APPLICABILITY OF BLOCKCHAIN TECHNOLOGY IN CONSTRUCTION PROJECT MANAGEMENT TASKS IN NGERIA

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**Abstract**

The construction industry in Nigeria is plagued by factors such as delays, cost overruns, and lack of transparency, which could be attributed to poor project management practices. These factors have significant negative impacts on project delivery, leading to clients’ dissatisfaction, delayed payments, and reputational damage. This research seeks to investigate the applicability of blockchain technology in the management of construction projects in Nigeria to address the aforementioned challenges. It adopts a qualitative research method, in which a semi-structured questionnaire was issued to 70 respondents made up of construction project management stakeholders. 50 questionnaires were returned, representing 80.83% response rate. The data obtained were analyzed using both descriptive methods. The results of the analysis shows that construction stakeholders have limited knowledge of blockchain technology. It also shows that enhanced transparency is rated as the highest benefit of the adoption of blockchain technology in construction project management in Nigeria with frequency 12, while lack of awareness is the greatest challenge rated with frequency 21 out of 50. Furthermore, technical expertise is rated as the highest critical success factor. The study concluded that the applicability of blockchain technology in construction project management has the potential to revolutionize the construction industry and mitigate the negative impacts of identified challenges in the industry. Given these findings, the study recommends the promotion of the application of blockchain technologies in construction project management tasks through the strengthening of institutional frameworks by government and built environment professional bodies.

**Key Words:** Blockchain Technology, Smart Contract, cryptography, Distributed Ledger Technology (DLT), Construction Project Management

* 1. **Introduction**

Technology is employed by many human life sectors to achieve efficiency and effectiveness thus, enabling management to be dependable, secure and acquiescent (Kamilu, Adindu, Muhammed, Yusuf, & Baba, 2023). In recent years, adoption of blockchain technology is spreading to nearly all sectors of the economy as it provides transparency, trust and efficiency in managing resources (Rijal & Saranani, 2023). A blockchain is a type of distributed ledger technology (DLT) that provides a foundation for creating decentralized, secure, and dependable activities (Pop *et al.,* 2020). Blockchain is an advanced database mechanism that allows transparent information sharing within a business network. This makes it possible for easy collaboration and exchange of information within the project environment as information shared are stored permanently in a ledger and protected by a digital fingerprint which cannot be manipulated. The advantage of this technology includes transparency, openness, and traceability by joining several computer sciences disciplines such as cryptography, data structures, and consensus algorithms (Narayanan, 2016; Zhao *et al.,* 2017).

Although, construction projects management tasks and practices in Nigeria is plagued with challenges such as delays, cost overruns, and lack of transparency and openness which can be attributed to poor project management practices (Nakamoto, 2008). These challenges have significant negative impacts on project delivery, leading to dissatisfied clients, delayed payments, and reputational damage to stakeholders (ELIAS, 2024). It is still inundated with many traditional practices despite the numerous revolutionary changes introduced by digitalization in almost all business sectors. Therefore, there is a need for innovative solutions that can enhance construction project management performance and trust among the stakeholders of this sector in Nigeria and. Hence, trust is found as one of the most important keys that underpin successful completion and improve productivity, enhance cooperation and teamwork development in construction project (Umar, Dodo, & AbdulAzeez, 2021). The use of blockchain technology in project management technology has been proposed as a potential solution to so many project challenges by providing a decentralized platform for stakeholders to share information, automate processes, and improve project performance (Tayeh *et al*., 2020). Hence, the need for an exploratory study of blockchain technology to evaluate its applicability in construction project management tasks in Nigeria to effect aforementioned changes for efficiency, and furthermore to eliminate project management setbacks arising from poor communication and information access, dispute between parties, and inefficient management of resources to improve construction project management practices in all projects sectors.

**2.0 Theoretical Framework**

**2.1 Overview of Blockchain origin.**

Blockchain (Satoshi Nakamoto’s white paper review): blockchain is an innovative technology first introduced in 2008 through the emergence of Bitcoin (Nakamoto, 2008; Abeyratne and Monfared, 2016). Bitcoin is considered as the first blockchain application that was introduced to the financial industry (Mingxiao *et al.,* 2017). Due to the mainstream attention on Bitcoin, blockchain was first seen as a way to create new digital currencies where people could anonymously transact among untrusted participants transcending geographical boundaries (Wang *et al.,* 2017). However, as time went on, new use cases were identified as industries went on a verge to explore the potentials of blockchain.Satoshi Nakamoto a peer to peer version of electronic cash will allow the transfer of bitcoin asset sent from one party to another without the need of third party or a financial institution. For this to be possible, Satoshi Nakamoto introduced a framework for bitcoin transaction using a cryptographic signature together with a hash function to transfer ownership of coin from one party to the other without involvement of financial institution.

Bitcoin transaction is described as a chain of cryptographic signature, whereby every owner of a digital asset transfers to another by digitally signing the hash function of the previous transaction and the public transaction key of the next owner and adding it to the coin as a way of avoiding double spending and providing proof of transaction and promoting trust and transparency while making transaction among parties.

Figure 2.1 (see below) shows a way of transferring bitcoin asset in a peer to peer network.

Figure1: (Nakamoto, 2008)

As seen above, the bitcoin transaction is unique and can go on by forming series of blocks attached to each transaction as they take place. Ownership of each transaction is been verified before moving to another owner. As Satoshi Nakamoto continues with his quest on building a framework for bitcoin transaction, a little challenge was identified. The problem of course is the payee can't verify that one of the owners did not double-spend the coin (Nakamoto, 2008). The solution proposed begin with a time stamp server (Nakamoto 2008). According Satoshi Nakamoto bitcoin white paper, a timestamp server works by taking a hash of a block of items to be time stamped and widely publishing the hash, such as in a newspaper or Usenet post. The timestamps provide proof and validation that a particular coin was sign at a particular time in order to be added to the hash. Every timestamp has a previous timestamp in the hash and continue to form a chain of hash.

Figure 2.2 (see below) shows a timestamp server.

Figure 2: (Nakamoto, 2008)

Bitcoin blockchain network is decentralized, which means the network is spread across networks of different nodes. This is done to improve the security of the network. The proof-of-work involves scanning for a value that when hashed, such as with SHA-256, the hash begins with a number of zero bits. The average work required is exponential in the number of zero bits required and can be verified by executing a single hash (Nakamoto, 2008). The proof of work is represented by the longest chain of transaction in a network. Subsequent blocks will continue to build on it. The CPU power and energy are expended on the longest chain making it nearly impossible for an attacker to hack the network. The attacker must redo the proof of work for every block on the longest chain. Satoshi’s idea was to eliminate the possibility of hackers.

**3.0 Research Methodology**

**Research Design**

This paper uses a mixed method of research approach by using a structured questionnaire and critical literature review analysis and archive resources to critically explore the potentiality of blockchain technology applicability to construction project management tasks in Nigeria.

**3.1 Source of Data**

The data for this research were sourced from 50 structured questionnaires that was returned out of seventy which was distributed. The reason for using small number (50) in this research was that the research was conducted in 2023 before 16th May of 2024 when the Notcoin was first listed that made the knowledge and awareness of cryptocurrency very rampantly everywhere in Nigeria. Some data were also sourced from archive and reviewed literatures. The questionnaires were administered online via Google Forms because it is cost-effective, fast, and efficient. The questionnaire was divided into four sections. The first section collected information on the demographic characteristics of the participants. The second section collected information on the participants' knowledge of blockchain technology, while the third section collected information on the potential use of blockchain technology in construction project management in Nigeria. The fourth section consisted of open-ended questions that allowed the respondents to provide additional comments about the topic.

**3.2 Data Analysis**

The methodology uses descriptive and inferential statistics analysis methods to analyze the data collected with structured questionnaires administered to major construction industry stakeholders in Nigeria. Data collected from the questionnaires were analyzed using Microsoft Excel in creating tables and charts to visually represent the data.

**4.0 Data presentation and Analysis**

**4.1 Awareness and usage of blockchain technology.**

To assess the awareness and usage of blockchain technology, participants were asked to choose from the options provided on their level of understanding of blockchain. The respondents were to pick an option of YES or NO for usage and level of awareness.

Table 1 Shows the level at which construction stakeholders have an awareness and knowledge of blockchain technology.

|  |  |  |
| --- | --- | --- |
| Respondents awareness | Frequency | Percentage/percentage |
| Yes | 47 | 94% |
| No | 3 | 6% |
|  Total | 50 | 100% |

Table 1: *Source: Authors field work 2023*

The result from table 1 indicates that 94% of the respondents have an awareness of blockchain technology, while 6% have not. Respondents claims to have an idea and awareness on blockchain technology without any perceived awareness of it.

**4.2 Usage of blockchain technology**

Table 2: Shows the level at which construction stakeholders have used blockchain on Organizational Purpose.

|  |  |  |
| --- | --- | --- |
| Respondent usage of blockchain | Frequency | Percentage/proportion |
| No | 42 | 84% |
| Yes | 8 | 16% |
| Total | 50 | 100% |

Table 2: *Source: Authors field work 2023*

Based on the responses of the 50 participants, 42 respondents (or 84%) answered "NO" to the question of whether they use blockchain technology on organizational purpose or not, while 8 respondents (or 16%) answered

"YES".
This suggests that the majority of participants do not use blockchain technology in their work places. It is important to note that this may be due to various factors such as lack of enlightenment or understanding of full benefits of blockchain technology, or the availability of alternative solutions that better suit their needs.

**4.3 Assessing the Applicability (Potential Use) of Blockchain Technology in Construction Project Management in Nigeria.**

**4.3.1 Relevance of Blockchain.**

Table 3: shows the relevance of blockchain technology in construction project management in Nigeria.

|  |  |  |
| --- | --- | --- |
|  | Frequency | Percentage/proportion |
| 5 | 14 | 28% |
| 4 | 19 | 38% |
| 3 | 13 | 26% |
| 2 | 3 | 6% |
| 1 | 1 | 2% |
| Total | 50 | 100% |
| Mean |  | 3.84 |

Table 3: *Source: Authors field work 2023*

The table shows the frequency and percentage distribution of codes representing a certain variable. The codes range from 1 to 5, with 5 being the highest level and 1 being the lowest level.
According to the table, the majority of the observations (38%) were coded as 4, while code 5 had a frequency of 14, representing 28% of the total. Code 3 had the third-highest frequency with 13 observations, representing 26% of the total. Code 2 had a frequency of 3, accounting for 6%, and code 1 had the lowest frequency with only one observation, representing 2% of the total.
The mean value of 3.84 indicates that, on average, the observations fall somewhere between codes 3 and 4. This suggests that the variable being measured is moderately high, but not the highest. The largest category is code 4, indicating that most of the observations fall into that category. The frequency of code 1 and 2 combined is relatively low, which implies that there are very few instances of low-level observations.

**4.3.2 Potential Benefits of Using Blockchain Technology in Construction Project Management in Nigeria.**

The first research objective aimed to identify the Applicability (potential benefits) of using blockchain technology in construction project management from the perspective of construction stakeholders in Nigeria via achieving the following factors that enhance the application of blockchain in construction PM.

Table 4: See below shows the frequency distribution of the benefits of blockchain technology in construction project management in Nigeria.

|  |  |  |  |
| --- | --- | --- | --- |
| Potential benefits | Frequency | Percentage/proportion | Ranking |
| 1. Enhanced transparency
 | 12 | 24% | 1 |
| 1. Efficiency in contract
 | 7 | 14%  | 2 |
| 1. Improved payment system
 | 6 | 12% | 3 |
| 1. Increase security
 | 7 | 14% | 2 |
| Total | 32 | 64% |  |

Table 4: *Source: Authors field work 2024*

Table 4 shows the frequency distribution table of the potential benefits that enhance the applicability of blockchain technology in construction project management in Nigeria.

The table shows four potential benefits of blockchain technology, namely enhanced transparency, efficiency in contract, improved payment system, and increased security. The number of respondents who identified each benefit is also provided in the table.
From the table, we can see that enhanced transparency is perceived as the most significant benefit of blockchain technology in construction project management by the respondents, with 12 respondents identifying it. This suggests that the use of blockchain technology can potentially increase transparency in construction project management processes and enhance accountability.
Efficiency in contract and increased security are also perceived as important benefits, with seven respondents each identifying them. This suggests that blockchain technology has the potential to streamline contract management processes, as well as enhance the security of project management data and transactions. Improved payment systems was identified as a potential benefit by six respondents, which suggests that blockchain technology can improve the efficiency and transparency of payment systems in the construction industry.

**4.4.3 Challenges That May Hinder the Applicability of Blockchain Technology in Construction Project Management in Nigeria.**

Table 4.6: The table below shows the frequency distribution of the challenges that may hinder the applicability of blockchain technology in construction project management in Nigeria.

|  |  |  |  |
| --- | --- | --- | --- |
| Challenges | Frequency | Percentage/proportion | Ranking |
| 1. Lack of awareness
 | 21 | 42% | 1 |
| 1. Complexity
 | 7 | 14% | 3 |
| 1. Regulatory and legal frameworks
 | 7 | 14% | 3 |
| 1. Resistance to change
 | 7 | 14% | 3 |
| 1. Electricity and power
 | 8 | 16% | 2 |
| Total | 50 | 100% |  |

*Source: Authors field work 2023*

The table above shows the frequency of challenges that may hinder the application of blockchain technology in construction project management in Nigeria.

The table shows five potential challenges of blockchain technology applicability, namely lack of awareness, complexity, regulatory and legal frameworks, resistance to change, and electricity and power challenges. The number of respondents who identified each challenge is also provided in the table.

From the table, we can see that lack of awareness is perceived as the most significant challenge that may hinder the applicability of blockchain technology in construction project management in Nigeria, with 21 respondents identifying it. This suggests that there is a need for increased education and awareness about blockchain technology in the construction industry in Nigeria. Electricity and power challenges are also perceived as significant challenges, with 8 respondents identifying them. This suggests that power outages and other electricity-related challenges in Nigeria may hinder the applicability and implementation of blockchain technology in the construction industry. Regulatory and legal frameworks, complexity, and resistance to changes are also identified as potential challenges, with 6-7 respondents each identifying them. This suggests that there is a need for clear and favorable regulatory and legal frameworks to support blockchain technology applicability, as well as simplified processes and a change management strategy that address the resistance to change among stakeholders.

**4.4.4 Critical Success Factors for Implementing Blockchain Technology in Construction Project Management in Nigeria.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Success factors** | **Frequency** | **Percentage/proportion** | **Ranking** |
| 1. Technical expertise
 | 17 | 34% | 1 |
| 1. Stakeholders Involvement
 | 9 | 18% | 2 |
| 1. Regulatory and legal frameworks
 | 7 | 14% | 3 |
| 1. Security and privacy
 | 5 | 10% | 5 |
| 1. Renewable energy sources
 | 6 | 12% | 4 |
| Total | 44 | 88% |  |

Table 4.7: Critical success factors for implementing blockchain technology in construction project management

*Source: Authors field work 2023*

Based on the responses from the survey, the critical success factors for implementing blockchain technology in construction project management in Nigeria are technical expertise, stakeholder involvement, regulatory and legal frameworks, security and privacy, and renewable energy sources. Technical expertise was the most frequently mentioned factor, indicating the importance of having knowledgeable professionals who can design and implement blockchain solutions.
Stakeholders’ involvement is also crucial for successful application of blockchain technology in construction project management, as it ensures buy-in and collaboration from all parties involved. Regulatory and legal frameworks need to be established to ensure compliance with relevant laws and regulations. Security and privacy concerns are also paramount, as blockchain technology relies on the integrity and confidentiality of data. Finally, renewable energy sources were identified as a factor, likely due to Nigeria's focus on sustainable development and energy independence. Overall, the most critical success factors are technical expertise, stakeholder involvement, and regulatory and legal frameworks.

**4.4.5: Construction Stakeholders Willingness to Adopt Blockchain Technology in Construction Project Management in Nigeria.**

Table 4.8: below shows the data distribution of the adoption of blockchain technology in construction project management in Nigeria.

|  |  |  |
| --- | --- | --- |
| Code | Frequency | Percentage/proportion |
| 5 | 21 | 42% |
| 4 | 20 | 40% |
| 3 | 9 | 18% |
| 2 | 0 | 0 |
| 1 | 0 | 0 |
| Total | 50 | 100% |
| Mean |  | 4.24 |

 *Source: Authors field work 2023*

Based on the data in the table above, it appears that there is a relatively high level of willingness to adopt blockchain technology in construction project management in Nigeria. The majority of respondents (42%) reported being "very willing" to adopt this technology, while an additional 40% reported being "willing". Only a small proportion of respondents (18%) reported feeling "neutral" towards the adoption of blockchain technology in construction project management, and there were no respondents who reported being "unwilling" or "very unwilling."

**4.5 Results and Discussion**

Conclusively, the demographic information collected from the sample of construction project management stakeholders in Nigeria provide a valuable foundation for understanding the attitudes and perceptions towards the applicability and adoption of blockchain technology in the industry. By taking into account factors such as experience, role, and knowledge and awareness of blockchain, we can begin to develop targeted strategies for promoting the adoption of blockchain technology in construction project management in Nigeria. The interpretations of the frequency distribution tables revealed important insights into the potential use of blockchain technology in construction project management in Nigeria. The table on the potential benefits showed that the respondents believed that enhanced transparency was the most significant benefit of using blockchain technology, with 12 out of 50 respondents (24%) indicating this. Efficiency in contract management, increased security, and improved payment systems were also seen as essential benefits, with 14 out of 50 respondents (28%) identifying them.

On the other hand, the table on the challenges that may hinder the adoption of blockchain technology revealed that lack of awareness was the most significant challenge, with 21 out of 50 respondents (42%) identifying it. This was followed by electricity and power challenges, regulatory and legal frameworks, resistance to change, and complexity. These results are consistent with previous studies that have identified lack of awareness, regulatory and legal frameworks, and resistance to change as critical barriers to blockchain technology adoption in other industries.
In terms of critical success factors for implementing blockchain technology in construction project management, the results showed that technical expertise was the most crucial factor, with 17 out of 50 respondents (34%) identifying it. Stakeholder involvement and regulatory and legal frameworks were also identified as critical success factors, with 9 out of 50 respondents (18%) and 7 out of 50 respondents (14%), respectively.

The results on willingness and likeliness to adopt blockchain technology in construction project management in Nigeria indicated that the majority of respondents were either very willing (42%) or willing (40%) to adopt this technology. This indicates that there is a positive perception of blockchain technology among construction project management stakeholders in Nigeria, which is consistent with previous studies that have shown a positive attitude towards blockchain technology adoption in other industries.

Overall, the findings from this research project indicated that blockchain technology applicability in construction project management has the potential to improve construction project management in Nigeria by enhancing transparency, efficiency, security, and payment systems. However, the application of this technology may face significant challenges such as lack of awareness, regulatory and legal frameworks, and resistance to change. Therefore, critical success factors such as technical expertise, stakeholders’ involvement, and regulatory and legal frameworks need to be considered to ensure the successful applicability of blockchain technology in construction project management in Nigeria.

**4.6 Conclusion**

In conclusion, the applicability concept of blockchain technology in construction project management has gained significant attention in recent years. From the literature reviewed and surveyed data, it is evident that the potential benefits of blockchain technology in the construction industry include enhanced transparency, efficiency in contracts, improved payment systems, and increased security. However, the adoption of blockchain technology also faces several challenges, including a lack of awareness, regulatory and legal frameworks, complexity, and resistance to change.
To successfully implement blockchain technology in construction project management, critical success factors such as technical expertise, stakeholder involvement, regulatory and legal frameworks, security, privacy, and renewable energy sources are crucial. The survey data also revealed that the majority of respondents were willing or very willing to adopt blockchain technology, and stakeholders were likely to recommend its usage in construction project management.

Overall, the implementation of blockchain technology in construction project management has the potential to revolutionize the construction industry and mitigate some of the challenges it faces. However, it is essential to consider the critical success factors and address the challenges to ensure successful application and implementation of the technology.

**Recommendations**

1. Increase awareness of blockchain technology in the Construction Project Management Sectors through training, workshops, and seminars. This will help stakeholders understand the potential benefits of blockchain technology and its application in project management.
2. Develop regulatory and legal frameworks that will support the applicability and implementation of blockchain technology in construction projects. This will help to address concerns around security, privacy, and liability.
3. Encourage stakeholder involvement and collaboration in the adoption and implementation of blockchain technology in construction project management. This will help to ensure that the technology is tailored to the needs of the industry and stakeholders are committed to its success.
4. Provision of steady electricity by Nigeria government, group and individuals

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