Status and extent of adoption of Blockchain technology in the delivery of construction projects [1]

Benedict Amade[2], Victor Odinakachukwu Agbara[3], Emmanuel Efe Uwaifo[4], Godson Okereke[5] and Ugochukwu Chinedu Udeozor[6]

Abstract

This study specifically set to identify the status and extent of utilization of Blockchain technology in the delivery of construction projects in Imo State, Nigeria. The study was guided by the technology acceptance model (TAM) theory. The study used a descriptive research design method of investigation, and a simple random sampling technique was used to select a sample size of 123 from a population of 194 practitioners using the Krejcie and Morgan's method of sample size determination. The data collection and survey instrument included a well-structured questionnaire, discussions, personal observations and visits to elicit information from respondents/construction project locations. The collected data was presented in the form of frequency distribution, figures, and charts using descriptive statistical tools using IBM SPSS Statistics version 25.0. The study's findings indicate a general low level of utilization/application of Blockchain technology in the delivery of construction projects in Imo state. This is due to the fact that none (0.00%) of the respondents have heard of Blockchain technology as applicable to construction projects-related activities, 9 (10.47%) have used Blockchain technology sparingly, 35 (40.70%) have never heard of Blockchain technology and 42 (48.84%) have heard of Blockchain technology, but never applied it on any construction project-related activity out of the eighty-six (86) responses used for the study. This study recommends that, a united front is needed to make Blockchain technology awareness-raising and encourage practitioners to embrace it. Blockchain can provide a dependable infrastructure for information management throughout all stages of the construction project life cycle as well as secure storage of sensitive sensor data.

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1.Introduction

Technical advancements have occurred at an almost unfathomable rate in recent years. Artificial intelligence, robotics, cloud computing, and the internet of things are just a few examples of how technology is changing our way of life and how we work (Agbara, 2024). The prospective changes in the commercial and social economy are not yet fully understood, but one thing appears certain: those who can use these technological developments on their company model can adapt fast, gain market competitive advantages, and give better service to clients and users.

Another of these groundbreaking technologies is Blockchain technology. Several advisors have identified its potential to transform sectors, business models, and operational processes like as payment settlement, accounting, administration, supply chain, customer interactions, funding, and so on. Blockchain is a sort of distributed ledger technology (DLT) that was publicly introduced as the underlying technology of Bitcoin about ten years ago. Blockchain is an information technology that is designed to adapt to structural issues. It can provide a comprehensive platform where project design and management take place in a Blockchain-backed building information model, integrated with a self-enforcing smart contract supplied by vendors chosen by a Blockchain network and managed by a Blockchain network on a larger scale of circular economy. This technology has the potential to bridge the trust gap between stakeholders (Mathews et al., 2017), automate many currently manual processes, provide a secure and reliable infrastructure for collaboration and information exchange, increase transparency, and provide a reliable chronological record keeping.

A public Blockchain is open to anybody, and data may be read or written by any user, whereas a private system is only accessible to a chosen few. A hybrid Blockchain, also known as a consortium Blockchain, enables exchange between various Blockchain networks. The source of Blockchain's power is the lack of administrative power and the power of the crowd over data validity.

Because of the way Blockchain works, it eliminates the requirement for trust between parties as well as the need for adversarial contractual agreements owing to a lack of confidence. This study looks into three areas of Blockchain technology's potential in the built environment sector. Payment and project management, procurement and supply chain management, building information modelling, and smart asset management are the four categories. Lastly, the difficulties associated with adopting Blockchain technology in construction projects are highlighted.

The potential application of Blockchain can reduce the issues we have in construction projects, which can be divided into three major elements. Payment and project management challenges; A construction project involves a web of hundreds of procedures, participants, products, and materials. Money transactions and/or data exchange are commonly carried out in tandem with

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project progress. During the construction process, there are several disagreements and lawsuits. Although payment terms and data confidentiality are established in a contract or agreement, disagreements over the agreed-upon standards frequently arise (Agbara, 2024; Taylor, 2017). Aside from being incredibly productive, one of the main benefits of such a platform is the high level of openness for all parties involved. A higher level of trust is believed to improve project performance while managing project interactions, particularly in a cross-disciplinary environment. With such a system and smart contracts, it is possible to ensure that all actions are carried out in accordance with the terms agreed upon. Many parts of a building project might benefit from increased transparency and better collaboration. In this section, we will look at how Blockchain can help to alleviate payment problems and improve project management efficiency.

The degree to which shared information can be trusted and used to meet the needs of the supply chain is referred to as information quality. It can be measured in terms of precision, frequency, credibility, and accessibility. At its heart is a computer model that contains a wealth of asset information such as 3D geometry, construction management data such as time schedules and budgets, and operation and maintenance indicators. Smart contracts can account for real-time project implications; such as change orders or schedule revisions. They can also be partially or completely self-executing and self-enforcing, expediting payment and claim procedures and allowing for simple contract verification and management.

The aim of this study is to evaluate the status and extent of adoption of Blockchain technology in the delivery of construction projects in Imo State.

2.Literature Review

2.1.1 Historical Development of Blockchain

The technology debuted alongside the popular cryptocurrency Bitcoin. Satoshi Nakamoto, an anonymous author, presented a paper titled "Bitcoin: A Peer-to-Peer Electronic Currency System" in 2008. Because the author wished to remain unknown, this article was released under the author identity Satoshi Nakamoto.

The goal is for the majority of system members to validate the content of each block. After a block has been inserted and verified, it cannot be deleted or changed (Wang et al., 2017). Each block could well be defined as a chunk of encrypted data. Anybody within the system can, in theory, add data to the chain of blocks and review the data at any moment, but no one can change the data without proper authority (Abeyratne et al., 2016). As a result, each "block" generates a complete and immutable history of the network's operations, which is shared with all system participants. As a block is authenticated, it is added to a chronological chain of other blocks, hence the name Blockchain. As a result, the Blockchain is a chain that holds verifiable records of every single transaction, document, and so on that has ever occurred in the system.

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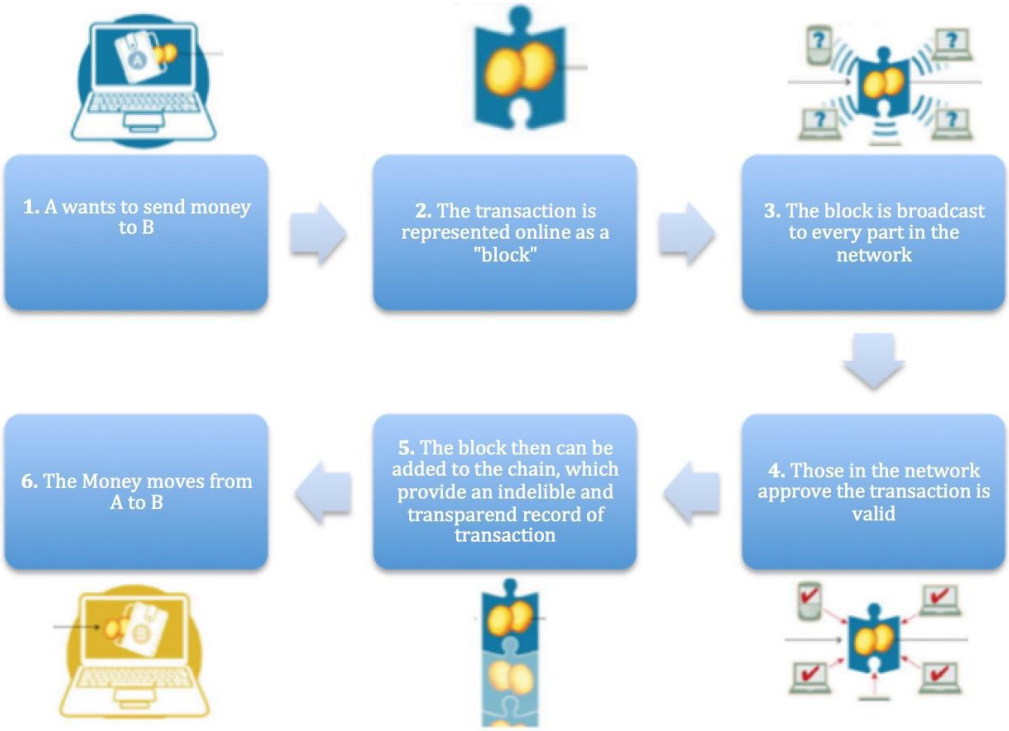

Figure 1: Example of how Blockchain technology works with money transaction (Crosby et al., 2016).

Blockchain technology is a game-changing tool for recording transactions and connecting them to build a "chain" known as a distributed ledger. Businesses are utilising blockchain to seize control of supply chains and contracts in ways that were not feasible even five years ago—but is widespread use of blockchain in construction realistic?

Even very huge building projects will become easier to handle as more construction businesses utilise Blockchain (Agbara, 2024). Continue reading to understand further about Blockchain and the improvements it proposes for the construction sector or visit our animated infographic for a visual breakdown.

It is analogous to a literal chain, with each link representing a separate transaction in a project. If one provider completes a delivery and satisfies their contract, the completed contract is finalized and added as a new "block," or link in the chain. This provides block chains a natural order that is easy to follow while looking for information.

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The three Blockchain concepts characterize it as secure, decentralized, and scalable to any size project and they include the underlisted (Agbara, 2024).

i. **Safeguard:** Multilayer encryption employs mathematical functions to conceal data in a difficult-to-crack coded string of characters.

ii. **Decentralization:** Transactions are automatically checked by connections known as "nodes," resulting in a digital paper trail of validated records.

iii. **Scalability:** Because the information isn't centralised, Blockchain can be scaled to accommodate very huge projects.

Because Blockchain projects are distributed, they eliminate the normal hierarchy of information in a project, making them secure, decentralised, and scalable. This increases project transparency by decreasing the need for back-and-forth discussion about simple goals. As a result, Blockchain technology can be used to improve the efficiency of any project.

2.2 Areas of Application and Opportunities of Blockchain Technology in Construction Projects.

Blockchain technology has already been used successfully in many different industries. But in this work, we tried to look at how Blockchain can be used for construction project-related activities.

2.2.1 Real Estate Applications

Real estate transactions are complicated, opaque, and costly because numerous parties are involved, including brokers, government property databases, title companies, escrow companies, inspectors, appraisers, and notaries public (Baiod, Light & Mahanti, 2021). According to the FBI, scammers are increasingly targeting real estate transactions. In 2017, for example, 9,645 victims of real estate fraud were reported. Blockchain in real estate provides efficient and dependable workflows, increasing transparency and visibility at all stages and, ultimately, providing safer investments for everyone. However, these scams represent only a small portion of the transactions that blockchain can affect and strengthen. Aside from addressing fraud, distributed ledger smart contracts simplify transaction processes, eliminate unnecessary intermediaries, lower costs for main parties, and speed up deal closing.

Furthermore, each property can have a corresponding digital address that contains occupancy, finance, legal, building performance, and physical attributes and transmits and maintains all historical transactions in perpetuity. The real estate industry is poised to use blockchain to solve current issues and change the way transactions are completed. These changes are already taking place in the real estate industry. In the Netherlands, for example, the Municipality of Rotterdam is

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collaborating with Deloitte to develop the first Blockchain application in real estate to document rental contracts.
Their projects include: (1) digitizing building data; (2) digitizing the ownership situation; (3) transferring ownership; (4) contract closure; and (5) unlocking contract information for third parties. A blockchain-based real estate transaction platform has been proposed. The platform, which aims to realize the real estate transaction information release and transaction, makes use of the Hyper Ledger Fabric platform to effectively connect purchasers, sellers, financial institutions, and government departments. It can also look up past transactions.

Baiod et al. (2021) provided valuable information on 17 blockchain companies that are revolutionizing the real estate industry. Propy17, for example, is a global real estate marketplace that uses smart contracts to facilitate international real estate transactions.

2.2.2. Building Management System

Preventive and planned maintenance are critical during the operational phase of a building for both safety and occupant satisfaction (Perera et al., 2020). A Blockchain-enabled automated system can aid in the monitoring of building maintenance procedures. Smart contracts allow for the easy and accurate management of maintenance requests, procurement processes, product delivery, payments, and other similar tasks. Because of the transparency provided by blockchain, the occupant and all other parties are aware of the status of the maintenance request from start to finish. It allows maintenance managers to determine who supplied and installed which building components and at what cost at any given time.

2.2.3. Combining Blockchain with Internet of Things (IoT) Devices

IoT, which includes RFID (Radio-Frequency Identification), GPS (Global Positioning System), GIS (Geographic Information System), and WSN (Wireless Sensor Network), is an intelligent, dependable, and high-speed information network that connects objects (Duan, Zhang, Gong, Brown, and Li, 2020). Instead of manual recording, IoT sensors can automatically capture information such as temperature and humidity. This ability to capture real-time information is especially important for frozen and fresh food products, as quality is closely related to the external environment]. IoT automation can improve the efficiency of monitoring and data collection while reducing manual errors. However, there are some issues with IoT deployments, such as data confidentiality, vulnerability, data integrity, and stakeholder privacy. As a result, when using IoT devices in supply chains, which can be developed by combining with the Blockchain protocol, protection and security are critical.

Many studies have combined blockchain technology and IoT, claiming that blockchain can help manage IoT and improve supply chain efficiency. Six propositions on the combination of

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blockchain and IoT can improve the scalability, security, auditing, efficiency, interoperability, and quality of IoT solutions.

The Internet of Things (IoT) is an opportunity to build an intelligent environment enabled by the integration of the physical and network worlds, which emerged as a result of modern civilization's steady progress in science and technology (Zhou, 2023). The Industrial Internet is a subset of the Internet of Things that focuses on the interaction and transfer of information between devices and people. It has very broad development and application prospects. With the rapid rise of a new round of scientific and technological innovation revolutions around the world, it not only promotes the long-term development of the manufacturing industry, but its transformation to digitalization and intelligence has also been elevated to a national strategic level. There has been a lot of talk about using Blockchain technology to solve information asymmetry problems in the instrument leasing platform. Combining blockchain technology in the leasing platform enables lessor and lessee nodes to build a decentralised Blockchain network and install a smart contract in it to complete the leasing process, allowing transaction information generated during leasing and data generated when the instrument is used to be uploaded to the blockchain and a consensus to form a block record in the network to be reached. The Internet of Things can provide accurate and timely data collection (Wu, Lu, Xue, Li, Zhao & Tang, 2022). Many core components of the IoT, such as RFID (Radio Frequency Identification) tags, NFC (Near Field Communication) tags, and GPS sensors, have been proposed by practitioners and scholars to help realise its concept. Furthermore, researchers have proposed smart construction objects (SCOs), an IoT model with sensing, processing, and communication capabilities to facilitate information exchange among construction resources.

2.2.4. Intelligent Contracts

In a nutshell, smart contracts are made up of if/then commands that eliminate the need for intermediaries, reduce the amount of physical paperwork, and can help to reduce potential attacks and fraud, arbitration, and enforcement costs (Li et al., 2019). Smart contracts are "contracts that are fully executable without human intervention" (McNamara & Sepasgozar, 2020) or "self-enforcing, monitoring external inputs from trusted sources to settle according to the contract's stipulations."

The implementation of blockchain necessitates the creation of smart contracts, which are regarded as the primary software artefact of most Blockchain technology-based solutions (Jurgelaitis, Ceponiene, Butkus, Burkina & Drungilas, 2023). Smart contracts are programs that run on a specific blockchain platform network. They can be used to cover parts or all of a business process by implementing software components that are hosted on a peer-to-peer network and allow data sharing among network participants through the use of a public blockchain ledger.

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Smart contracts are programs that are stored on a blockchain and are only activated when certain criteria are met (John William, Rajendran, Pranam, Berry, Sreedharan, Gul & Paul, 2023). They are frequently used to automate the implementation of an agreement in order to allow all parties to ensure an immediate conclusion without the need for an intermediary or additional delay. They can also automate a workflow by triggering subsequent actions when certain criteria are met. A network of computers performs the required activities when the predefined conditions are met and validated.

Blockchain also empowers resources by embedding autonomous agents in provenance records, quality control, and transactions via virtual smart contracts. Smart contracts are computer programs that can be customized to regulate ledger writing laws. Smart contracts are executable programs that can be executed automatically if a predetermined condition is met, such as the parties to a transaction honoring their agreement. Along with the contract terms, legal restrictions and agreement conditions are encoded in computer language. Smart contracts are self-enforcing and tamper-proof, which results in significant benefits such as the elimination of middlemen and the reduction of transaction, contracting, enforcement, and compliance costs. Low-value transactions may be more cost-effective, and blockchain may facilitate transaction system interoperability (Ahmad Termizi, Wan Alwi, Manan & Varbanov, 2023).

Smart contracts are one of the most important aspects of Blockchain for construction. Smart contracts are self-executing pieces of code that execute contract terms when pre-defined obligations are met (Li et al., 2019). Because some elements may still require human input and control, smart contracts can also be thought of as automatable traditional contracts. According to the Winfield-Rock Report, blockchain combined with smart contracts can solve some of the problems associated with BIM adoption, such as increasing trust and collaboration, because the availability of a real-time, change-resistant, and hack-resistant record of data with trustworthy time entries improves the data's reliability, integrity, and transparency. The report also notes that many issues remain to be addressed, such as untested legal issues and the ongoing need for clear and express contract terms, as well as mitigating measures that reduce the risk that parties enter into unintended obligations and disputes.

Smart contract technology may provide a more dependable way to track contracts via a decentralised network (Mohammed, Almousa, Ghaithan & Hadidi, 2021). The goal is to create a self-executing electronic digital agreement between two or more parties. The smart contract could be a technique for forming and monitoring construction contracts. A smart contract must be triggered in order to achieve the desired result. Smart contracts, on the other hand, must interact with real-world objects and building components if they are to be used in construction projects. Here is where Blockchain oracles could help overcome the barrier of engaging with the non-digital world.

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2.3. Theoretical Foundation

2.3.1 Technology Acceptance Model (TAM)

Davis created this model, which is based on the TRA framework, to address the ambiguous status of psychometric and theoretical in TRA by removing subjective norms (Taherdoost, 2022). The TAM framework, one of the most widely used adoption frameworks, places a strong emphasis on perceived usefulness and ease of use. Although attitude towards technology use is an important consideration when using the TAM framework (Figure 2), TAM also considers the impact of two important beliefs (perceived usability and perceived ease of use) on users' attitudes, which are measured as favorability and unfavorability towards the system.

In order to use independent variables (causal influences) to explain technology acceptance (behavioral intention or actual use), the prediction must be accurate, as inaccurate predictions may result in questionable decision-making and a failed technology integration process (Nnaji et al., 2023).

The TAM model has recently been used in studies to assess how well blockchain-based technologies are accepted (Amade et al., 2022; Taherdoost, 2022; Saputra & Darma, 2022; Wang, Liu, Liu & Huang, 2022). It implies that the TAM model accurately predicts the adoption of new technologies.

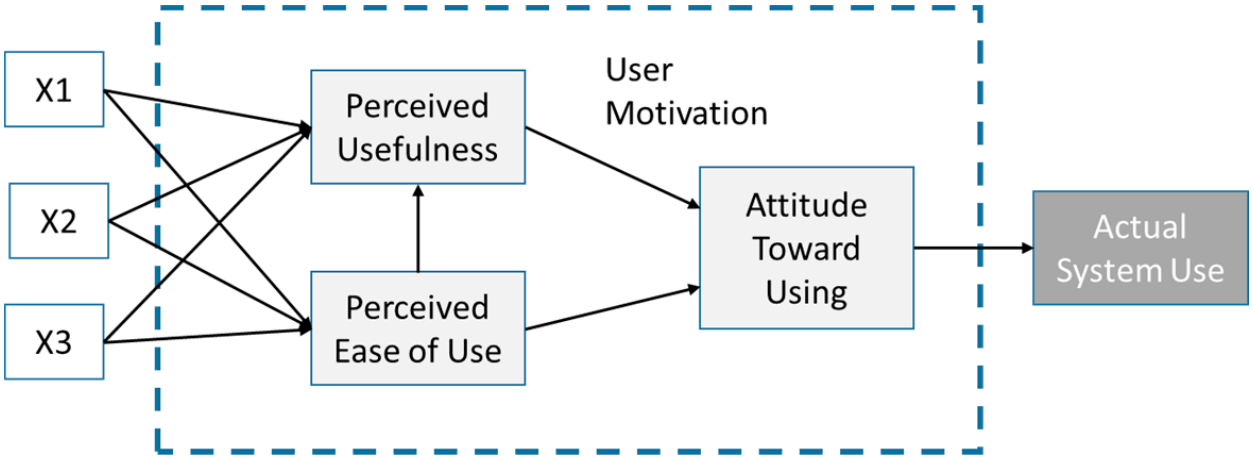

Figure 2. Original TAM.

In this model, the influence of perceived ease of use and perceived usefulness on the attitude and BI are direct and indirect, respectively, and the perceived ease of use impacts the perceived usefulness directly.

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Despite the fact that numerous research models have been developed and various factors have been tested in the field of information technology, various authors agree that the TAM is the most popular research model (Mondego & Gide, 2022). TAM can forecast information technology use and factors influencing acceptance, according to the explanation. The research combines TAM constructs with additional factors that pose challenges for blockchain, such as trust, social influence, user interface, government regulation, and security.

As a result, predictive and explanatory technology acceptance models enable researchers and professionals to generate reliable and relevant contextual data on potential technology acceptance (Nnaji et al., 2023). As illustrated in Figure 2, this model also considers external factors such as system characteristics, user training, user participation in design, and so on.

This theory is key to this study in the sense that its attempt to explain the impact of adopting Blockchain technology, on its perceived use and favorability for adoption and application on construction project delivery.

3.Methodology

The research method consists of both the quantitative, qualitative and exploratory type used in this study. In order to determine the opinions, attitudes, and perceptions of interest in this research, questionnaires with the aid of focused group interviews were typically used. This study will have an exploratory study approach. The main idea of an exploratory study in particular is to find out what is happening; to seek new insights; to ask questions and to assess phenomena in a new light (Hultgren & Pajala, 2018). In this study, this will be particularly useful since we are striving to clarify the understanding of a problem even if it is difficult to specify the problem (Hultgren & Pajala, 2018; Saunders et al., 2009). According to Saunders et al. (2009), there are three different ways to carry out an exploratory research, namely viz; a search of the literature, interviewing "experts" in the subject and conducting focus group interviews.

The study was carried out in Imo state where there are numerous ongoing infrastructure construction projects with a main emphasis on construction projects and practitioners applying emerging technologies such as Blockchain technology in the delivery of their projects. The essence of deploying this approach is to enable the researcher to get ample information that would aid in arriving at the desired objectives of the study. The practitioners consulted in the course of conducting this study were those who are information technology (IT) savvy and complaint. The professionals include project managers, consultants, contractors, engineers (structural, civil and service engineers), architects, builders, quantity surveyors and other construction practitioners.

This consists of all the elements or group of persons that possess the requisite knowledge needed for the purpose of achieving the study's objectives (Kothari, 2004). The targeted population which would constitute the unit of analysis for the study will comprise of selected professionals and registered construction project management stakeholders in Imo state. The details of the

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professionals were gotten from the database of their professional bodies. They include project managers, consultants, contractors, engineers (structural, civil and service engineers), architects, builders, quantity surveyors and other construction practitioners who are principally involved in the business of managing construction project using Blockchain technology and related technologies. The table below describes the details of professionals (targeted population) for study.

Table 1: Study Population

S/N	Targeted Professionals	Population Size
1	Engineers	63
2	Project Managers	32
3	Consultants	23
4	Quantity Surveyors	28
5	Architects	12
6	Builders	25
7	Others	11
	Total	194

Source: Field Survey, 2023

There are a myriad of professions playing an active role in the construction industry namely: Engineering (civil, structural, mechanical and electrical), Quantity surveying, Project management Architects, Builders; all the aforementioned constitute the Design team. Whereas the project promoters/Clients and Consultants are the other key players. Other than the above-mentioned we also have subcontractors and material suppliers. The sampling frame refers to the source of the population. It is a means of representing the elements of the population (Gwaya, 2015; Mugenda & Mugenda, 2004). The sampling unit is the basic unit containing the elements of the population to be sampled. It may be the unit itself or the unit in which the element is contained. This study covers the clients, design team and consultants as the sampling frame. Due to the difficulty of establishing the number of individual clients; they were surveyed subjectively through ongoing projects for this study. The questionnaires for the design teams were designed for the most technical person in the clients' organizations.

These are the processes or tactics utilized by the researcher to choose sample representatives from the designed demographic information. There are two sorts of sampling procedures: probability sampling techniques and non-probability sampling techniques (Egwi, 2022). In order to fulfil the goal or purpose of this research, the researcher chose respondents using a probability sampling approach known as the simple random sample technique. In addition to "pure random sampling," the method of chance was utilized to choose responders from the sample frame. This provides all respondents with the same opportunity to pick. As a result, the basic random selection technique is acceptable for achieving the necessary generalizability of the study's conclusions.

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The sample size was determined using the Krejcie and Morgan Method of sample size determination. The sample size using the Krejcie and Morgan Method (Krejcie & Morgan 1970) is 123. The method used to collect the data consists of research instruments. In other words, the study used information from a primary source. The primary data came from site surveys at project locations. Thereafter, the instrument was used to design and collect well-structured questions for purposes of collecting primary data. To accomplish the objectives of the study, a number of questions were included in the questionnaire. This includes all of the various aspects that have to do with the issue in context. Subject-matter specialists in the construction industry who are IT savvy and conversant with Blockchain Technology as it relates to the construction projects and the industry were contacted.

3.1 Instruments for Data Collection

The questionnaire facilitated the possible collection of required information. The first section of the questionnaire's questions would be from demographic information, with close-ended questions and responses expected from the respondents.

3.2 Method of Data Analysis

The data collected via the administered questionnaires was checked for accuracy and relevance before being coded and entered into an IBM SPSS Statistics version 25.0. In order to reach a more dependable and reliable conclusion, the demographic results were presented using tables, charts and figures.

3.3 Results

3.4. Analysis of Questionnaire

The study population consists of 194 personnel from construction firms selected around Imo State, Nigeria. Questionnaires were self-administered to the professionals in the construction firms. The number of questionnaires distributed based on the sample size as determined by the Krejcie and Morgan's method of sample size determination which was 123 and those retrieved as well as those found useable for the analysis and projects involved by the professionals are shown in table 2.

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Table 2 Response from Questionnaire

S/N	Targeted Professionals	Population Size	Sample Size	Sample Returned	Number Used	Projects Involved in
1	Engineers	63	34	23	21	Road construction Owerri – Orlu road
2	Project Managers	32	21	18	17	-
3	Consultants	23	15	12	12	-
4	Quantity Surveyors	28	16	11	9	Construction of Hotel building at Hospital Junction, world bank.
5	Architects	12	10	7	7	-
6	Builders	25	19	15	13	Flood Control projects at FHA Estate Egbeada Imo State.
7	Others	11	8	7	7	-
	Total	194	123	93	86	

3.5. Demographic Characteristics of Respondents

In the first section of the questionnaire the respondent's characteristics as regards their discipline, years of experience, qualifications, sector of operation etc are presented.

3.5.1. Discipline of Respondents

Table 3 shows the discipline of all the respondents who participated in the study. Of note, 21 (24.42%) are engineers, while 17 (19.77%) are project managers. Other professionals have also contributed (12) and (9) like consultants and quantity surveyors. Also, the highest response rate was from engineers (21 responses), while the least is by procurement officers and land surveyors with a response rate of 2 and 2 respectively.

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Table 3. Discipline of Respondents

Targeted Professionals	Frequency	Percentage
Engineers	21	24.42
Project Managers	17	19.77
Consultants	12	13.95
Quantity Surveyors	9	10.47
Architects	7	8.14
Builders	13	15.12
Estate Surveyors	3	3.49
Land Surveyors	2	2.33
Procurement Officers	2	2.33
Total	**86**	**100.00**

3.5.2. Years of Experience of Respondents

Figure 4.1 shows the years of experience of all the respondents who participated in the study. Of note, 18 (20.93%) have spent 20 years and above in the industry, while 19 (22.09%) have spent between 6 to 10 years. Others have also spent between 16 to 20 years 13 (15.12%). Also, the highest response rate was from 11 to 15 years 21 responses (24.42%), while the next to the least is between 1 to 5 years with a response rate of 15 and (17.44%).

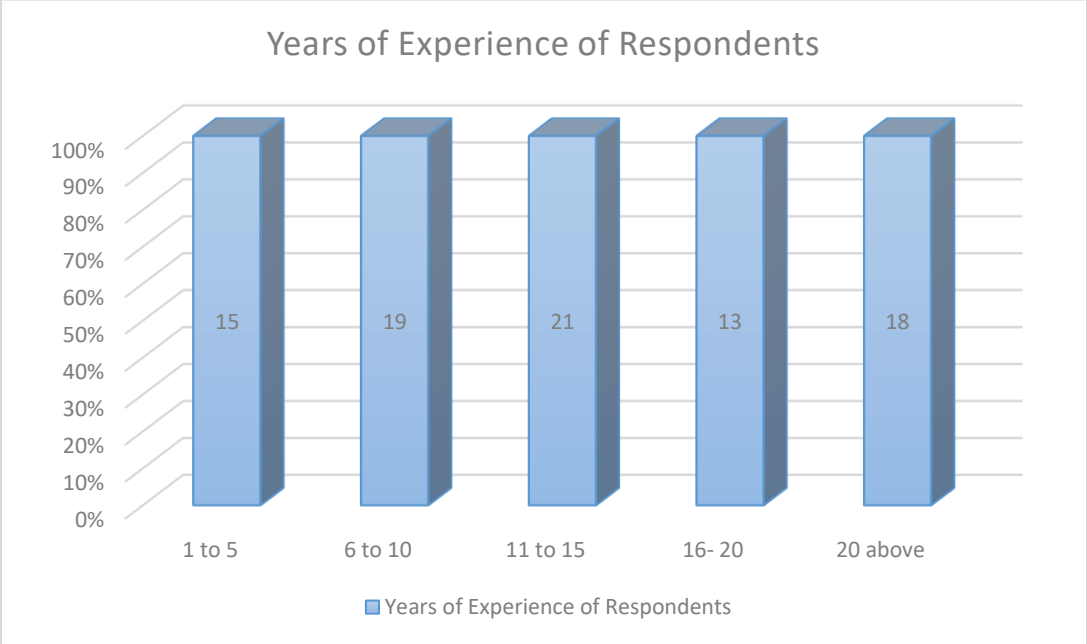

Figure 3. Years of Experience of Respondents

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3.5.3. Qualifications of Respondents

Table 4 shows the qualifications of all the respondents who participated in the study. The highest response rate was from B.Eng/B.Tech/B.Sc/HND holders with 45 responses (52.33%), while the next to the least is PhD holders with a response rate of 4 and (4.65%). While those with M.Eng/M.Sc/MBA had a response rate of 37 (43.02%).

Table 4. Qualifications of Respondents

Qualifications	Frequency	Percentage
B. Eng/B.Tech/B.Sc/HND	45	52.33
M. Eng/ M.Sc./MBA	37	43.02
PhD	4	4.65
Total	**86**	**100**

3.5.4. Sector of Operation of Respondents

Figure 4 shows the response percentage related to personal information. The result obtained showed that (24.42%) 21of participants in this survey worked in the public sector while, 54 (62.79%) worked in private, while 11 (12.79%) worked in both Private and Public Sectors.

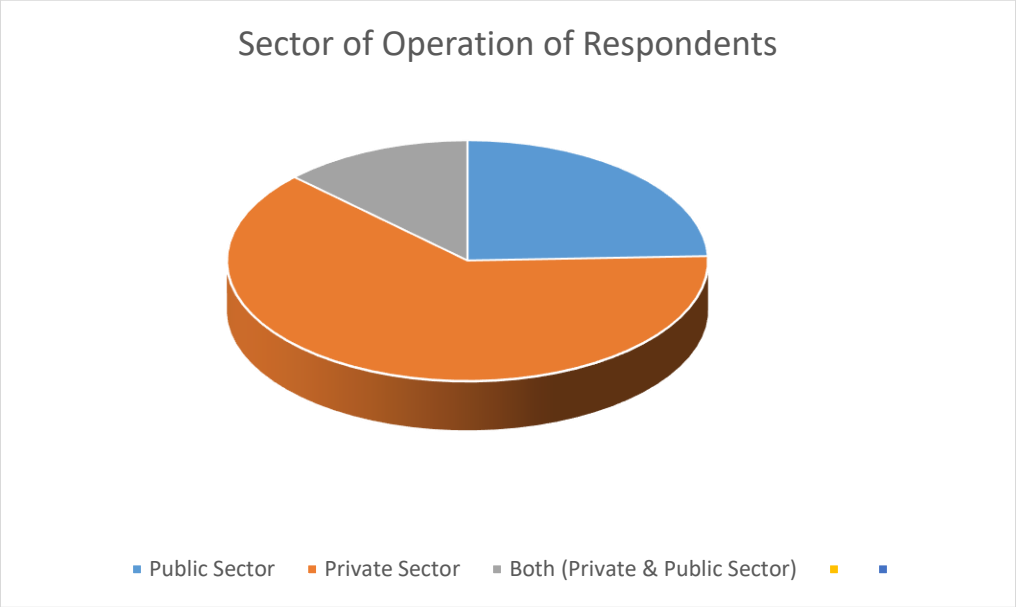

Figure 4. Sector of Operation of Respondents

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3.5.5. Status and Extent of Utilization of Blockchain Technology

In a bid to achieve the research's objective, respondents were provided with the following set of questions. The status and extent of utilization of Blockchain technology on construction projects is depicted in figure 5 and the results show that 42 (48.84%) of the respondents have heard of Blockchain Technology but it has never been used on construction projects. In contrast, 35 (40. 70%) of the respondents have never heard of Blockchain Technology, while 9 (10.47%) had only used it sparingly, such as in electronic and procurement related functions. While none of the respondents (0.00%) had used/applied Blockchain Technology on their construction projects.

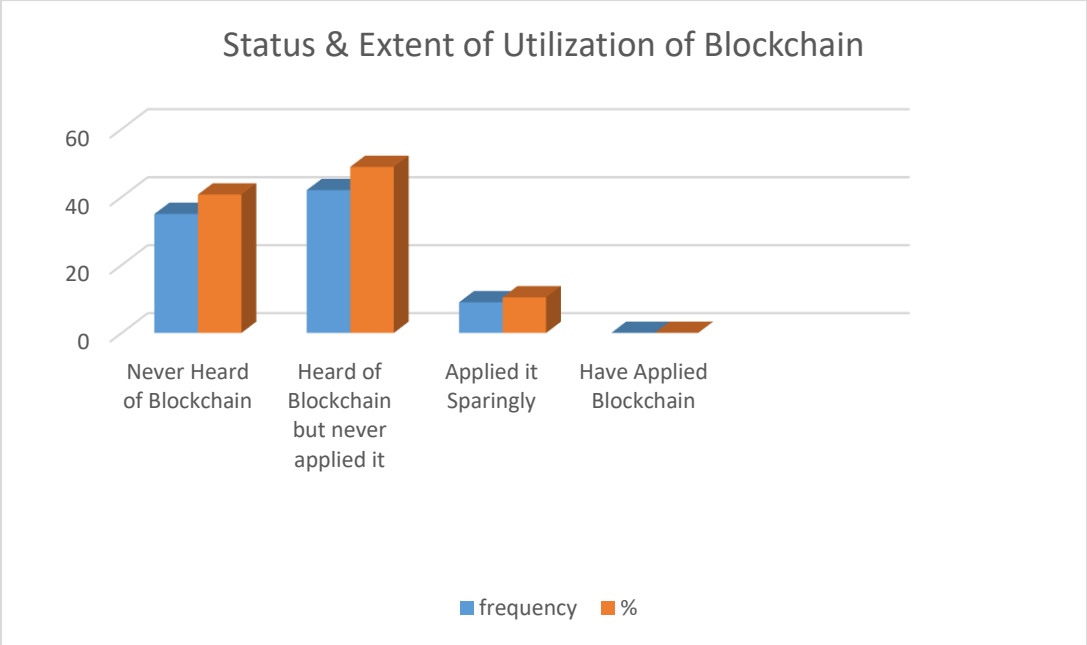

Figure 5. Status and Extent of Utilization of Blockchain Technology

4. Results Discussion

The findings from the study depicts that, out of the eighty-six (86) responses on the status and extent of utilization of Blockchain Technology, 42 (48.84%) of the respondents opined that they have heard of Blockchain Technology but it has never been used on their construction projects. In contrast, 35 (40.70%) of the respondents have never heard of Blockchain Technology, while 9 (10.47%) have only used it sparingly, such as in electronic and procurement related functions.

While none of the respondents (0.00%) has used/applied Blockchain Technology on their construction projects. However, this could be an indication that awareness of Blockchain

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technology in Nigeria has not been encouraging. A cursory look at some of the studies conducted on Blockchain with regards to construction related projects indicates that a handful of them were conducted in advanced climes with little or virtually none in developing countries and Nigeria in particular. Some of the researchers who did similar studies with regards to Blockchain technology include that of the two authors (Agbara, 2024; Oye-Bamgbose, 2019; Amade et al., 2022).

Successful Blockchain adoption and implementation on construction projects in Nigeria and Imo state in particular is expected to improve the industry's current situation, prospects, and achievement. It is vital to determine and assess critical Blockchain barriers at the organisational level in order to increase Blockchain adoption in Nigeria.

5. Conclusion and Recommendations

The study specifically identified the status and extent of utilization of Blockchain technology in the delivery of construction projects in Imo State.

In the course of conducting the research, the status and extent of utilization of Blockchain Technology on construction projects was determined. In terms of the status and extent of utilization of Blockchain technology's deployment in the delivery of construction projects, there is a general low level on the extent of utilization of Blockchain technology in the delivery of construction projects in Imo state, Nigeria, given the fact that none of the respondents 0.00% has used/applied Blockchain Technology on their construction projects in recent time. And that 48.84% of the respondents opined that they have heard of Blockchain Technology, but it has never been used on their construction projects. 40.70% of the respondents have never heard of Blockchain Technology, while 10.47% have only used it sparingly and mostly in the form of electronic procurement related functions. The study recommends that in order to grasp the utilization of Blockchain technology as one of the key essential elements for construction project realization, there is need for a united front to make the necessary information available through Blockchain technology awareness-raising among construction project stakeholders in the Nigerian construction industry. Given that Blockchain technology is a life-saving program, an enormous amount of information will need to be created through professional association meetings, workshops, and conferences, among other venues, to help raise Blockchain technology awareness and encourage practitioners to accept it whole heartedly as it has the much-needed magic wand to change the tide of construction project delivery to the right destination.

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References

Abeyratne, S. A. & Monfared, R. P. (2016). Blockchain ready manufacturing supply chain using distributed ledger. *International Journal of Research in Engineering and Technology, 5*(9), 1–10.https://doi.org/10.15623/ijret.2016.0509001.

Agbara, V. O. (2024). The barriers to adopting Blockchain technology in construction project delivery. A master's thesis of the Federal University of Technology, Owerri, Nigeria.

Ahmad Termizi, S.N.A., Wan Alwi, S.R., Manan, Z.A. & Varbanov, P.S. (2023). Potential application of blockchain technology in eco-industrial park development. *Sustainability, 15*(52). https://doi.org/10.3390/su15010052.

Amade, B., Ogbonna, A.C., Raphael, L.C., Obodoh, D.A. & Okore, O.L. (2022). Willingness of users to adopt blockchain technology on construction projects. *The Twelfth International Conference on Construction in the 21st Century (CITC-12)* Amman, Jordan | May 16-19, 2022. 184-194.

Baiod, W. Light, J. & Mahanti, A. (2021). Blockchain technology and its applications across multiple domains: a technology review. *Journal of International Technology and Information Management, 29*(4), 78-119. https://scholarworks.lib.csusb.edu/jitim/vol29/iss4/4.

Crosby, M., Nachiappan, P., Pattanayak, P., Verma, S. & Kalyanaraman, V. (2006). Blockchain technology: beyond Bitcoin. *Applied Innovation Review* (2).

Duan, J., Zhang, C., Gong, Y., Brown, S. & Li, Z. (2020). A content-analysis based literature review in blockchain adoption within food supply chain. *International Journal of Environmental Research and Public Health, 17*(1784). doi:10.3390/ijerph17051784 www.mdpi.com/journal/ijerph.

Egwi, C.O. (2022). An appraisal of building information modelling (BIM) application as an enabler for successful construction project delivery in Nigeria. A Master's Dissertation of the Robert Gordon University, Aberdeen.

Gwaya, A.O. (2015). Development of a project management evaluation model for the construction industry in Kenya. A PhD Thesis of the Jomo Kenyatta University of Agriculture and Technology, Kenya.

Hultgren, M. & Pajala, F. (2018). Blockchain technology in construction industry transparency and traceability in supply chain. A Master's Thesis of University of Stockholm, Sweden.

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John William., A.D., Rajendran, S., Pranam, P., Berry, Y., Sreedharan, A., Gul, J. & Paul, A. (2023). Blockchain technologies: smart contracts for consumer electronics data sharing and secure payment. *Electronics, 12*(208), 1-13. https://doi.org/10.3390/electronics12010208.

Jurgelaitis, M., Ceponiene, L., Butkus, K., Butkiene, R. & Drungilas, V. (2023). MDA-based approach for Blockchain smart contract development. *Applied Science, 13*(487), 1-28. https://doi.org/10.3390/app13010487.

Kothari, C. K. (2004). *Research methodology: methods and techniques*. (2nd revised ed.). New Delhi, India: New Age International Publishers.

Krejcie, R.V. & Morgan, D.W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30,* 607-610.

Li, J., Greenwood, D. & Kassem, M. (2019). Blockchain in the built environment and construction industry: A systematic review, conceptual models and practical use cases. *Automation in Construction, 102.* 288-307. ISSN 0926-5805. URL: http://dx.doi.org/10.1016/j.autcon.2019.02.005.

Mathews, M., Robles, D. & Bowe, B. (2017). BIM + blockchain: A solution to the trust problem in collaboration? In: CITA BIM Gathering 2017, Dublin.

McNamara, A.J. & Sepasgozar, S.M.E. (2020). Developing a theoretical framework for intelligent contract acceptance. *Construction Innovation.* Emerald Publishing Limited. 1-25. DOI 10.1108/CI-07-2019-0061.

Mohammed, A., Almousa, A., Ghaithan, A. & Hadidi, L.A. (2021). The role of blockchain in improving the processes and workflows in construction projects. *Applied Science,* 11, (8835). 1-21. https://doi.org/10.3390/app11198835.

Mondego, D. & Gide, E. (2018). The use of the technology acceptance model to analyse the cloud-based payment systems: a comprehensive review of the literature. *Journal of Information Systems and Technology Management – Jistem USP 19*(2022), 1-30. DOI: 10.4301/S1807-1775202219007.

Mugenda, O. M. & Mugenda, A. G. (2004). *Research Methods Quantitative and Qualitative Approaches*. NAIROBI, Kenya.: ACTS Press.

Nnaji, C., Okpala, I., Awolusi, I. & Gambatese, J. (2023). A systematic review of technology acceptance models and theories in construction research. *Journal of Information Technology in Construction (ITcon), Vol. 28,* 39-69. DOI: 10.36680/j.itcon.2023.003.

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Oye-Bamgbose, O. (2019). How blockchain technology can be used for trade finance processes in Nigeria. A Dissertation of the Dublin Business School.

Perera, S., Nanayakkara, S., Rodrigo, M.N.N., Senaratne, S. & Weinand, R. (2020). Blockchain technology: is it hype or real in the construction industry. *Journal of Industrial Information Integration* (2020), doi: https://doi.org/10.1016/j.jii.2020.100125.

Saputra, U. W. E. & Darma, G. S. (2022). The intention to use blockchain in Indonesia using extended approach technology acceptance model (TAM). *CommIT Journal 16*(1), 27–35, 2022.

Saunders, M., Lewis, P. & Thornhill, A. (2009). *Research methods for business students fifth edition*. Edinburg Gate: Pearson.

Taherdoost, H. (2022). A critical review of blockchain acceptance models—blockchain technology adoption frameworks and applications. *Computers, 11*(24), 1-31. https://doi.org/10.3390/computers11020024.

Taylor, D. (2017). Construction and Blockchain: how can it help the industry? Published in Capterra Construction Management Blog. http://blog.capterra.com/construction-and-blockchain-how-can-it-help-theindustry/, 2017–2–28.

Wang, J., Wu, P., Wang, X. & Shou, W. (2017). The outlook of blockchain technology for construction engineering management. *Frontiers of engineering management, 4*, 67-75.

Wang, X., Liu, L., Liu, J. & Huang, X. (2022). Understanding the determinants of blockchain technology adoption in the construction industry. *Buildings, 12*(1709), 1-17. https://doi.org/10.3390/ buildings12101709.

Wu, R., Ishfaq, K., Hussain, S., Asmi, F., Siddiquei, A.N. & Anwar, M.A. (2022). Investigating the intentions to adopt cryptocurrency among e-retailers: a Perspective from the mediation of technostress and technology involvement. *Sustainability, 14*(641), 1-21. https://doi.org/10.3390/su14020641.

Zhou, J.H. (2023). Industrial internet sensor node construction and system construction based on blockchain technology. *Journal of Sensors, Volume 2023*, Article ID 6137395.1-13. https://doi.org/10.1155/2023/6137395.

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