Blockchain for Pharmaceutical Supply Chain Integrity Counterfeit Drug Prevention in Bangladesh

Empowering Trust, Securing Health

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1. Introduction

"Blockchain for Pharmaceutical Supply Chain Integrity" is underway to use blockchain technology to improve the supply chain's efficiency, security, and transparency in the fight against counterfeit medications. Using blockchain technology might be a game-changer in the Bangladeshi pharmaceutical industry, which is plagued by a small number of dominant players and serious problems with patient access and medication quality. Public health and economic stability are seriously jeopardized since over 10% of medications in poor and middle-income nations are either inadequate or fake.

Pharmaceutical items may be tracked from production to distribution with the use of blockchain technology, which provides end-to-end visibility throughout the supply chain. This skill not only assists in maintaining regulatory compliance but also considerably minimizes the possibility of counterfeit medications entering the market, hence boosting patient safety.[3][4]. Blockchain's decentralized nature and cryptographic security features further reinforce the verification of medical supplies, making it exceedingly difficult for counterfeit items to penetrate the supply chain.[5][6].

Even though it promises to be a game-changer, blockchain technology is encountering some hurdles in entering Bangladesh's pharmaceutical business due to a lack of clarity in the regulatory frameworks and hefty initial setup costs. These lead to restrictions that most small entities will find cumbersome, especially those that do not have the capacity to digitize themselves. Successful adoption of such technology demands collaboration among industry players to build the necessary network and operational standards that might optimize advantages from blockchain about strengthening the integrity of the pharmaceutical supply chain. [7][3].

Generally, prospects for blockchain in pharmaceutical supply chains look optimistic, despite numerous research and pilot projects now happening, while interest in the applications looks to be expanding. There will be increasing regulations from regulatory bodies regarding the supply chain transparency. Thus, it is inevitable that blood isn't "going to be shed" when it is time for the safe digestion of pharmaceuticals in Bangladesh. Perhaps in the rest of the world, on their feet bakeries to integrate with the final practice drugs in the supply chain for pharmaceuticals.[8][4].

2. Background

The pharmaceutical market in Bangladesh is believed to be extremely concentrated at the top, with the topmost 10 businesses holding about 70% of the market share [1]. Because of this, there have been increasingly aggressive marketing methods among the pharmaceutical businesses as they battle for higher shares in worse market visibility. Yet, in such a competitive business, it is surprising to have minimal data on the promotional strategies of the corporations and the medical representatives (MRs) who are the major drivers of prescriptions among the healthcare providers [1].

The main problem worldwide remains poor access to quality-assured medical products, especially in low- and middle-income countries (LMICs), where up to one-third of the population is deprived of timely access

to essential medicines. Reportedly, it is estimated that some ten percent of medicines in LMICs are substandard or falsified, causing massive economic losses and serious health risks to consumers. National regulatory authorities have an important role in ensuring access to quality-assured medicines and controlling counterfeit products; however, many of them in LMICs face considerable challenges such as limited regulatory capacity and lack of investment in regulatory system strengthening.

Bangladesh had an extraordinary advance in the magnitude of its pharmaceutical sector since the development of indigenous manufacturers to virtually totally fulfill domestic medication demand after 50 years of birth. Of this advantageous framework, patenting rights were considerably put to use for generating generic pharmaceuticals and would boost the sector against worldwide competition. This notwithstanding, rising issues persist over the quality of medications, with the increasing presence of counterfeit pharmaceuticals in underdeveloped nations. The aforementioned has now made regulatory weakness coupled with a need for comprehensive monitoring methods increasingly essential as the business grows in Bangladesh.

It is a really bright promise for calling the integrity of the pharmaceutical supply chain into question using blockchain technology by making transparency and security better [3]. The uses of blockchain against counterfeit medications, the security of medical devices, and enhanced health supply chain operations might offer an indication about the possible alterations it can bring [3]. However, many of the initiatives on this technology are still active at proof of concept and even pilot levels, which implies that more investigations and alignment with the policy frameworks would be needed for them to reach their full potential in the area of pharmaceuticals [3].

3. Blockchain Technology

Blockchain is a disruptive technology for the integrity of the pharmaceutical supply chain to tackle problems such as counterfeit pharmaceuticals in Bangladesh. Blockchain is like a decentralized ledger that retains records of transactions of assets through a network of computers, where its immutability feature is safe and assures the integrity and authenticity [3] [4]. Each transaction is documented with blocks in chronological sequence, thereby making it tamper-resistant and safe, guarding itself against exposure to counterfeit pharmaceuticals.

(i) Advantages of Blockchain in Pharmaceutical Supply Chain

End-to-end visibility afforded by blockchain adoption in pharmaceutical supply chain management. All stakeholders may trace pharmaceuticals from producer to seller. So, any counterfeit drug might be recognized on any layer [4]. Greater transparency helps ensure regulatory requirements and decreases the hazards of counterfeit medications being brought into the market, moving towards improved patient care and safety concerns [3][4].

Blockchain will also make a unique digital identity for every pharmaceutical product or serial number (QR code), also saved in a protected way on the blockchain, which can be examined by consumers and healthcare experts to get guaranteed authenticity of medicine with a scan on a smartphone [4][5]. This will genuinely enable patients to treat themselves and establish a spectrum of trust inside the same.

(ii) Regulatory compliance & security

Regulatory compliance is particularly crucial in the pharmaceutical sector. Blockchain can reduce the cost by automatizing paperwork and give real-time access into supply chain activities [4]. Regulations are baked into blockchain, prohibiting any infractions at source. Also, blockchain's decentralized approach to transactions helps its security as it functions more like a replicated state machine spread across numerous nodes, making it difficult for miscreants to infect various systems in supply chains [7].

Furthermore, blockchain's decentralization concept obviates intermediaries and so minimizes transaction costs of supply chain relationship monitoring likewise. Also, with smart contracts, i.e., automated agreements that execute transactions upon fulfillment of established conditions, greater transparency and efficiency may be attained within the pharmaceutical supply chain [7].

4. Traceability

(i) Overview of Blockchain Technology

Blockchain technology is regarded to be a disruptive breakthrough in the pharmaceutical supply chain to overcome challenges connected to data integrity, traceability, counterfeit risk, etc. In essence, blockchain establishes a distributed ledger for transactions so that all parties in the supply chain have access to the same set of information, which promotes transparency and decreases information asymmetry [7][3]. This is especially significant in the pharmaceutical sector, as the safety of pharmaceuticals is a problem that impacts patients' health and public health.

(ii) Benefits of Blockchain Implementation

Data Integrity and Traceability

The biggest benefit of using blockchain technology in pharmaceutical supply chains is the assurance of data integrity as well as secure digital traceability. Each transaction, such as manufacturing and distributing drugs, is encoded in the blockchain, and it accounts for accurate tracking of a pharmaceutical product all through the chain—from the manufacturer to the end consumer [11][12]—thereby mitigating the entry of counterfeit medicines into the supply chain and ensuring authentic medicines reach consumers [3].

Reduced Transaction Costs

Simplifying procedures and decreasing transaction costs may entail getting rid of middlemen. Information is decentralized, therefore allowing all the nodes in the network to access the same data without requiring an approval of a third party [7]. Reduced intermediates result in lower transaction costs, greater operational efficiency, and give the greatest advantages to firms, such as those looking to strengthen their supply chain management practices [7][13].

(iii) Challenges in Implementation

Legal and Regulatory Framework

There are a few problems to be solved with regard to the deployment of blockchain technology in the supply chains of medicines. First and foremost, there is the awareness of legal and regulatory difficulties sitting in undeveloped frameworks in certain countries such as Egypt, while legislative reforms pertaining to data protection and ownership are still in process [7]. Companies may not be incentivized to fully utilize blockchain solutions owing to the lack of regulatory clarity on the usage of technology and its scalability.

Initial Setup and Running Costs

The initial cost necessary to build up a blockchain infrastructure is a big disincentive for most firms. Companies have to put up a completely new technological infrastructure and also teach their personnel to efficiently use this technology [7]. Hence, these initial expenditures may discourage small firms from utilizing blockchain technology as they may not have the funds to digitize themselves [3][13].

(iv) Practical Considerations for Implementation

For instance, above all, it will improve human resource management.

Employee Training: Training employees on blockchain technology and how to use it will help prevent human error in the system and ensure smooth flow operations. [7].

Clear Communication of Benefits: The benefits of going to the blockchain must be explained by the companies as to how it can assist their external relations and efficiency by letting it internalize the advantages of having the blockchain-enabled supply chain.[7].

Monitoring and assessment: Implementation should be monitored regularly, and the evaluation of the phenomena should determine whether it obtains the intended outcomes in the technical aspect. [7].

Seamless Integration with IoT: Incorporation of the blockchain-enabled solutions through a larger Internet of Things (IoT) infrastructure might be the reason internal processes become more effective, leading to even additional efficiency improvements. [7][13].

5. Benefits of Blockchain for Counterfeit Drug Prevention

Blockchain technology is a huge forward step in the line of action towards the successful path of avoiding counterfeiting of medications, a consequence that has made it significant in the pharmaceutical supply chain. The qualities of this technology—decentralization, transparency, and immutability—make it suitable for playing the game in which the globe is challenged by counterfeit pharmaceuticals.

(i) Enhanced Traceability

The most crucial potential of the blockchain is that it produces an immutable record of transactions that offers wider traceability in the pharmaceutical supply chain. From manufacturing up to delivery, operations are documented and provide a tamper-proof audit trail visible to all interested

participants.[4][14]. With such openness, it becomes easier to discover counterfeit pharmaceuticals or even the source of an issue and aids the safe recall procedure if the necessity of such arises.[5].

(ii) Enhanced Safety and Authentication

Blockchaining is a very established technique based on cryptographic seals and smart contracts that increase the security and authentication of pharmaceutical items. Attached with unique identities and coded into the blockchain, the technology truly makes it tougher for even the most sophisticated counterfeit drug goods from making their way into the supply chains of different locales. This becomes especially crucial in places where fake pharmaceuticals grow, thereby assuring safety for the users and protecting the product's quality itself. [5][6].

(iii) Cost Reduction

Through the various middlemen that are present between the manufacturer and the patient, the cost of operation can substantially be decreased with an increase in safety. Streamlining the process and primarily eliminating redundant layers would eventually minimize the possible sites of admission and departure for counterfeit medications to the market completely.[15][4]. Automated compliance processes, by means of a digital trail on the blockchain, will ensure the pharma business fulfills most, if not all, compliance requirements in a more efficient and cheap way compared to the manual ways all the time. [5][6].

(iv) Regulatory Compliance

Documentation is extremely highly controlled within the pharmaceutical sectors about the manufacturing and distribution of pharmaceuticals. Such compliance processes would also be unfamiliar with the blockchain technology as it preserves real-time, accurate records to meet with precise regulations. It therefore establishes a seamless bridge for all stakeholders and regulators to develop a better environment for compliance in efficiency and boost all-around confidence in the pharmaceutical supply chain. [5][6].

(v) Combatting Organized Crime

For instance, they look beyond the damage to the people but into the bigger domains covering the status of the economy and organized crime. Adopting blockchain's capabilities will allow a collective of important parties to make their approach toward the refutation of these illicit actions in that the technology gives an open and verifiable means regarding the monitoring and authentication of items along their lifecycle [4][14].

6. Future Expectations

With regard to the future promises of blockchain technology to revolutionize the pharmaceutical supply chain, especially where it is sought to solve compliance, traceability, and efficiency concerns, the lines through which the promises run are quickly becoming obvious. Communicating between regulatory bodies and bringing about an increased focus on transparency in supply chains brings blockchain even

more potently to bear on the needs of pharmaceutical companies as they evolve and transform trading environment conditions through which their trading partners establish trust with each other [8][4]. Their distinguishing features, inherent in the spirit of the idea, include a decentralized and immutable characteristic: real-time visibility and a secure record of each transaction, which is vital to the integrity of the whole supply chain [4][16].

In healthcare, blockchain may drastically cut costs and administrative tasks by automating paperwork and simplifying compliance with the regulations [8][4]. This adjustment is needed owing to the influence of the COVID-19 pandemic on monitoring of the pharmaceutical sector and the necessity for resilient supply chains. Product visualization will grow better via adopting blockchain technology, and it will lessen probable hazards caused by wild counterfeit pharmaceuticals, which is a multi-billion-dollar concern in markets [16][7].

In addition to this, blockchain may be linked into the system so as to enhance coordination across sectors, which would be regarded as a critical difficulty within the pharmaceutical environment in Bangladesh [2]. These limits among human health practitioners, animal health providers, and environmentalists hamper the effective collaborative response to situations like that of antibiotic resistance concerns [2]. With what blockchain delivers transparency-wise, it will likely make the collaboration and data-sharing optimum among stakeholders and, maybe, lead to much larger strategies addressing such public health challenges.

Blockchain technology is still in its infancy within the pharmaceutical supply chain, although, with focused applied research and pilot studies, rising interest in its application can already be seen [7][3]. As more organizations grasp blockchain's potential to boost operational performance by verifying the authenticity and traceability of medications, investments in this technology will likely go up [7]. The cost of setting up, however, is still a barrier, along with the notion or push towards collaborative interfacing among the industry actors for the creation of successful networks [3].

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