challenges. The Healthcare industry is full of errors, high administrative costs, and inefficiencies. The implementation of blockchain helps a lot in solving the most pressing compliance, data security issues, and interoperability [18]. However, upon unlocking the potential of blockchain technology, the healthcare process slows down and changes due to implementation cost. This leads to a negative relationship between the application of BCT and the cost of spending. In the long-term, a positive relationship between BCT application and cost-spending is evidenced [19]. This is supported by the fact that costs involved in maintenance and security, data redundancy and interoperability.

V. RECOMMENDATIONS

To progressively foster and overcome the challenges involved in the application of blockchain technology in the pharmaceutical industries, the following recommendations are appropriate. To increase the effectiveness of blockchain technology in the pharmaceutical industries and the healthcare industry as a whole, health organizations need to be coupled with Artificial Intelligence. As shown in Fig. 1 below by [20] AI increased access of information among all public as well as stakeholders.

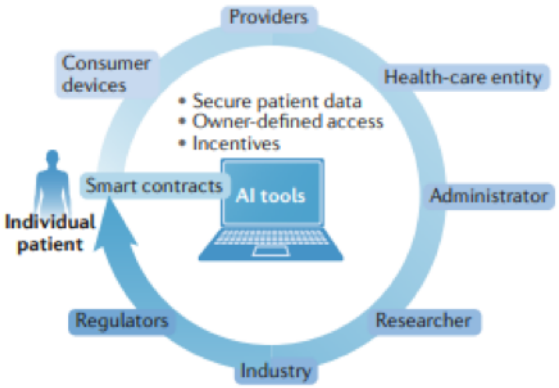

Fig. 1. The Integration of AI with BCT by [20].

In the info graphic above, smart contracts commence as patient-owned data elements, which is a centrepiece for transparent and secure information flow. All the stakeholders in healthcare system can access the information more conveniently hence increasing effectiveness. To create standardization in the application of BCT in the pharmaceutical industries, enormous computation power and consensus among all participants before broadcasting of the complete network should be adopted. All participants in healthcare industry need to be educated on efficiency of blockchain technology to increase cooperation and usage of the technology in healthcare industry as a whole.

VI. CONCLUSION

The blockchain technology is acquiring substantial attention from people and organizations of almost all dimensions. Its application has the capability of transforming the traditional health and pharmaceutical industries. The technology enhances transparency and security of the process as well as healthcare quality which at a lower cost. In this paper, the factors hindering and encouraging the application of blockchain technology in the pharmaceutical industries were discussed. Illiterate individuals, stakeholders, and limited network were found to be the common factors preventing the application of blockchain technology in the pharmaceutical industries. The technologys system robustness, overall performance and government policies and laws were reported as the supporting factors. Although the relationship between implementation of blockchain technology and cost spending is negative in short-term, in the long run, the relationship is positive.

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REFERENCES

[1] J. Daniel, A. Sargolzaei, M. Abdelghani, S. Sargolzaei, and B. Amaba, "Blockchain technology, cognitive computing, and healthcare innovations," *J. Adv. Inf. Technol*, vol. 8, no. 3, 2017.

[2] M. A. Engelhardt, "Hitching healthcare to the chain: An introduction to blockchain technology in the healthcare sector," *Technology Innovation Management Review*, vol. 7, no. 10, 2017.

[3] S. Wichansawakun and H. S. Buttar, "Antioxidant diets and functional foods promote healthy aging and longevity through diverse mechanisms of action," in *The role of functional food security in global health*. Elsevier, 2019, pp. 541–563.

[4] S. Yadav and S. P. Singh, "Blockchain critical success factors for sustainable supply chain," *Resources, Conservation and Recycling*, vol. 152, p. 104505, 2020.

[5] Y. Wang, J. H. Han, and P. Beynon-Davies, "Understanding blockchain technology for future supply chains: a systematic literature review and research agenda," *Supply Chain Management: An International Journal*, 2019.

[6] F. Casino, T. K. Dasaklis, and C. Patsakis, "A systematic literature review of blockchain-based applications: current status, classification and open issues," *Telematics and informatics*, vol. 36, pp. 55–81, 2019.

[7] C. C. Agbo, Q. H. Mahmoud, and J. M. Eklund, "Blockchain technology in healthcare: a systematic review," in *Healthcare*, vol. 7, no. 2. Multidisciplinary Digital Publishing Institute, 2019, p. 56.
[8] E. Gökalp, M. O. Gökalp, S. Çoban, and P. E. Eren, "Analysing opportunities and challenges of integrated blockchain technologies in healthcare," in *Eurosymposium on systems analysis and design*. Springer, 2018, pp. 174–183.
[9] G. J. Katuwal, S. Pandey, M. Hennessey, and B. Lamichhane, "Applications of blockchain in healthcare: current landscape & challenges," *arXiv preprint arXiv:1812.02776*, 2018.
[10] J. A. Schmittdiel, A. Gopalan, M. W. Lin, S. Banerjee, C. V. Chau, and A. S. Adams, "Population health management for diabetes: health care system-level approaches for improving quality and addressing disparities," *Current diabetes reports*, vol. 17, no. 5, p. 31, 2017.
[11] K. A. Colón, "Creating a patient-centered, global, decentralized health system: Combining new payment and care delivery models with telemedicine, ai, and blockchain technology," *Blockchain in Healthcare Today*, vol. 1, pp. 10–30 953, 2018.
[12] R. V. Van Schendel, C. G. Van El, E. Pajkrt, L. Henneman, and M. C. Cornel, "Implementing non-invasive prenatal testing for aneuploidy in a national healthcare system: global challenges and national solutions," *BMC health services research*, vol. 17, no. 1, pp. 1–10, 2017.
[13] S. E. Chang, Y.-C. Chen, and M.-F. Lu, "Supply chain re-engineering using blockchain technology: A case of smart contract based tracking process," *Technological Forecasting and Social Change*, vol. 144, pp. 1–11, 2019.
[14] S. Alla, L. Soltanisehat, U. Tatar, and O. Keskin, "Blockchain technology in electronic healthcare systems," in *Proceedings of the 2018 IISE Annual Conference*, 2018, pp. 1–6.
[15] L. A. Linn and M. B. Koo, "Blockchain for health data and its potential use in health it and health care related research," in *ONC/NIST Use of Blockchain for Healthcare and Research Workshop. Gaithersburg, Maryland, United States: ONC/NIST*, 2016, pp. 1–10.
[16] N. O. Nawari and S. Ravindran, "Blockchain and building information modeling (bim): Review and applications in post-disaster recovery," *Buildings*, vol. 9, no. 6, p. 149, 2019.
[17] Z. Allam and D. S. Jones, "On the coronavirus (covid-19) outbreak and the smart city network: universal data sharing standards coupled with artificial intelligence (ai) to benefit urban health monitoring and management," in *Healthcare*, vol. 8, no. 1. Multidisciplinary Digital Publishing Institute, 2020, p. 46.
[18] W. J. Gordon and C. Catalini, "Blockchain technology for healthcare: facilitating the transition to patient-driven interoperability," *Computational and structural biotechnology journal*, vol. 16, pp. 224–230, 2018.
[19] M. Mettler, "Blockchain technology in healthcare: The revolution starts here," in *2016 IEEE 18th international conference on e-health networking, applications and services (Healthcom)*. IEEE, 2016, pp. 1–3.
[20] C. Krittanawong, A. J. Rogers, M. Aydar, E. Choi, K. W. Johnson, Z. Wang, and S. M. Narayan, "Integrating blockchain technology with artificial intelligence for cardiovascular medicine," *Nature Reviews Cardiology*, vol. 17, no. 1, pp. 1–3, 2020.