

Smart Contracts and Supply Chain Management Using Blockchain

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ABSTRACT

With a Fourth Industrial Revolution making inroads, encompassing all sectors of the industry with numerous concepts of disruptive technology such as Artificial Intelligence, Blockchain, Virtual and Augmented Reality, Internet of Things (IoT), Robotics and 3D Printing we have barely scratched the surface of its Scope, Implication, and Applications in various branches of the Construction Industry. This research aims to investigate the potential of Blockchain technology in the context of Smart Contracts and Supply chain management (SCM) applications in the construction sector. Most of the time, cost overruns have been attributed to the sluggish pace of contractual impediments or inefficacy of material and machinery procurement processes. The executive of material and data stream is a crucial need for development organizations. Effective execution in these regions can give significant benefits and permit more main incentives for customers. The industry is regularly censured for being delayed to grasp the change it needs and at the exact moment has been referred to as ready for the interruption because of the intricacy of work and a sheer number of guidelines and gauges, trust and check issues in regards to consistency to work principles still loom to a great extent. The momentum built by BIM infusion in the industry could be leveraged to bring Blockchain technology to the fore to mitigate Information Asymmetry by -distributing information to generate decentralized consensus building among various stakeholders involved.

Keywords: Blockchain; Supply Chain Management; Smart Contracts; Information Asymmetry; Disruptive Technologies.

INTRODUCTION

The construction industry is a crucial economic engine of economic growth for a country since it assures and maintains critical infrastructure assets, pushes expansion, and protects the current construction foundation for continuing socioeconomic progress. It contributed an average of 7.9% at 2203.46 INR Billion from 2011 until the second quarter of 2019 (Trading Economics). Naturally, the construction industry is vastly different, but a more efficient business is necessary to keep the global economy on track.

McKinsey & Company research (2015) indicates that development efficiency has been level for quite a long time while manufacturing productivity has approximately doubled and improved (McKinsey 2015).

This research aims to investigate the extent of Blockchain technology in the context of Smart Contracts and SCM applications in construction. Most of the time, cost overruns have been attributed to the sluggish pace of contractual impediments or inefficacy of material and machinery procurement processes. Material and information flow management is a top responsibility for construction organizations. Efficient performance in these areas can give considerable benefits and enable you to deliver more value to your clients.

Modernization of the construction sector is frequently hampered by a lack of desire to adopt technology improvements compared to other industries' triumphs (Oesterreich & Teuteberg, 2016). Blockchain, also known as distributed ledger technology (DLT), is seen to have the potential to alter a wide range of global businesses, including construction. According to McKinsey Worldwide Institute (2017), there is a \$1.6 trillion shortfall in global building each year. Improving and modifying regulatory systems has been effective in Australia, Germany, and Singapore through expanding transparency, investing in R&D, process improvement, developing institutionalized building laws, and focusing on outcomes. Payments and supply chain shortages are one of the challenges that the construction industry encounters in terms of contractual rights, delivery of specified material(s), supply delay, and so on, leading to conflicts that may sometimes end in project failure due to schedule and expense overruns (Cardeira, 2015; Wang et al., 2017b).

RESEARCH METHODOLOGY

A systematic literature review (SLR) was carried out to determine the breadth of DLT applications in the construction sector and to assess the extent to which DLT has been investigated in the context above. From searches in four databases (ASCE Journal, Science Direct, IEEE Journal, and ResearchGate), 32 papers were selected. After using incorporation and rejection criteria and audit of edited compositions, 11 papers were chosen for the survey. On initial substance examination, these were assembled into three classes as point by point in Table 1.

BLOCKCHAIN TECHNOLOGY

Blockchain is a type of distributed ledger technology (DLT) that was first widely publicized as the underlying technology of Bitcoin (Satoshi Nakamoto) about ten years ago (2009). The technology concept behind the Blockchain is similar to that of a database, except that you interact with that database is different.

Table 1 Details of Papers Reviewed

Categorization	Papers Cited	Referenc es
1. Blockchain Technology	3	Hultgren & Pajala(2018), Balint Penzes et al. (2018), Turka& Kline (2017).
2. Smart Contracts	7	Mason (2019), Liyanage et al. (2019), Gatteschi et al. (2018), Dhakal (2018), Alharby & Moorsel (2017), Mason (2017), Christidis & Devetsikiotis (2016).
3. Supply Chain Management	5	Chang et al. (2019),Hackius & Petersen (2017), Apte & Petrovsky (2016), Singh & Dinesh (2014), Song,Tao & Li (2010).

As a result, Blockchain evolves into a distributed, tamperproof digital ledger in which transactions are verified through consensus (participants confirm changes with one another), and cryptography ensures the integrity and security of the information, eliminating the need for a central certifying authority.

BLOCKCHAIN AND TRUST IN THE GLOBAL INDUSTRY

In recent years, technological innovations have multiplied at a rapid pace. A.I., robotics, cloud computing, and the Internet of Things are just a few examples of how technology transforms the way we work. The potential changes in the socio-economic and commercial spheres have not yet been thoroughly investigated. However, one thing is clear: those who incorporate technological advances into their business model can adapt quickly and gain a competitive advantage in the market by providing better service to clients.

Blockchain provides one such potential. It has been recognized for its capacity to revolutionize industries, business models, and operational procedures such as payment settlement, accounting, administration, supply chain, consumer contacts, and finance.

Trust is the most valuable and intangible asset in any organization. It functions at various levels within a firm, mostly between management and employees. Traditional third-party trust and transparency have become more complex, information is uneven, and it typically becomes time-consuming and costly.

Furthermore, the 2008 subprime mortgage crisis served as a wake-up call that the system was highly susceptible. Since then, the established third-promised party's trust and confidence have begun to shift toward alternate options.

Blockchain is one such option because it allows for the transparent distribution of information among all network participants (information symmetry), with no single party having total control over the data (decentralized). The information is disseminated in a predetermined, unchangeable, almost synchronous way, and the data saved on the Blockchain is immutable.

BLOCKCHAIN AND CONSTRUCTION INDUSTRY

Since its introduction, communication technology has had a tremendous influence on the connection between these stakeholders in the construction industry, recognized as one of the world's most fragmented, high-impact sectors that relies on collaborative processes involving numerous stakeholders.

Paper documentation was the first wave of specialization, either in information processes (designing and planning) or material processes (construction, maintenance, and demolition). Today's digitalization enables more specialization (fragmentation) of jobs and responsibilities. As a result, Blockchain will emerge as the next wave for integrating these dispersed specialties via transparency.

Because many items are created via complicated supply chains, supply quality management has emerged as a critical paradigm in the construction industry for balancing supply risks and profit consequences. For decades, the industry's lack of responsibility has been an ongoing issue that has significantly influenced profit margins; corporations are set to discover methods to cut costs and dodge criticism. Blockchain can enable consensus platforms for all stakeholders in order to improve traceability, specification, and accountability.

Further, we explore the potentials and scope of Blockchain under the following parts

- ✓ Contracts
- ✓ Procurement & Supply Chain Management

SMART CONTRACTS

Construction contracts are designed to eliminate the costs and complications of customized contracts (Furst and Ramsey 2016). Nick Szabo, a cryptographer, created the smart phrase contract in 1994, defining it as a computerized transaction system that performs the provisions of a contract. A smart contract, taken to its logical conclusion, may be characterized as "contracts that are entirely executable without human involvement" (Morgan 2014).

Smart contracts give tools for improving a wide range of processes, automating them, and ultimately making them more successful. Other parties or sources of information are frequently required to be involved in smart contract-enabled activities. These collaborators,

known as oracles, keep the smart contract and the process it governs connected shown in table 2.

Table 2 Types and Characteristics of Smart Contracts

	Public Smart Contracts	Permissioned Smart Contracts
Common	Immutable record, Proper encryption on data, Interoperability among different platforms, Traceable modifications.	
Unique	Easy to deploy, Accessible for the public	The faster settlement, Low operational cost, Authorized access.

APPLICATION AND SCOPE

APPLICATION

(a) NXT is a public blockchain platform that includes built-in smart contracts in the form of templates; it allows smart contracts to be built using those templates but lacks customization; Ethereum, on the other hand, is a public blockchain platform that supports customized smart contracts through the use of a Turing-complete programming language.

(b) Only users with permissions can join the network under a private contract. Before entering the network, a firm or a group of companies is generally in charge of granting such permissions to users. Ever ledger, Ripple, and Eris are a few examples.

SCOPE

HYPOTHETICAL MODEL (LAND ACQUISITION AND PAYMENTS)

Land acquisition in India is cited as a primary reason for the delay in projects due to the complexity of legal sanctions and clearances and land records regarding ownership. The information about size, location, no-objection certificates, and various compliance certificates can be loaded on a knowledge base using an electronic data interface (EDI). This knowledge base will be made available to the Blockchain connecting Landowner, Government, and Government-authorized Advocates as shown in figure 3. The process has been explained in figure 4,5.

BENEFITS IN CONSTRUCTION INDUSTRY

The essential contract obligations represented below are the commercial bargain struck between the parties. These are the essential obligations undertaken and the rationale as to why a construction contract is required.

- Accuracy: If contractual terms and conditions are appropriately registered on a smart contract, accurate execution and monitoring of conditions can decrease the frequency of claims and disputes related to the time component, improving stakeholder relationships.

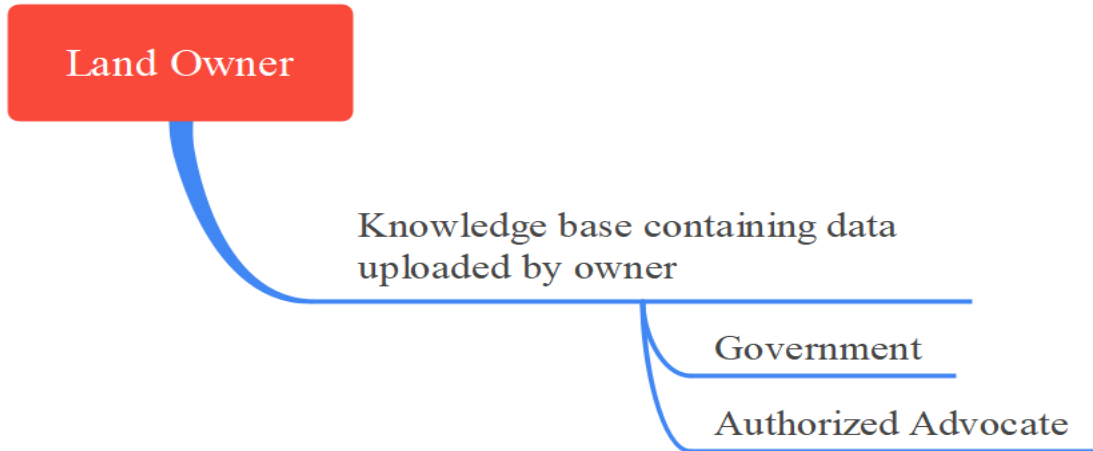


Figure 3 Common Knowledge Base and Network Nodes

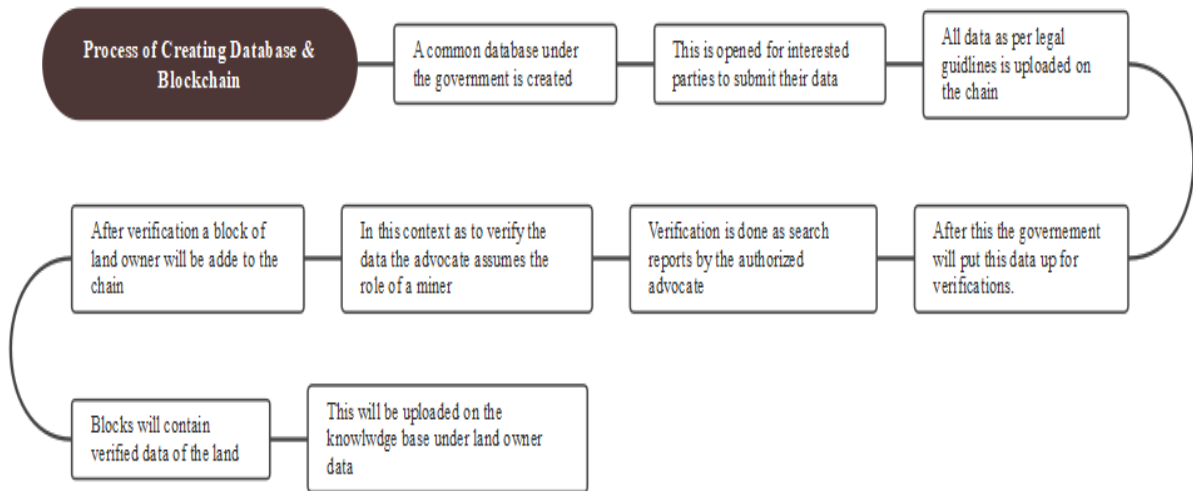


Figure 4 Process of Creating Database and Blockchain

- **Transparency:** Because the Blockchain can record every payment, transaction, business interaction, and execution, the whole process is transparent and compliant.
- **Compliance:** Contractual norms can be essential and applied as part of smart contracts under the Indian Contract Act of 1872. Regulatory compliance may be easily proved when combined with project information captured on Blockchain. Overheads, administration, and project management may all be made more cost-efficient.

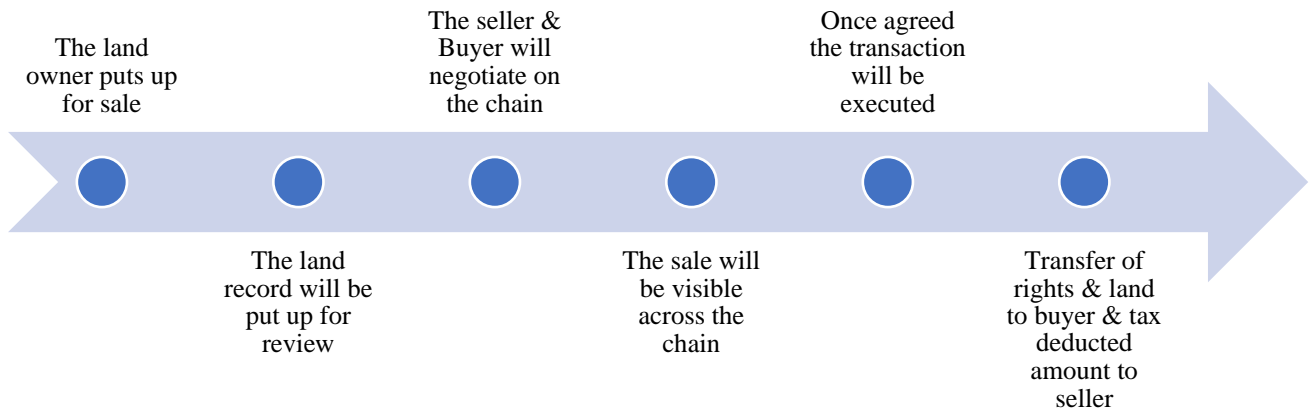


Figure 5 Process of Transaction and Transfer of Rights

LIMITATIONS

- Other parties or sources of information are typically required to be engaged as part of such a smart contract-enabled operation. These collaborators, known as oracles, keep the smart contract and the process it governs connected. Because Oracle nodes are a single point of truth, they are prone to attack, compromise, manipulation, and collusion. This is known as the oracle problem.
- Smart Contracts, like Blockchain, have the virtue of immutability. While this immutability establishes security requirements, it is not without limits. Because they are practically hard to update, even minor programming errors might turn out to be costly and time consuming to repair after the smart contract is released to run.

SUPPLY CHAIN MANAGEMENT

Supply Chain Management (SCM) is concerned with material information and management across a network of stakeholders engaged in the design, manufacturing, and distribution processes. Current national and international trade policies provide information on the payment procedure to the supplier.

This series of events lends itself well to being converted to blockchain technology for the objectives of seamless, verifiable, and secure supply chain management. By inputting transactions, all papers and events may be documented and confirmed at each level. The current definition of SCM is a little broader, although it is still heavily driven by logistics.

The construction industry relies significantly on the supply schedule of materials on-site at the execution of activities. Demand information does not flow directly from customers to manufacturers. As construction materials to be procured involve various specifications

and bulk orders are made, quality management becomes an integral part of material management. Adherence to scheduled delivery, quality, and required specification are what can deliver the industry demands of Blockchain to smoothen out the purchase and delivery aspect of supply chain management.

APPLICATION

Some of the initiatives that are already merging Blockchain Technology with IoT to produce new and practical solutions to current problems are as follows:

- Slock: Slock is the intersection between Blockchain and IoT. It is a decentralized marketplace for renting and selling real things—2015 (Slock. it).
- Skuchain: Skuchain is a blockchain technology business specializing in B2B trade finance and supply chain financing. (Skuchain, 2015).

SCOPE AND BENEFITS

A few examinations and counseling papers have laid out the essential benefits of utilizing blockchains in the inventory network (IBM, 2017b; Kehoe et al., 2017; Laaper et al., 2017; Madhwal and Panfilov, 2017; Nowinski and Kozma, 2017; O'Byrne, 2017). As interest in blockchains and keen agreements develops, we intend to diagram their expected abilities and good use cases in SCM. Following procedure dependent on Blockchain: For providers and coordinations, the end of extensive conveyance times and actual checks equivalently affects installments, which might be given without respect for process status error.

- (a) Traceability: To address the issue of the continuous following, the structure urges members to foster their shrewd agreements. A brilliant agreement can collaborate with other agreements utilizing the occasion component to get to data or even empower programmed notices straightforwardly.
- (b) Data stockpiling: By joining on-chain and off-chain innovations, the structure centers around following shipment status changes, checking installments, and recording time.
- (c) Cost-cutting measures: The activity adjusts the condition of smart contracts while recording the conveyance status on the Blockchain. Common inquiries about the following status are kept away from, and cost decreases are accomplished by putting away just painstakingly chosen information on-chain.
- (d) Payment: Payment exchanges are started when delivering notices and review affirmations are gotten. Savvy gets that influence from a public critical foundation to check exchanges can confirm altering/phony versus unknown altering/imitation.

CONCLUSION

Given the digital infrastructural capacity and the nature of construction activities involved in India, Blockchain does offer a solution to the complexity of work, a sheer number of regulations and standards, trust and verification issues regarding compliance to work standards that slogs the industry. Even as the industry has been quoted as ripe for

disruptions, it is still a long way to adopt and adapt the technology. A detailed analysis of the same has been done below & in figure 6.

CHALLENGES

The major challenge is to design a system as tamperproof as the Blockchain itself because incorrect decisions may be made if the data stored is corrupted.

- The ability of automated contracts to deal with change and uncertainty is a significant impediment to smart contract deployment. Construction contracts frequently include terminology that allows for a flexible strategy to deal with uncertainty. Algorithms, which are basically "if this then this," make up a computer program. This is the semi-automated version of the smart contract. An essential component of such a smart contract-enabled workflow is that other parties' sources of information must frequently be included. These collaborators, known as oracles, maintain the connection between the smart contract and its regulatory process.
- Although smart contracts offer enormous promise for tackling real-world issues, most existing platforms and applications are still in their early stages. Smart contracts frequently encounter issues ranging from semantic dependencies to the pseudonymous operation of illicit operations. This part examines the constraints of existing smart contracts and solutions presented in recent research papers, highlights remaining obstacles, and offers recommendations for future paths. These obstacles are divided into three categories: technology, legality, and usability, and acceptability.
 - ✓ **Legalization:** While smart permission contracts are ready for widespread deployment in enterprises, several fundamental challenges remain unresolved. Notably, there are no established methods of building smart contracts to fit varied design needs, particularly where legal issues are involved. There is a dearth of legislation and regulations governing smart contracts from a legal standpoint. It might not be easy to secure government permission for blockchains and smart contracts. With this technology, there is still the question of enforcement and jurisdiction. Organizations should carefully consider the impact of such a lack of government acceptance when considering opportunities.
 - ✓ **Usability:** Logic-based computer programs have a low degree of involvement, do not allow humans to negotiate and make adjustments based on subsequent agreed-upon revisions, and are not flexible with exceptions such as errors. Furthermore, because blockchains are peer-to-peer, allowing regular individuals to manage their data is hazardous directly.
 - ✓ **Acceptance:** Despite the buzz around blockchain contracts in both the public and consortium realms, there are many misunderstandings regarding the technology. For starters, there have been numerous false use cases and overblown expectations. Second, convincing stakeholders and consumers to embrace new technology can be difficult even with solid use cases.

SWOT Analysis of Adoption of Blockchain

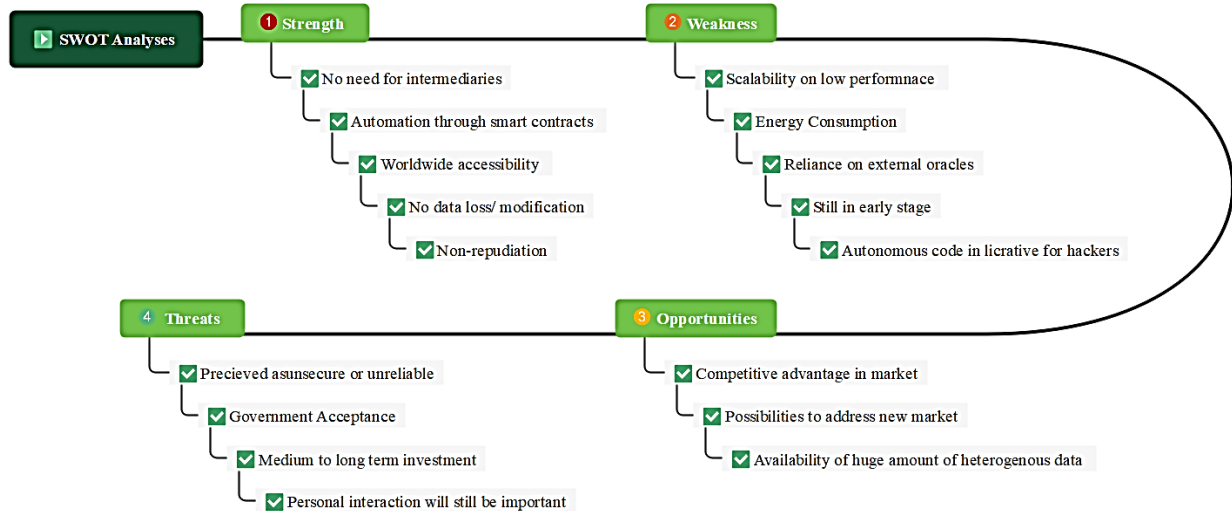


Figure 6 Adoption of Blockchain technology through SWOT.

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