

Blockchain Against Fake Medicines: A Lifeline for Pakistan



Overview

Poor quality and fake drugs still present severe health and governance issues in low and middle-income nations, and the World Health Organization estimates that close to one in ten health and medical products in developing economies is either substandard or falsified (*Organization, 2017*). Over time, weak supply chain transparency and product integrity have been revealed through regulatory recalls and quality checks in Pakistan (*Zaheer et al., 2019*), and counterfeit penetration of the market has distorted the competitive environment, reduced the credibility of regulators, and added to the overall healthcare costs.

As a reaction, blockchain technology, with its decentralized and irreversible ledger structure, has been suggested as a tool to improve traceability and strengthen audit procedures in pharmaceutical distribution systems (*Casino et al., 2019*). This paper is an in-depth critique of the question of whether blockchain can strategically enhance the governance and transparency of the pharmaceutical industry in Pakistan or whether institutional and infrastructural constraints might limit its potential effect.

Counterfeit Medicine Crisis in Pakistan

Poor-quality and counterfeit medical products represent a grave threat to worldwide health, especially in developing economies (middle and low income) with weak regulatory controls and supply chains. According to the World Health Organization, it is estimated that almost ten percent of medical products in developing countries are of poor quality or falsified, thus compromising the safety of patients and their treatment outcomes (*Organization, 2017*). In Pakistan, regulatory inspections and laboratory monitoring have recurrently found issues with medicine quality, including the absence of post-marketing oversight and limited provincial capacity to enforce regulations (*Rasheed et al., 2019*).



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Table 1: Prevalence Estimates of Substandard and Falsified Medical Products in Low- and Middle-Income Countries

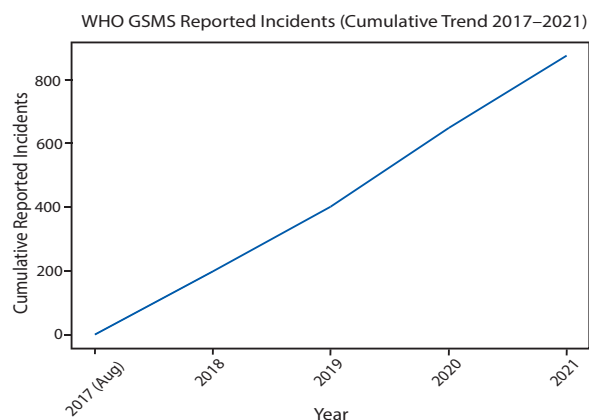
Period	Regulatory/Policy Milestone (Pakistan)	Notable enforcement/ surveillance evidence & examples	Governance implication
2010–2012	Post-PIC crisis reforms; impetus for a stronger federal regulator culminating in the DRAP Act (DRAP Act passed 2012).	Large public crisis at Punjab Institute of Cardiology (2012) prompted national-level reform and forensic investigations. (DRAP Act origin; PIC crisis reporting). (Drug Regulatory Authority of Pakistan)	Reactive reform: crisis-driven centralization of regulatory authority; focus on closing immediate safety gaps.
2013–2015	DRAP operationalization and initial efforts to harmonize provincial/federal roles under the DRAP Act (implementation phase).	WHO launched/expanded GSMS reporting capacity; WHO noted growing reporting participation by Member States (GSMS baseline activity). (World Health Organization)	Central oversight strengthened on paper, but post-marketing surveillance & inter-provincial coordination remained uneven.
2016–2020	Expansion of post-marketing surveillance and laboratory testing capacity; regulatory guidance updates.	Peer-reviewed situational analyses documented persistent gaps in routine surveillance and enforcement capacity in Pakistan (Rasheed et al., 2019). WHO continued GSMS monitoring showing global signals. (PMC)	Transition from reactive to more structured surveillance efforts, but implementation heterogeneity across provinces.
2021–2025	Growing focus on digitalization, track-and-trace discussions and increased rapid alerts (DRAP public alerts); international alerts (WHO) on contaminated ingredients highlight ongoing vulnerabilities.	WHO GSMS activity report (Aug 2017–Dec 2021) documents hundreds of incidents; recent DRAP/WHO alerts (e.g., 2024 contaminated propylene glycol / ethylene glycol seizures) demonstrate continued enforcement activity. (World Health Organization)	Movement toward system-level visibility and digital solutions, but persistent operational, infrastructure and data-quality barriers remain.

Biannual warnings issued promptly by the Drug Regulatory Authority of Pakistan also confirm that falsified and spurious products continue to be detected (*Drug Regulatory Authority of Pakistan alerts [DRAP], 2025*). In addition to clinical hazards, counterfeit medicines disrupt markets, decrease state revenue, and raise medical expenses, indicating the structural flaws in traceability and regulatory alignment.

The pharmaceutical regulatory system in Pakistan has been structurally reformed over the past ten years. Institutional strengthening notwithstanding, institutional vulnerabilities are indicated in enforcement data and surveillance reports. Table 1 summarizes the key regulatory milestones and enforcement developments between the years 2010–2025.

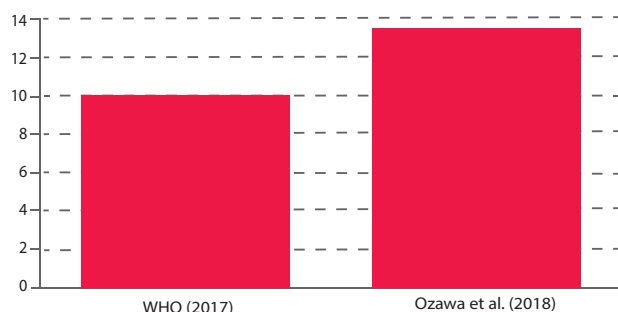
An example of the persistent vulnerability and the requirement to enhance traceability and vigilance can be seen in Figure 1, which illustrates 877 cases of substandard and falsified medical products reported in 113 different countries (2017–2021) with a 36.3% yearly growth (*World Health Organization, 2024*).

WHO GSMS Cumulative Reporting (2017–2021)



Prevalence Comparison Bar Chart

According to Figure 2, 10–13.6 percent of medical products in LMICs are of poor quality or falsified (*Organization, 2017; Ozawa et al., 2018*), which highlights the existing gaps in supply chains, including in Pakistan.



Pharmaceutical Supply Chain Weaknesses

The continued existence of poor-quality and counterfeit drugs in Pakistan lies in the structural vulnerabilities of the pharmaceutical supply chain in the nation. Disjointed

regulatory control and lack of post-marketing monitoring lower the overall accountability of the system and undermine enforcement ability (*Rasheed et al., 2019*). The supply chain comprises several middlemen, such as manufacturers, distributors, wholesalers, and retailers, which introduce a complexity of documentation and more diversion opportunities or the chance of substitutes, especially where no batch-level tracing and real-time validation systems are in place (*Organization, 2017*). In addition to this, the lack of digital integration between national authorities limits information dissemination and swift response. The lack of transparency and auditability is further exacerbated by relying on paper-based or siloed systems that prevail in LMICs (*Ozawa et al., 2018*). These knowledge lapses require governance reforms that are based on improved traceability and regulatory coordination.

Blockchain for Governance

The significance of the concept of blockchain to the pharmaceutical supply chain is based on enhancing governance rather than the technological novelty itself. Being a decentralized, cryptographically secured ledger, it provides time-stamped records that cannot be modified without consensus, increasing documentation integrity and the reliability of audits (*Anam et al., 2025*). This immutability enables end-to-end traceability between distribution, manufacturing, and dispensing to minimize information asymmetry and preclude any possibility of diversion or counterfeit infiltration in fragmented supply chains (*Adekola & Dada, 2024*). Regulatory control can be strengthened further by automating compliance checks and creating real-time anomaly alerts with the help of smart contracts (*Vijaya et al., 2026*). Nevertheless, the mentioned advantages of governance can be achieved only when blockchain is integrated into the institutional framework and reinforced by institutional coordination and interoperability standards (*Bali et al., 2022*).

Blockchain to Strengthen Pharmaceutical Control

The pharmaceutical supply chain in Pakistan has traceability and documentation flaws that can be addressed by blockchain, a solution with a governance focus. With its irrevocable and time-stamped registry, it can improve data integrity and post-market surveillance, and unit-level serialization can provide end-to-end traceability and minimize the risks of diversion and counterfeit infiltrations (*Adekola & Dada, 2024; Casino et al., 2019*).

Blockchain reduces information asymmetry and enhances accountability among supply chain participants by increasing transparency (*Kshetri, 2018*). Coupling blockchain with regulators, such as DRAP, may enable real-time monitoring, faster recalls, and trustworthy audit trails, while smart contracts can automate compliance checks (*Bali et al., 2022*). Nevertheless, the benefits rely less on the technology itself and more on regulatory integration and coordinated implementation (*Mackey & Nayyar, 2017*).

Governance Benefits of Blockchain

Blockchain is suggested as an organizational solution to the lack of transparency in complex supply chains. Its cryptographically recorded transactions are more resilient than entries in central databases, and its inability to revise an entry without network consensus makes it less vulnerable to data manipulation than centralized systems (Casino *et al.*, 2019). From a governance perspective, blockchain enhances traceability, auditability, and transparency by providing end-to-end visibility of product movement and minimizing information asymmetry among supply chain participants (Kshetri, 2018). This is particularly relevant in the pharmaceutical system to curb diversion and counterfeit infiltration. Its unalterable auditing record can help assess the authenticity of drugs in real-time, aligning with regulatory schemes like the U.S. Drug Supply Chain Security Act (Kannarkat *et al.*, 2024; Mackey & Nayyar, 2017). However, its effectiveness depends on the integration of regulations and institutional preparedness.

Feasibility and Readiness in Pakistan

The pharmaceutical industry in Pakistan cannot implement blockchain to its full potential without appropriate institutions, regulations, and infrastructure. Integrating blockchain into traditional governance infrastructure is complicated by outdated IT systems, lack of digital capabilities, and fragmented processes involving federal and provincial regulators (Adekola & Dada, 2024; Anam *et al.*, 2025). The absence of interoperability and integrated data governance systems further complicates standardization and system integration.

Digital preparedness is still limited, especially among small and medium-sized pharmaceutical firms. Transitioning from paper-based systems to distributed ledgers requires technical skills, infrastructure upgrades, and compliance adjustments, imposing a disproportionate financial and operational burden on SMEs (Adekola & Dada, 2024; Islam *et al.*, 2024). High capital costs, cybersecurity demands, and maintenance costs further hinder adoption (Oriekhoe *et al.*, 2024). Regulatory uncertainty, particularly the absence of a specific blockchain framework, creates ambiguity regarding data ownership and the legality of digital records (Riedel, 2024). Additionally, unreliable electricity, limited internet connectivity, and reliance on legacy systems hamper sustainable operations (Fayez *et al.*, 2024; Nazir & Khan, 2022). These factors suggest that blockchain implementation in Pakistan should be gradual, policy-oriented, and accompanied by targeted capacity-building, rather than a single, system-wide rollout.

Conclusion

Poor and counterfeit medicines continue to expose vulnerabilities in Pakistan's pharmaceutical supply chain, particularly in traceability, documentation integrity, and regulatory integration. Although blockchain provides a governance-focused system to improve auditability and end-to-end traceability through immutable transaction records and digital verification, it cannot serve as a

standalone solution. Its success depends on regulatory integration, legal recognition of digital records, prepared infrastructure, and coordinated stakeholder involvement. In the absence of institutional alignment, technological adoption may remain procedural rather than transformative. A gradual approach—beginning with pilot projects in high-risk categories, integration into DRAP systems, and targeted capacity-building—is a more realistic path, positioning blockchain as a conditional governance reform tool rather than a technological panacea.

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