



# Benefit and Challenge of Blockchain Technology in Pharmaceutical Supply Chain Management

Surjandy, Meyliana, Erick Fernando, Kristianus Oktriono

**Abstract:** *Pharmaceutical Industry Supply Chain Management (SCM) has been an invigorating research topic because the industry strives to explore innovative ways to secure the medicine distribution and to ensure the authenticity of medicine consumed by the patients. A surge in the counterfeit drug has called an urgent effort for the industry to eradicate. In this scope, the fake medicine harm serious health problem for patients. To cope with this urgency, Blockchain offers the new innovative technology that captures the security and accountability in the financial industry for decades. In this spectrum, the new generation of blockchain with smart contract feature enables the utilization of blockchain in an enterprise setting such as Supply Chain Management Systems. In this point, this study explored contemporary for benefit and challenge blockchain adoption based on Systematic Literature Review methodology. At a closer look, the research indicates the impact of the Blockchain Adoption Technology in Pharmaceutical Industry SCM in for four aspects, i.e. supplier, producer, logistic/distributor, and customer. In a specific range, this research explores significant factors from ten leading journals (one thousand two hundred and fourteen papers) and selects solely eighteen relevant documents. The examination reveals the critical research development of blockchain technology adoption in Pharmaceutical SCM and twenty-three essential factors.*

**Keywords :** *Blockchain, Blockchain Tracing Component, Blockchain in Supply Chain Management Systems.*

## I. INTRODUCTION

Supply Chain Management (SCM) in the pharmaceutical industry associates an essential process. In this lens, SCM in pharmaceutical has evolved, amplified upon the most effective solution, such as addressing drug counterfeiting. At

a closer look, it has proliferated across economic sectors. In this vein, the identified issue is considered challenging to monitor drug sale transaction, drug purchasing, list per customer, drug production process, and drug stock inventory[1]. In this sense, the up-to-date blockchain technology with smart contract feature can gain an edge over rivals as the propitious solution for SCM in the pharmaceutical industry[2][3]. As the literature indicates, early researches reported that blockchain technology could trace the product (provenance), immune from the fake product, transparent[4][5][6], genuine product tracing[7][8], shipping or distributing[9]. However, previous types of research stated that it was arduous to describe the impact of blockchain technology in perspective of Supply Change Management, consisting of supplier, producer, logistic/distributor, and customer. Therefore, this research explores the implications of blockchain technology adoption in SCM pharmaceutical industry. In consonance with the study, The researchers utilized the Systematic Literature Review Prisma method[10] in the process of collecting data stage to the result of data analysis, finding the contemporary research status of blockchain adoption, and elaborating the essential factors of research backgrounds such as country, author's background and institution. Figure 1. Show the general step for this study that facilitated Systematic Literature Review (SLR) methodology, the literature collected ten popular searching locations for a journal such as MDPI, Emerald Insight, Taylor and Francis, ACM, SAGE, InderScience Online, IEEE Xplore, Wiley, Science Direct and SCOPUS without time limitation for the searching process. A Thousand and two hundred fourteen papers are obtained based on keywords search; then acquired fifty-four as candidates and eighteen selected eventually. Several essentials factors of Blockchain adoption technology indicated the pros and cons of the pharmaceutical industry. The result of this study covers salient points for Blockchain technology adoption in the pharmaceutical industry.

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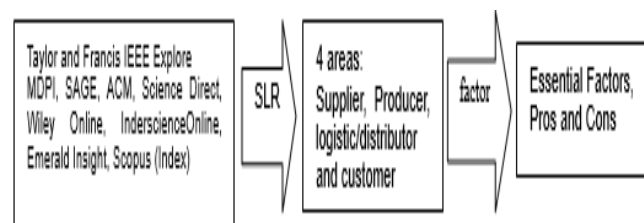


Figure 1. General Research Design

## II. LITERATURE REVIEW

### A. Supply Chain Management

The supply chain is management process that integrated among several business parts, including suppliers, manufacturer, distributors and retailer/customer in which they work together to process from raw materials into a product, then distributed to retailers/customer [11].

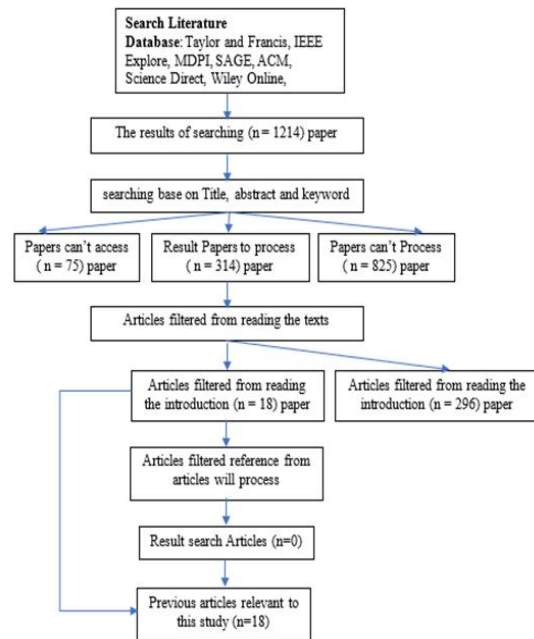
### B. Blockchain

Blockchain is a developing technology since its inception, where it is published in a paper that is initiated by a person/a group named Satoshi Nakamoto in 2008[12]. On the other hand, financial transaction applications implemented blockchain, namely Bitcoin in a decade [13].

## III. RESEARCH METHODOLOGY

Systematic Literature Review method has burst onto the research scene as a facilitator for the quest for essential factors that recently discussed in the papers regarding the adoption of Blockchain Technology for the pharmaceutical industry [10]. This study utilized SLR method with the aim to look for the recent research study of Blockchain Technology in Pharmaceutical Industry, the Prisma Method SLR, and the range of steps in this study [14].

In the searching process, the keywords include "Blockchain," "Blockchain AND Drug," and "Blockchain AND Pharma". In the aspect of the timeline, the research set no time limitation for the searching process. At the first stage, the search for the title of the paper matches keywords and obtains a thousand and two hundred fourteen documents. Following that, the second stage examined the reading of the introduction of the paper content and listed fifty-four documents. The last searching stage perused all the paper content and gained nineteen as a selected document. Figure 2 describes the step of the sequential processes of selecting paper. Following the paper selection, the analysis process initiates the quest for essential factor in 4 aspects of SCM; then the last part describes the pros and cons of selected essential factor obtained in the pharmaceutical industry as depicted in figure 1.



**Figure 2. Systematic Literature Review approach PRISMA Method**

## IV. RESULT AND DISCUSSION

This session will discuss the contemporary status of blockchain technology adoption in SCM & prominent factors obtained characteristic or background factors such as the year of publishing, the discussion factor, and types of publication (journal, conference, or symposium).

### A. Publication Year

The Publication year is one of the essential information that describes the development of the research. In this part, this study confirmed that the earliest two papers were found in 2017 (11%), and it was very reasonable due to the enhancement feature of Blockchain smart contract in 2015[2] and 2014[15]. Since its advent, industry 4.0 is formally announced. The second ten papers were populated in 2018 (55%), and it indicated significant research development and the last six papers found until mid-2019.

### B. Paper Characteristic

The publication type consists of twelve (12) papers from an international journal (66.6%), three (3) papers from the international conference (16,7%), and three (3) papers from another type such as domain expert opinion and news. Table 1 described the detail of paper characteristic.

**Table 1. Paper Characteristic**

Year	Types	Journal/ Conference/ Symposium Description	Paper (s)	Papers %
2017	Journal	Medical Reference Services Quarterly	1	5.5%
2017	Other	Expert Opinion on Drug Safety	1	5.5%
		Total 2017	2	11%
2018	Journal	International Journal of Computer Applications	1	5.5%
2018	Conference	MATEC Web of Conference	1	5.5%

2018	Journal	The Lancet	1	5.5%
2018	Journal	Journal of Pharmaceutical and Biomedical Analysis	1	5.5%
2018	Journal	Pathogens and Global Health	1	5.5%
2018	Journal	Postgraduate Medicine	1	5.5%
2018	Journal	International Journal of Environmental Research and Public Health	1	5.5%
2018	Journal	JMIR Research Protocols	1	5.5%
2018	Other	Applied Health Economics and Health Safety	1	5.5%
2018	Journal	Cryptography	1	5.5%
Total 2018			10	55%
2019	Journal	Journal of Pharmaceutical Sciences	1	5.5%
2019	Journal	The Lancet	1	5.5%
2019	Conference	ICCSF, Association for Computing Machinery	1	5.5%
2019	Other	Genetic Engineering and Biotechnology News	1	5.5%
2019	Conference	11th International Conference on Communications Systems & Networks (Comsnets)	1	5.5%
2019	Journal	Electronics	1	5.5%
Total 2019			6	34%
Total			18	100%

**C. The Research of Blockchain Technology Adoption in Pharmaceutical SCM**

This paragraph will show the influence of the adoption of Blockchain Technology in Pharmaceutical Supply Chain Management. Table 2 shows the recapitulated of Blockchain Technology in Pharmaceutical SCM area

**Table 2. Blockchain Technology in Pharmaceutical SCM**

Pharmacy	Blockchain for	References	Paper (s)	Papers %
Supplier	Tracking & Tracing, Provenance,	[16]	1	5.5
Producer	Production Stage trace, Protect dosage, Prevent Drug Counterfeit	[6],[17],[18],[19],[20],[21]	6	33.3
Logistic/ Distributor	Product Distribution, Tracking & Tracing, New Business Network, Prevent Drug Counterfeit	[5],[16],[20],[21],[22],[23],[24],[25],[26],[27]	10	55.6
Customer	Customer Safety and security	[5],[6],[16],[17],[18],[19],[20],[21],[22],[23],[24],[25],[26],[27],[28],[29],[30],[31]	18	100

The research recently focusses on customer’s safety and security aspect. Undoubtedly, 100% of research is looking for the aspect of safety and security of the customer. Following that, 55% of research involved the usage of Blockchain technology for logistics and distribution to prevent counterfeit drug. In this context, producer area applies Blockchain

technology to protect production stages including drug dosage formula and to avoid drug counterfeit. The last Blockchain influenced to the supplier in tracing and ensuring the drug originality.

**D. Essential Factors**

This study obtained 23 essential factors in 18 documents. The first factor is related to the security aspect in 10 papers (55.6%). The second is safety and traceability factors found in six papers (33.3%). The third factor refers to authenticity, distributed, efficacy, innovative, and trust factors in 3 papers, respectively, with the average of each factor, is 16.7%. The fourth is accuracy, integrity, privacy, transparency and validity factors in two journals with the level of 11.1%. The ultimate aspect is cost-efficiency, decentralized, immutable, integration, legitimacy, quality, reliability, sensitivity, usability, and visibility in the paper with a level of 5.6% for each factor. Table 3 describes the detail of each factor and the reference(s).

**Table 3. The Essential Factors**

No	Factors	References	Paper (s)	Papers %
1	Security	[22],[16],[6],[21],[23],[29],[30],[31],[26],[27]	10	55.6
2	Safety	[16],[6],[5],[25],[26],[27]	6	33.3
3	Traceability	[22],[17],[16],[20],[29],[25]	6	33.3
4	Authenticity	[17],[20],[30]	3	16.7
5	Distributed	[21],[24],[29]	3	16.7
6	Efficacy	[5],[24],[30]	3	16.7
7	Innovative	[19],[21],[31]	3	16.7
8	Trusty	[17],[5],[26]	3	16.7
9	Accuracy	[19],[26]	2	11.1
10	Integrity	[30],[31]	2	11.1
11	Privacy	[19],[21]	2	11.1
12	Transparency	[5],[30]	2	11.1
13	Validity	[16],[29]	2	11.1
14	Cost Efficiency	[19]	1	5.6
15	Decentralized	[23]	1	5.6
16	Immutable	[24]	1	5.6
17	Integration	[18]	1	5.6
18	Legitimacy	[16]	1	5.6
19	Quality	[5]	1	5.6
20	Reliability	[26]	1	5.6
21	Sensitivity	[26]	1	5.6
22	Usability	[27]	1	5.6
23	Visibility	[22]	1	5.6

Total papers = 18

**E. Paper Author Characteristic**

The author profiles are an essential factor in describing who performed the research and where the research conducted. 18 papers represented 16 countries with university from USA as the most active paper contributors with 5 papers



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(31.25%), followed by China and Netherland with 2 papers (12.50%), Belgium, Croatia, Denmark, India, Ireland, Korea, Pakistan, Philippine, Russia, Spain, Sweden, Taiwan, and UK with 1 paper (6.25%), respectively.

Institutional author background indicated that university produced 13 papers (72.22%), three papers (16.67%) by College or Institute and two papers (11.11%) by others institution.

**Table 4. Papers Author Characteristic**

No	Country	Paper(s)	Papers %
1	USA	5	31.25%
2	China	2	12.50%
3	Netherland	2	12.50%
4	Belgium	1	6.25%
5	Croatia	1	6.25%
6	Denmark	1	6.25%
7	India	1	6.25%
8	Ireland	1	6.25%
9	Korea	1	6.25%
10	Pakistan	1	6.25%
11	Philippine	1	6.25%
12	Russia	1	6.25%
13	Spain	1	6.25%
14	Sweden	1	6.25%
15	Taiwan	1	6.25%
16	UK	1	6.25%

### F. The Benefit and Challenge of Blockchain characteristic in the Pharmaceutical Industry

The usage of Blockchain Technology brings not only positive value but also the negative value that should be considered by the pharmaceutical industry. Table 5 depicted the several factors of identified Blockchain characteristic that potentially emerges pros and cons in pharmaceutical industry.

**Table 5. Papers Author Characteristic**

No	Blockchain Characteristic	Benefit	Challenge
1	Distributed, Visibility, Transparent,	Distributed information by Blockchain is to ensure consensus and transparent transaction in the node.  Buyer can trace the drug to ensure that customers receive the best quality of the drug (Visibility & Transparent).	The use of Blockchain is to ensure the drug ingredient is not for publication due to drug patent formula (patent)  Some drug is a very special drug for a specific disease (privacy issue)
2	Consensus, Peer-2-Peer, Traceability	This feature will ensure the original drug distribution from the manufacturer to the consumer. Fake drug counterfeit	The consensus information will be put on the block and share to all node. However, there is regulation in a specific country such as Indonesia that is not allowed to distribute information (known by others) of drug receipt except certain people such as a pharmacist.

No	Blockchain Characteristic	Benefit	Challenge
3	Secure	Protect drug formula changes Ensure the robot instruction	The processing of drug production is very fast; however, securing process (proof of work, proof of stack) takes sometimes, and it potentially may cause the delay recording data. Throughput 7 transactions per second for Bitcoin

### V. RESEARCH LIMITATION & IMPLICATION

The study limitation is associated with several relevant publishers (9 publishers and 1 Scopus-indexed). In this frame, the source of paper language is in English. The final part is related to the restriction of access to literature in several journals.

The study gathered essential aspect such as adoption area of Blockchain Technology in SCM Pharmaceutical such as for tracking drug stage procedure and drug doses formula, securing distribution drug process. In this respect, the aim of the Blockchain Technology utilization is for customer safety. The study also revealed twenty-three essential factors that can be utilized for future research.

### VI. CONCLUSION AND FUTURE RESEARCH

The development of Blockchain Technology is rapidly growing recently, especially in a developed country such as USA, China, Netherland, and followed by developing a country that will adopt Blockchain technology to strengthen the Supply Chain Management System in the pharmaceutical industry.

The future research can be performed by exploring the essential factor listed by using PCA (Primary Component Analysis) technique and developing the model that potentially used to strengthening the Supply Chain Management Systems in other areas.

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