

تحديات ومعوقات تنفيذ العقود الذكية
في صناعة البناء والتشييد في المملكة العربية السعودية

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Challenges and Barriers to the Implementation of Smart Contracts in the construction industry in the Kingdom of Saudi Arabia

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Chapter 1. Introduction

The global economy heavily relies on the construction industry, which contributed approximately 6% of the world's GDP in 2018. It is predicted to grow to about 14.7% of the total by 2030. Nevertheless, this industry has been criticized for years due to low productivity, subpar performance, and slow innovation. With increasing digitization and exponential rise of valuable data, Information and Communication Technology (ICT) advances are now transforming virtually every business. Due to the implementation of ICTs to increase production and efficiency, other sectors such as automotive, aerospace, and aviation have seen significant advancements. On the other hand, the Architecture, Engineering, and Construction (AEC) sector, on the other hand, lags behind in this trend of digital innovation. The development of smart contracts is being looked at more and more as a component of the digital transformation of the construction sector (Ye, et al. 2022).

Building Information Modeling (BIM) adoption may be facilitated by smart contracts, which have the potential to assist in addressing a number of significant concerns in the construction sector, including contract conflicts and payment problems. The construction business often has contract disagreements. Contradictions, errors, or incorrect terminology in construction contracts may make implementation challenging. Paper-based contracts are still widely used, making it challenging to track changes and document implementation. The lack of a solid basis for disagreements and claims fosters erroneous behavior and poor compliance with agreements on the part of clients or contractors. When employing smart contracts, consistency may be established, and all changes are securely recorded and readily apparent. Another problem that is getting worse is financing. In order to receive payments on schedule and maintain a steady flow of income, construction projects must be effectively finished. Challenges such as non-payment, delayed payment, and improper payment are to blame for conflicts, increased costs, poorer results, and delays in construction. Recent advancements in smart contract innovation make it easy to manage transactions in a reliable and safe manner. The difficulty in adopting BIM is a problem with IT developments. Unavoidable barriers to implementing and employing BIM more efficiently include the risks related to information security and intellectual property ownership. In fact, by using another party's BIM model, one party may unknowingly breach that company's intellectual property

rights. Therefore, the possession of electronic information in BIM becomes a problem that won't go away and that could be fixed through the implementation of smart contracts in construction projects. In the meanwhile, information security may also be guaranteed since BIM allows for the tracking of any modifications. It's usual to refer to or discuss smart contracts as a component of the blockchain. On the blockchain, smart contracts are seen as a link, element, layer, feature, or 'one of the most crucial features.' The smart contract, however, has a distinct meaning, connotation, and value to the construction sector as a driver for pertinent automation and a vital innovation for digital transformation. This application of smart contracts is still in its infancy. In its early stages, an invention may face a number of problems, such as difficulties evaluating its effectiveness administrative and technical obstacles to further growth. As a result, it is very important to outline the benefits and point out the challenges in the creation of smart contracts from their inception to their full maturity (Ye, et al. 2022).

1.1 Problem Statement

People often think that the construction industry is reluctant to use new innovations. The fact that smart contracts could protect against late payments could be a big reason for adopting. Even though the use of smart technology is becoming more popular around the world, the low adoption of distributed ledger technology, which is at the core of blockchain technology, in the construction sector in the Arab world is due to a number of barriers. There aren't enough experts in the Arab region who know how smart contract technology can allow the construction industry to become more productive, cooperative, and transparent in the digital age. This is because smart contract technology can record, enable, and improve digital security, as well as open up new areas of application and help the construction industry make a smooth transition to the digital age.

1.2 Research Objectives

The purpose of this study is to evaluate the possibilities and obstacles associated with the deployment of smart contracts in the construction industry. This study also aims to serve as a pioneering investigation into the adoption of smart contracts in Saudi Arabia's construction industry by answering the primary research question of what advantages, uses, difficulties, and potential future applications smart contracts can offer to solve construction

industry problems in Saudi Arabia. Furthermore, the research aims to outline the advantages, uses, difficulties, and future potential that smart contracts may bring to address the issues in the Saudi Arabian construction business. Additionally, the purpose of this research is to assess the use and deployment of smart contracts in the building and infrastructure industries.

1.3 Research Methodology

This study largely relies on a quantitative technique with a comparative casual design to attain its objectives. Using this research technique, the researcher is able to explore the barriers connected with smart contract adoption in the Saudi Arabian construction industry. The questionnaire begins with a summary of the research, its aims, and the advantages of the findings. The participants will then confirm that their participation was voluntary and that their data will be treated with the utmost discretion and will not be shared with any third parties. With this questionnaire, the data and information essential to characterize the study problem will be acquired. The survey will be available through Google Form Link online. The researcher contacts the study population using social media sites such as Facebook and WhatsApp groups, and even direct interviews, and they delete duplicate or incomplete questions.

The employment of technology and its various applications are rapidly increasing worldwide within the construction industry. However, in comparison to other industries such as finance and automotive, the construction industry exhibits a slower inclination towards technological advancement, possibly attributed to the nature of the industry (Mason et J., 2018). For optimum utilization, the incorporation of a smart contract is crucial (Reiff et M., 2020). The aim of this investigation is to expose the potential of adapting smart contracts within the construction sector of Saudi Arabia, as well as identifying any potential hindrances. This chapter will outline the study design and data collection methods utilized in this research

1.4. Research approach and design

The quantitative approach with a questionnaire was heavily relied upon in this study to accomplish the research's goals.

1.5. Data collection tool

There are two categories of data collection techniques:

1. Primary source: a questionnaire was created specifically to gather primary data about all the study variables and the demographics of the research sample based on prior empirical studies and the research aims.
2. Secondary source: To comprehend the theoretical underpinnings of the study and create its model and hypotheses, books, journals, and theses were used.

1.6. Significance of the Research

This study's objective is to assess the advantages and disadvantages of the use of smart contracts in the construction sector. By responding to the main research question of what benefits, uses, challenges, and possible applications that smart contracts may provide to address construction industry problems in Saudi Arabia, this study also aims to serve as an innovative study into the widespread use of smart contracts in that country's construction industry. This study largely will rely on the quantitative method using a questionnaire to achieve its objectives. Through the use of Google Form Link, the survey will be made available online.

1.7. Question Search

Kindly give each factor the most closely Barriers (in your opinion), where:

1. Strongly agree
2. Agree
3. Neither agree nor disagree
4. Disagree

The most closely challenges and Barriers in Saudi construction projects		(Please add [√] as appropriate)				
		1	2	3	4	5
1	Internet of things is a important technology than can facilitate smart contacts.					
2	Smart contracts offer exceptional levels of security in the construction industry by virtue of their advanced technology.					
3	Smart contracts have proven to create significant improvements in the realm of Finance and Economics.					
4	Smart contracts have been shown to play a pivotal role in enhancing data reliability.					
5	Smart contracts offer efficient management of stakeholders by automating various aspects of contract execution and enforcement.					
6	The Internet of Things (IoT) has the potential to significantly diminish the amount of time consumed in executing smart contracts.					
7	The Internet of Things has ushered in a new era of technological advancements. This innovative platform has the capacity to automate peer-to-peer business interactions, providing an efficient and seamless experience to all stakeholders involved.					
8	The integration of the Internet of Things (IoT) has resulted in a reduction of costs associated with central server administration in the implementation of smart contracts.					
9	The integration of the Internet of Things (IoT) into smart contracts represents a powerful method of control and monitoring.					

The most closely challenges and Barriers in Saudi construction projects		(Please add [√] as appropriate)				
		1	2	3	4	5
10	Smart contracts have the remarkable ability to integrate Building Information Modeling (BIM), Artificial Intelligence (AI), and Internet of Things (IoT).					
11	Smart contracts security is an essential aspect of modern-day technological advancements. In this regard, the ability to accurately, quickly, and reliably share an attack list is crucial.					
12	Smart contracts play an integral role in ensuring the security and reliability of cloud service providers.					
13	Smart contract security allows users to bypass the use of brokers and instead distribute surface-level agreement cloud.					
14	Smart contracts have the ability to significantly decrease administrative service costs, providing a valuable solution for businesses seeking to streamline their processes.					
15	Smart contracts significantly enhance the operational efficiency of various services.					

Chapter 2. Literature Review

Two of the biggest problems facing the construction industry are late payments and disputes between partners. Disputes might include things like failure of the company, cost overruns and time delays, cash flow problems, and payment holding. Inability of project participants to comply with due dates for payments, a shortage of payment assurance, and unwillingness to pay, according to the conclusions of a government of a New South Wales government study into the bankruptcy of the building sector, are the main reasons for contractual disputes in the business. To solve these problems and offer a secure payment environment, the industry must deploy innovative technologies. Despite its resistance, the construction industry may be compelled to embrace new technology as a result of the rapid technological development in the sector in order to achieve revolutionary alterations (Arslan, Tuncan, Birgonul, & Dikmen, 2006).

Blockchain and smart contracts are two such innovations that have significantly impacted a number of sectors, including the banking and healthcare industries. A blockchain can be characterized as a distributed public ledger that stores all transaction data exchanged within the system's stakeholders. Therefore, it provides a safe and synchronized record of transactions to all parties participating in a business network. A data transaction can only be completed with the agreement of all system users. Every transaction sequence is recorded in the blockchain ledger from beginning to finish, creating definite, verifiable, and irreversible records of every transaction ever done. There are several industries where blockchain technology may be used. One of the primary utilizations of blockchain innovation is the smart contract, which is crucial for the digitization of conventional paper contracts (Crosby, Nachiappan, Pattanayak, Verma, & Kalyanamaran, 2016).

The goal of a smart contract is to recreate legally enforceable contracts using computer code that is executed on the blockchain public system. Smart contracts are a kind of computerized transaction protocol. In the program, clauses, and instructions might be programmed. Smart contracts are self-enforcing because they run when the contractual criteria specified in the code are satisfied. Moreover, smart contracts provide the embedding of digital transaction data, such as payment amounts, and the automated transmission of data between the contract parties following the completion of the instructions (Crosby et al., 2016).

Smart contracts prohibit the quantity to be purchased so that no one party may access the funds. The payment amount won't be transferred to the accounts of the parties unless the conditions are met. Due to its binary logic, which makes sure that inputs and outputs are equal, and that the fulfillment of contract requirements relies on defined scope, smart contracts are crucial. Blockchain is a decentralized innovation, therefore it does away with the requirement for additional middlemen like banks, notaries, and exchanges. Because of smart contracts' inherited characteristics and dispersed qualities, it also lessens payment fraud. Being distributed implies that every party on the network validates each contract's output. Since other users on the network will notice and mark the effort as unreliable, one person cannot make the contract release the money. In other words, every participant in this system must confirm any transaction before it can be completed. Smart contracts also reduce transaction costs and raise party confidence in contracts. As well as this, smart contracts and blockchain technologies are impermeable, once a smart contract is made, it cannot be changed. Hence, it is almost impossible to alter the code or smart contract. Transactions involving digital data in smart contracts, such as purchases, are impractical without the use of cryptocurrency, a digital or virtual currency designed to be used as a means of exchange. Cryptography controls the introduction of new cryptocurrency kinds and ensures secure and verified transactions (Rutink, 2018).

By combining the strengths of blockchain with smart contracts, a secure payment environment might be created. This essay discusses the significant advantages of blockchain and smart contract technologies for the building sector as well as how these technologies may be used to address industry-wide insolvencies. In the building sector, there are several agreements between stakeholders. The contracts that have been formed may take on several forms, such as those between an employer and an employee, an employee and a subcontractor, an employee and a supplier, etc. As a result, this sector of the economy is primarily contractually oriented, making smart contract technology highly desirable to resolve contractual disputes and payment issues (Cardeira, 2017).

Little academic research regarding smart contract uses in the construction sector is available since smart contracts are cutting-edge technology. According to Perico (2018), the building information modeling (BIM), timelining, liens, and insurance sections of the construction sector might all benefit from the use of blockchain technology. Cardeira (2017) has pointed

out that the system can automatically pay progress interims because of the combination of smart contracts and Building Information Modeling (BIM). Cardeira (2018) introduced a smart contract-based payment system for use in contracts with several parties in which the instructions for payments between parties are programmed in the program. With the designed online payment system, as long as the employer and contractor follow the instructions, the payment will automatically be issued. As a result, the contractor cannot withdraw money until the subcontractors have been paid. The suggested idea in this article discusses how the procurement phase and interim payments of a smart contract in the construction sector may be implemented. Smart contracts might provide several advantages for the construction sector, including lowering exchange and transaction costs, offering ongoing as-built cost data, as well as voiding third parties, lowering administrative costs associated with tracking down payments, preventing parties from missing payment due dates, minimizing contractual disputes, and boosting performance and confidence, etc. (Mason, 2017).

2.1 Construction Industry in Saudi Arabia

The entire amount of building contracts issued in Saudi Arabia in 2017 was reportedly over USD 24 billion, according to Deloitte (2017). Although the start of some of them has been delayed or postponed because of the recent declines in oil prices and the government program of financial reforms, this does not change the fact that Saudi Arabia's construction market is one of the main drivers for domestic economic growth and development. Saudi construction companies are the most significant and costliest clients in several economic sectors, including those related to supplies, equipment, and logistical support. However, in addition to implementing performance evaluation tool, there is an obvious a need to increase the performance and output of Saudi construction contractors. Several large-scale projects seem to be delivered with obvious flaws, either in specifications or functioning, despite the vast values of contracts given to construction firms (Deloitte and Touche, 2017).

According to Kwame, Baiden, and Badu (2016), Construction companies in emerging countries often lack the ability to compete with global firms. One of the factors that negatively affect local contractors' performance in many economies is the use of outdated technology, equipment, and training programs for staff and workers.

Timeline

A. **Weeks 1-3:**

- Develop research question and hypothesis
- Conduct literature review.
- Develop research design.
- Create data collection plan.

B. **Weeks 3-9:**

- Analyze the data and write the research report

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