Factors Influencing the Adoption of Blockchain Technology in the Construction Industry: A System Dynamics Approach

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Abstract: The construction industry is always a slow adopter of innovative technologies than other sectors of the economy. Although some technologies, such as Building Information Modelling (BIM), robotics, among others, have been implemented, their adoption has faced some challenges. Blockchain technology is also considered a game-changer for the construction sector with the functionalities and capabilities to improve the construction supply chain, improve transparency, sustainability, and the like. Hence, this study using the system dynamics approach aims to conceptualize the complex causal interrelationship of the key factors influencing blockchain technology adoption in the construction industry. The analytical findings revealed that stakeholders' awareness and satisfaction, support from top management, and the development of standardized and compatible blockchain solutions would enhance its adoption in construction firms and the construction industry. The study also emphasizes the need to integrate blockchain technology with the existing technologies towards facilitating the delivery of smart buildings and cities as well as enhancing the operation of modular integrated construction (MiC) projects both in Hong Kong and overseas

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1. Introduction

The construction industry in recent years has been implementing some advanced technologies towards automating construction works and activities. These initiatives are considered critical to the future of construction [1]. Some of these key technologies include Building Information Modelling (BIM), RFID (Radio-frequency identification), augmented reality, Industry 4.0, and, recently, blockchain technology. For instance, BIM has a wide range of applications from building projects to transportation engineering projects, etc. [2,3], similarly to the other range of technologies. The use of these technologies has given rise to the concept of smart building and cities [4,5], which has the prospect of improving information sharing, security, data exchange, among others, throughout the project lifecycle and between project partners [6].

However, the fragmented nature of the construction industry [7], the issue of mistrust, coordination, and lack of confidence among contracting parties [8] have made construction stakeholders and firms not to be able to maximize the benefits of some of these technologies. For example, in utilizing BIM in a project, a lot of risks and legal liabilities do arise, which is still a drawback to the concept of automating construction information [9] and the use of these tools. Some of these BIM legal issues include model ownership, who is liable for errors in the model, copyright, and intellectual property protection [10].

Blockchain technology (BCT), a distributed ledger technology based on a peer-to-peer system, is regarded as a verifiable system to address trust, transparency, and risk management in a construction project. Hunhevicz and Hall [8] believed the benefits of using BCT would address most of the current drawbacks of other technologies. More so, traceability is another key functionality of BCT, which is a critical requirement in the supply chain [11]; which has enhanced blockchain adoption in sectors such as agricultural and food sector [12]; pharmaceutical [13]; recycling, e-procurement [14], among others. Incorporating blockchain and existing tools such as BIM and RFID in construction projects can address social and environmental sustainability issues along the construction supply chain.

A study by Elghaish et al. [15] also demonstrated the BCT system's core functionality in enabling automated and distinctive financial transactions in construction projects. Also, its decentralized nature will help improve coordination and collaboration in the industry [16]. However, apart from academic-based reviews and pilot test-runs of BCT in the literature, there is no known application of blockchain in construction projects despite its numerous benefits as a disruptive technology and its functionalities to address some shortcomings of existing systems such as BIM, geosystems, among others. BCT's slow uptake in the construction sector is not surprising because the adoption rate of BIM and other new and innovative tools are usually slow [17,18].

Given the above, the current study aims to identify the key factors and their causal relationships as it influences and facilitates the adoption of BCT in the construction industry. These influencing factors for BCT adoption will be examined at the organizational and project level and at the industry level to ensure a holistic implementation of blockchain in construction firms and projects. The study's findings will help construction stakeholders, organizations, and policymakers understand the complexity of the interrelated factors that affect blockchain implementation and how to resolve it. The findings will also assist the relevant stakeholders in implementing blockchain and associated technologies in the industry. The paper reiterated the need for the construction industry to explore the various functions of BCT towards quantifying the actual benefits.

2. Literature Review

In all countries of the world, the construction industry will continue to be pivotal to economic development because of its large revenue base. It is one of the biggest industries in the world. Adoption of blockchain technology in the construction industry will offer huge potential for sporadic development. BCT has significantly improved the construction industry with wide innovations that have changed the industry's status quo. Many studies have been carried out on the application of blockchain technology to the construction industry, and some of them will be reviewed and examined in this section. Sheng et al. [19] provided a solution to the problem caused by a lack of uniform and transparent information in the management of quality information, which leads to disputes among parties. The study proposed a landmark solution through the development of a novel blockchain-based framework for managing quality information. The framework is called the product organization process. Shojaei et al. [20] presented the implementation of smart contracts in the construction industry by integrating blockchain and BIM.

The authors' developed a Hyperledger fabric, which was applied in simple construction projects and later extended to smart contracts applications. The developed model provided an adequate solution to the problems of numerous litigations experienced in the traditional method of contract agreements and implementation. The blockchain application in this study proved that blockchain is an efficient system of overseeing construction projects through the maintenance of a tamper-proof record of projects from the starting point to the completion. The project's record in this digital way provides enough evidence that BCT can be used in dispute resolution. Kim et al. [21] identified several blockchain technology applications to the construction industry and the potential benefits the adoption can bring to the industry. The benefits include easy resolution of legal disputes, reduced transaction cost and time, and entrenchment of transparency in the industry.

All aspects of smart contracts for construction purposes ranging from contract initialization, payments, implementation, programming, and certification were examined by Ahmadisheykhsarmast and Sonmez [22],. The use of smart contracts decreased the cases of litigation in courts, significantly thereby saving costs and time. Yadav and Singh [23] presented the adoption of blockchain technology to the supply chain. The work proposed an efficient, sustainable supply chain management (SSCM) as a replacement for the traditional supply chain management. The principal components of the BCT as related to the supply chain. The components were analyzed and used to model the sustainable supply chain using the principal component analysis. The proposed SSCM generated a better result than the traditional supply chain management upon implementation. Li et al. [24] analyzed the current state of distributed ledger technology (blockchain) by analyzing the different areas in the construction industries with the major objective of enhancing coherent adoption. The authors' emphasized the need for a coherent and not a diverse adoption of the BCT in the construction industry. Kouhizadeh and Sarkis [25] focused on the adoption of blockchain technology to supply chain management identifying potential uses among green supply chain management with numerous functions and activities. The authors' concluded that blockchain is a disruptive technology with numerous opportunities across all sectors of national development.

Related blockchain application in other fields: Blockchain's wide adoption and success in cryptocurrency has made it very attractive to many other sectors of the economy [26]. Many practitioners and organizations have keyed into it because of the need to ensure efficient supply chain competitiveness and improvement [27]. Blockchain technology is a distributed ledger system [28]. The BCT is a peer to peer system (P2P) because each network node has an equal privilege to network information and resources. Resources are shared without starvation because race conditions cannot occur. Like a typical P2P network, there is no single point of failure, and the coordinator cannot be as in a centralized system. The BCT has been widely adopted in cryptocurrency and, precisely, in bitcoin because of the decentralization, security, and transparency it provides. It also eliminated all the problems encountered in a centralized system. Bitcoin has eliminated the need to go through any third party as in the traditional financial transactions. All nodes in the network have access to all resources in an equal way. The potentials of blockchain and its hype are difficult to parse [29].

The proponents of blockchain have emphasized that this technology's wide application will bring about efficient supply chain management. Warehousing, inventory, choice of material, and distribution in supply chain activities will all be positively influenced by the adoption of blockchain technology [25]. This is the drive behind the hype of this technology. The application of BCT to smart contracts has also attracted attention from the organizations in the construction industry. The contract signing, agreement, and implementation have been a big issue in the construction industry, causing so many litigations between the partners involved. The introduction of BCT has automatically eradicated this problem.

3. Research Methodology

The research data were sourced from the Scopus database, and this was used because it offered extensive coverage of a substantial number of articles and journals [30] compared to ISI Web of Science (WoS) and also contained significantly (if not all) the papers in WoS [31,32]. The search criteria were 'Blockchain,' *and* 'Construction' *or* 'benefit' *or* 'barrier' *or* 'driver,' and the articles searched were confined to English and construction-related without any regional or geographical restrictions. All blockchain articles related to the construction industry with the chosen criterion were selected without any restrictions. The research design and framework followed a comprehensive approach in which blockchain adoption in construction industries was predicated on three basic factors: drivers, barriers, and benefits.

The influencing factors were viewed principally from two perspectives of organizational level and industry level. These levels gave birth to two causal loops used for the research design and analysis. The first causal loop was developed by crystallizing the key factors that influence BCT adoption in construction firms and processes, representing the organizational/project level. The second causal loop focused on the variables considered salient to BCT adoption at the industry level. The two causal loops developed using the system dynamic approach were used to establish the research framework.

3.1 System Dynamics and Modelling

The system dynamics modelling was used to determine the factors influencing blockchain technology adoption in the construction industry. System dynamics and modelling are mathematical algorithms employed in the accurate modelling of cause-effect situations in a particular problem. Unexpected situations and uncertainties in real-life situations are not easy to represent in a problem but can be accurately represented through forward and reverse loops used in system modelling and dynamics. System dynamics and modelling has been applied to several types of problems, and it starts with problem formulation, framework design, causal loop modelling, dynamic modelling, and implementation [33].

It has also been widely applied in solving problems in the construction industries. For this particular study, system dynamics and modelling is used in the design of causal loops, which are instrumental to the formulation of causal effects and feedbacks into the factors influencing the adoption of blockchain technology in the construction industries, such as a study by Saka et al. [18]. It consists of different nodes and arrows, which generates the feedback loops into the system. Causal loop diagrams were drawn with Vensim PLE software (version 7.3.5). Sapiri et al. [34] provide an in-depth study on system dynamic modelling and the use of the Vensim software.

The nodes and arrows form the feedback loops into the system. Loops are categorized into a reinforcing loop or a balancing loop, and a reinforcing loop is denoted by even negative signs or only positive signs. In contrast, a balancing loop is characterized by odd negative signs. Reinforcing loops causes instability in the system because changes increase as the feedback loop changes. The balanced loops are more stable because of their oscillation growth.

4. Results and Discussion

This section discusses the influencing factors that affect the adoption of blockchain technology in the construction industry and the development of the causal loop diagrams for their interrelationship at the organizational and industry levels.

4.1 Factors affecting BCT adoption

The analysis of the extant literature revealed several factors – barriers, benefits, and drivers to the adoption of BCT in the construction industry. A key factor affecting the adoption of BCT is the immaturity of the technology [11], although it is more than a decade old. However, it has mostly be employed in cryptocurrency transactions such as Bitcoin, Ethereum, etc. Hence, it still needs more improvement and development to actualize the potential benefits, such as facilitating the tracking of products for sustainability issues [25]. Another key barrier to its adoption is scalability [35]. Scalability relates to the limited rate at which a blockchain system can process transactions (TXs), and is affected by the block size limit and the average time to validate each block TXs. Existing blockchain platforms such as Bitcoin, Ethereum still face this issue. However, the proposition of solutions such as the lightning protocol and sharding partitioning schemes but Bitcoin and Ethereum is still in the pipeline.

More so, this scalability problem of blockchain solutions and the computational intensiveness, needed to validate TXs results in TXs delays and subsequent energy costs. The massive energy consumption by blockchain systems [36,37] is a major hindrance to its adoption in the construction industry in which clients and firms face much emphasis on cost reduction [7,38]. Although employing BCT in construction projects is beneficial to enhancing sustainability in such projects [39], the increasing energy cost of BCT infrastructure needs to be checked. For example, for each mined Bitcoin Tx block, 4kg of carbon are emitted compared to an average of 5kg for humans per year. Other barriers relate to lack of expertise [29], reluctance to invest in new systems, lack of awareness [40], the disparity in information disclosure in the construction supply chain [41,42], among others.

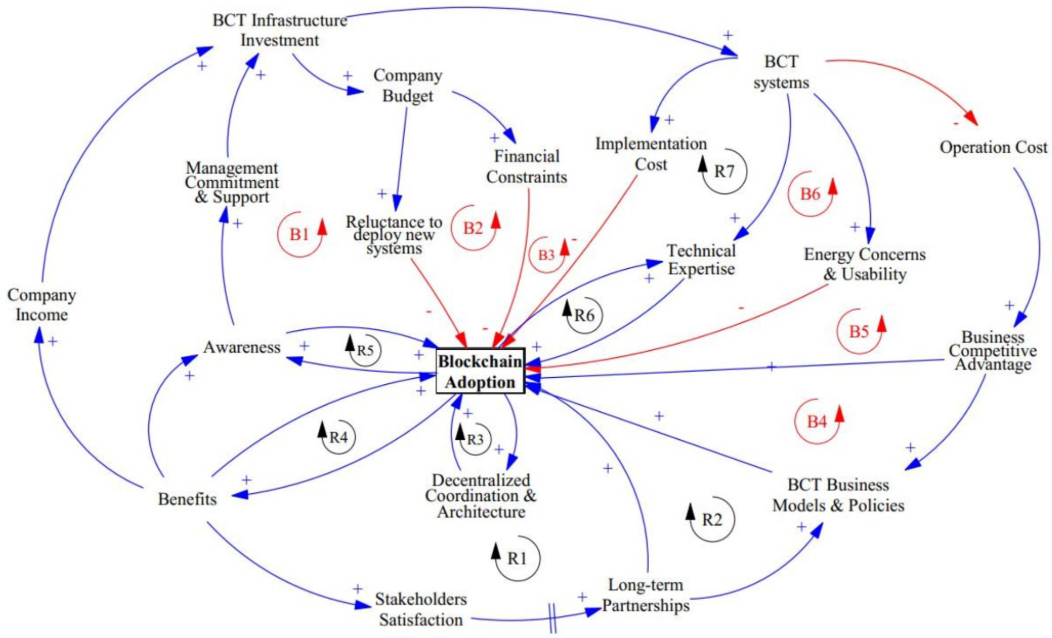
Despite these barriers, as earlier highlighted, there are numerous benefits to outweigh these challenges to its adoption. A key benefit is using smart contracts in BCT [43] to improve construction efficiency and manage contract risks. Also, the use of BCT will enable stakeholders in construction projects to operate in a trustless environment that promotes transparency and accountability. BCT is a decentralized network that does not require a third-party validation or authority [37] to maximize this benefit. Blockchain application in the construction supply chain can reduce the intermediation between the client, contractors, suppliers, and other numerous participants in the supply chain. The disintermediation of the supply chain is possible in BCT due to its capacity to promote TXs among participating peers [44]. More so, the integration of BCT with other technologies [6,45] will help expedite the implementation of smart buildings and cities in the built environment and aid the digitalization of the supply chain.

4.2 Causal relationship of the influencing factors of BCT adoption

Causal loop diagrams were employed in this section to illustrate and understand the dynamics of the interrelationships of the several variables that affect BCT adoption in the construction industry. In order to effectively model and investigate the complexity of the causal relationships of these factors, two dynamic models were developed. The first one examines the causal interrelationship at the project/organizational level, and the second causal loop focuses on the interrelationship at the industry level.

4.2.1 Causal effects at the project/organizational level

Figure 1 illustrates the causal relationships of the influencing factors at the project and organizational level. Overall, 13 loops were identified, which comprises of seven reinforcing loops and six balancing loops.



Reinforcing loops

R1: Blockchain adoption +→ Benefits +→ Stakeholders satisfaction +→ Long-term partnerships +→ Blockchain adoption.
R2: Blockchain adoption +→ Benefits +→ Stakeholders satisfaction +→ Long-term partnerships +→ BCT Business models & policies +→ Blockchain adoption.
R3: Blockchain adoption +→ Decentralized coordination and architecture +→ Blockchain adoption.
R4: Blockchain adoption +→ Benefits +→ Blockchain adoption.
R5: Blockchain adoption +→ Awareness +→ Blockchain adoption.
R6: Blockchain adoption +→ Technical expertise +→ Blockchain adoption.
R7: Blockchain adoption +→ Benefits +→ Company income +→ BCT infrastructure investment +→ BCT systems +→ Technical expertise +→ Blockchain adoption.

Balancing loops

B1: Blockchain adoption +→ Awareness +→ Management commitment & support +→ BCT infrastructure investment +→ Company budget +→ Reluctance to deploy new systems -→ Blockchain adoption.
B2: Blockchain adoption +→ Awareness +→ Management commitment & support +→ BCT infrastructure investment +→ Company budget +→ Financial constraints -→ Blockchain adoption.
B3: Blockchain adoption +→ Awareness +→ Management commitment & support +→ BCT infrastructure investment +→ BCT systems +→ Implementation cost -→ Blockchain adoption.
B4: Blockchain adoption +→ Awareness +→ Management commitment & support +→ BCT infrastructure investment +→ BCT systems -→ Operation Cost +→ Business Competitive Advantage +→ BCT Business Models & Policies +→ Blockchain adoption.
B5: Blockchain adoption +→ Awareness +→ Management commitment & support +→ BCT infrastructure investment +→ BCT systems -→ Operation Cost +→ Business Competitive Advantage +→ Blockchain adoption.
B6: Blockchain adoption +→ Awareness +→ Management commitment & support +→ BCT infrastructure investment +→ BCT systems +→ Energy concerns & Usability -→ Blockchain adoption.

Figure 1: Causal loop showing the interrelatedness of the influencing factors at the organizational level

The reinforcing loop in the causal loop diagram of Figure 1 are:

R1: Loop R1 is a reinforcing loop driven by the satisfaction derived by construction stakeholders from the benefits gained from their adoption of BCT in their projects. An increase in this satisfaction will lead to supply chain participants engaging in long-term partnerships with crucial project collaborations brought about by the peer-to-peer system of blockchain, and this will lead to further adoption of BCT in the long-run.

R2: More so, an increase in these benefits will enable stakeholders to engage in long-term project collaboration and, as a result, prompt them to develop appropriate business models and policies to manage the BCT-enabled projects. The resultant effect is increased blockchain adoption.

R3: An increase in BCT adoption in construction projects will positively influence the coordination and management of such projects and vice versa.

R4 & R5: As seen in reinforcing loops 4 and 5, an increase or decrease in derived benefits and level of awareness of BCT will have a resultant effect on its adoption in the construction industry.

R6: Blockchain adoption will influence organizations to enhance their knowledge and experience in using and to manage BCT systems, which will further aid its application in future projects. However, firms that fail to adopt BCT will have no experience in the management of the BCT system.

R7: Construction firms adopting BCT and deriving significant benefits will see an increase in its income, which will encourage the investment in BCT infrastructure and systems with a resultant increase in their staff's technical expertise and more deployed BCT-enabled projects.

The balancing loops in the causal loop diagram include:

B1: Causal loop B1 represents a key balancing loop in BCT adoption in a firm. An increase in BCT adoption will have an increasing or decreasing effect on the awareness of top management, which will, in turn, affect their commitment and support for blockchain in their enterprise. A positive commitment can result in investment in the blockchain, which inevitably increases the firm's budget. Such an increase in the budget might make the top management reluctance to deploy new BCT systems in their firm and invariably stiff further blockchain adoption.

B2: Loop B2 is somewhat similar to B1; however, in this case, an increase in the company budget will increase the financial constraints faced by the firm and vice versa. The resultant effect is an increase or decrease in BCT adoption with such firms or projects.

B3: An increase or decrease in investment in BCT system by the construction firm's management will determine the number of available BCT infrastructure to be deployed for construction processes, which in turn affects the high cost of implementing the system. An increase in the implementation cost will negatively affect the future adoption of blockchain.

B4: Availability of BCT systems in an organization will lead to a decrease in its operating cost over time and give such firms a competitive edge over its rivals and enable such firms to develop appropriate BCT business models to consolidate the superiority in the business.

B5: Like loop B4, an increase or decrease in the competitive advantage a construction enterprise has over its rivals due to its adoption and investment in BCT system will have a resultant effect on future BCT adoption.

B6: Causal loop B6 is another balancing loop between an increase in blockchain adoption and energy cost and usability concerns of BCT systems. The increasing energy cost of managing existing BCT systems is a determent to its implementation in the construction industry. Kaur and Gandhi (2020) suggested removing block size limit and improving the TXs validation process to reduce time spent on committing a TX block and the resultant carbon footing.

4.2.2 Causal effects at the industry level

Figure 2 illustrates the causal relationships of the influencing factors at the industry level. Overall, 16 loops were identified, which consists of ten reinforcing loops and six balancing loops.

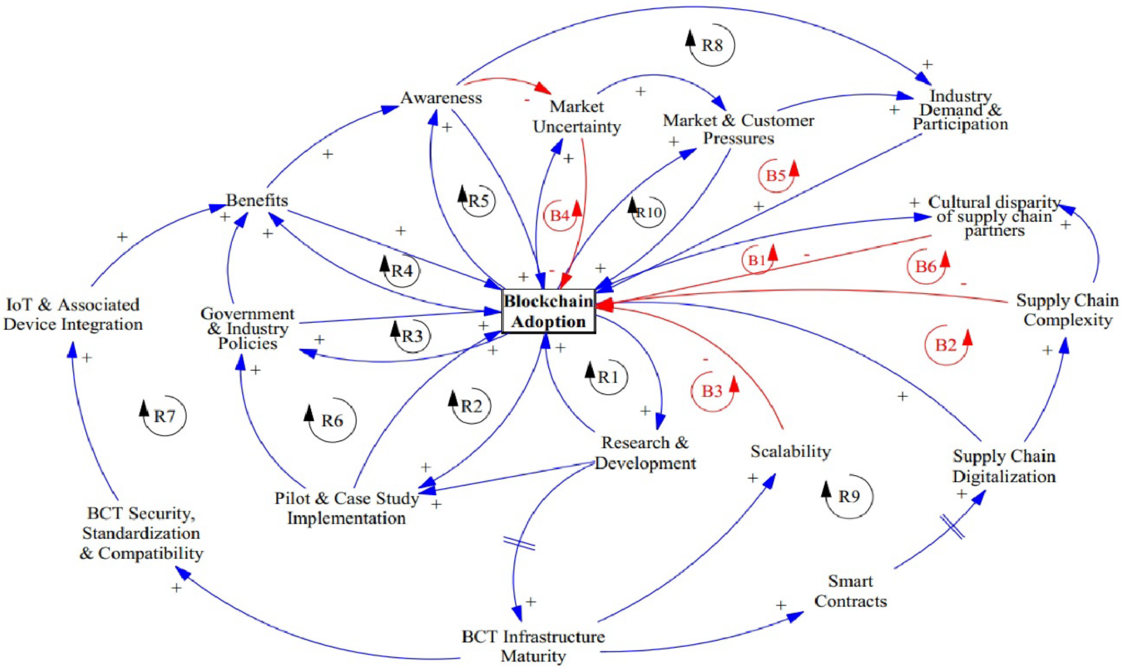
The reinforcing loop in the causal loop diagram of Figure 2 are:

R1 – R5: The reinforcing causal loops R1 – R5 are key influencing factors that can single-handedly advance blockchain technology implementation in the construction industry. An increase in the adoption of BCT will increase its benefits (R4) to the industry and the awareness of stakeholders (R5). Also, when the government develop an interest in BCT and develop relevant regulatory policies and standards (R3), which will further improve its adoption. An increase in BCT-related research (R1) and relevant case study project implementation (R2) will enable construction firms and other stakeholders to adopt BCT if its performance is evaluated positively.

R6: BIM adoption influences researchers and software developers to conduct more studies and develop BCT tools suitable for construction processes. The developed systems could be tested on real-life case study projects. A positive progression in its implementation in these projects will lead the government to legislate its use and develop appropriate policies in collaboration with professional bodies and industry stakeholders. The resultant effect is increased benefits accruable to the involved firms and stakeholders, which will, in turn, enhance BCT adoption.

R7: A key barrier to BCT adoption is the immaturity of its technology. Hence, further industry research will ameliorate this challenge towards the rapid development of BCT infrastructure and improve the security and standardization of blockchain systems. Once BCT technologies are more standardized, it will enhance its interoperability with other BCT solutions and other technologies such as BIM, GIS, RFID, sensors, among others. Using these integrated technologies will positively strengthen the benefits of BCT implementation in the construction industry and make passive clients and other industry practitioners adopt BCT further.

R8: A key driving force to BCT adoption is the active demand and participation of industry practitioners; hence, benefits from its adoption and increased stakeholders' awareness will prompt them to adopt blockchain.



Reinforcing loops

R1: Blockchain adoption +→ Research & Development +→ Blockchain adoption.
R2: Blockchain adoption +→ Pilot & Case Study Implementation +→ Blockchain adoption.
R3: Blockchain adoption +→ Government & Industry Policies +→ Blockchain adoption.
R4: Blockchain adoption +→ Benefits +→ Blockchain adoption.
R5: Blockchain adoption +→ Awareness +→ Blockchain adoption.
R6: Blockchain adoption +→ Research & Development +→ Pilot & Case Study Implementation +→ Government & Industry Policies +→ Benefits +→ Blockchain adoption.
R7: Blockchain adoption +→ Research & Development +→ BCT Infrastructure Maturity +→ BCT Security, Standardization & Compatibility +→ IoT & Associated Device Integration +→ Benefits +→ Blockchain adoption.
R8: Blockchain adoption +→ Benefits + Awareness +→ Industry Demand & Participation +→ Blockchain adoption.
R9: Blockchain adoption +→ Research & Development +→ BCT Infrastructure Maturity +→ Smart Contracts +→ Supply Chain Digitalization +→ Blockchain adoption.
R10: Blockchain adoption +→ Market & Customer Pressures +→ Blockchain adoption.

Balancing loops

B1: Blockchain adoption +→ Cultural disparity of supply chain partners −→ Blockchain adoption.
B2: Blockchain adoption +→ Research & Development +→ BCT Infrastructure Maturity +→ Smart Contracts +→ Supply Chain Digitalization +→ Supply Chain Complexity −→ Blockchain adoption.
B3: Blockchain adoption +→ Research & Development +→ BCT Infrastructure Maturity +→ Scalability −→ Blockchain adoption.
B4: Blockchain adoption +→ Market Uncertainty −→ Blockchain adoption.
B5: Blockchain adoption +→ Awareness −→ Market Uncertainty +→ Market & Customer Pressures +→ Industry Demand & Participation +→ Blockchain adoption.
B6: Blockchain adoption +→ Research & Development +→ BCT Infrastructure Maturity +→ Smart Contracts +→ Supply Chain Digitalization +→ Supply Chain Complexity +→ Cultural disparity of spply chain partners −→ Blockchain adoption.

Figure 2: Causal loop showing the interrelatedness of the influencing factors at the industry level

R9: The availability of matured BCT systems and the use of smart contracts will enhance the digitalization of the supply chain and results in more adoption

R10: A positive pressure from developers, customers, and the construction market would lead to more adoption of blockchain in the construction industry.

The balancing loops in the causal loop diagram (Figure 2) include:

B1: Partners in the construction supply chain tend to hold information critical to their survival and competitive advantage over rivals. Blockchain brings transparency in TX, which traditional participants in the supply chain oppose; hence, it will make them uninterested in BCT adoption.

B2: The digitalization of the construction supply chain will increase the complexity of the supply chain and managing this complexity will negatively affect BCT adoption.

B3: The scalability problems are beyond developing more efficient and matured BCT systems. Hence, its associated challenges need to be solved; otherwise, blockchain adoption might be slowed in the industry.

B4: Bitcoin, a key BCT-based financial system, has generated mixed public perceptions, mostly negative. Therefore, stakeholders in the construction industry might be hesitant to adopt blockchain.

B5: Improvement in stakeholders' awareness will reduce the market uncertainty about BCT adoption, making industry practitioners and customer demand BCT application in their projects.

B6: An increase in the construction chain's complexity will further affect the disparity among the participating stakeholders, with the resultant negative effect on BCT adoption.

Conclusions

The construction industry is a massive sector with a considerable impact on the livelihood of human and the ecosystem. However, the construction process is fraught with several challenges that inhibit the project's success and make for unsustainable products. Hence, many technologies such as BIM, RFID, etc. and lately, blockchain has been developed to address these issues and automate the whole life cycle of built assets. The paper explores the literature to examine the relevant benefits of blockchain adoption and other influencing factors affecting BCT adoption in the construction industry. BCT's potential advantage to address some shortcomings that discourage the industry from implementing other technologies and facilitating sustainability in construction projects makes the need for this study more worthwhile.

A review of the literature help to deduce the key influencing factors affecting the adoption of blockchain technology in the construction industry, while system dynamics via the development of causal loops helped model the causal interrelationships among the key factors. The most significant influencing factors at the organizational and industry levels are awareness, benefits derivable from BCT adoption, stakeholders' demand, and satisfaction. More so, for the organizational level, the key factors are continuous support from top management, investment, and deployment of BCT infrastructure, the need for decentralized coordination of construction activities. However, the implementation and energy cost of BCT systems has a prohibitive effect on its adoption. The increasing budget of the firm can make the management reluctant also to deploy new systems.

Meanwhile, at the industry level, the key factors related to government policies in support of blockchain and BCT-research and development, will pave the way for increasing effectiveness and standardization of BCT infrastructure. Scalability problems of BCT systems are still a hindrance as well as the current public opinion about blockchain. Also, the issue of non-disclosure of information by supply chain partners needs to be resolved to improve BCT implementation in the construction industry. The knowledge and understanding of these key factors will help industrial practitioners and other stakeholders to adopt BCT in the industry.

More so, the illustration of the causal relationship between the identified variables will better help stakeholders implement blockchain in their projects. A BCT-based supply chain network will be very suitable for modular integrated construction (MiC) projects where there are varied chains of supply partners. A limitation of this study is that a single corpus database (Scopus) was used, and future studies could consider more databases articles for review. Further research is necessary to provide empirical modelling and analytical evaluation of these factors. An investigation of the value of blockchain technology for the construction market and business in general and MiC projects, needs to be conducted to facilitate its wider adoption.

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