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BLOCKCHAIN IMPLEMENTATION IN CONSTRUCTION: AN EMPIRICAL ANALYSIS OF THE BENEFITS IN NIGERIA

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ABSTRACT

Blockchain Technology (BcT) has emerged as a transformative force across various industries, including the construction sector. Stakeholders within the construction industry increasingly recognize its potential benefits in construction processes. This paper examines the benefits of BcT in Nigeria. The study utilized a survey design, in gathering information from questionnaires administered to construction professionals. Statistical tools such as Mean Item Scores (MIS) and Explanatory Factor Analysis (EFA) were used to analyze data from 222 respondents. A Cronbach's α test was also used to verify the reliability of the instrument. The study found that the adoption and implementation of BcT in the construction industry are low and still in the initial stages. However, BcT should not be disregarded due to its promising outlook. The study also revealed that the top benefits of BcT for construction project performance in an emerging economy include achieving value for money, enhancing transparency in the construction process, intensifying collaboration among professionals, promoting homogeneity and effectiveness in project administration, accelerating infrastructure development, and improving the quality of services. BcT was treated as an autonomous technology in this paper. The paper highlights the need to study the current level of BcT implementation and its immense benefits in modern construction activities within an emerging market.

Keywords: Blockchain Technology, Professional, Factor Analysis, Construction.

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1. INTRODUCTION

Blockchain Technology (BcT) is an innovative development that facilitates new types of distributed software systems. These systems allow components to achieve consensus on a shared state for exchanging transactional and decentralized data across a wide network of non-trusted participants, without relying on a central authority (Singh, et al., 2023). It is a unified digital money processing system that creates, validates, and tracks authenticated digital asset transactions (Zilin, 2023). The concept of BcT was introduced in 1991 when Stuart Haber and W. Scott Stornetta developed their initial research on a cryptographically secured chain of blocks. According to Nakamoto (2008), the first Distributed Ledger Technology (DLT), Bitcoin, was launched as the world's first cryptocurrency, detailed in Satoshi Nakamoto's whitepaper. Since then, BcT has gained widespread acceptance across various economic sectors globally (Lawal, et al., 2023). In essence, BcT has been redefining the operational systems of society and its activities in the financial, political, humanitarian, and legal sectors (Selvanesan, 2023).

BcT is being explored by a wide variety of sectors, including banking, knowledge sharing institutions, identity security, insurance, digital dispute resolution, real estate, crowd financing, big data analytics, education, and notably, the construction industry (Ibrahim, et al. (2021). According to Laroiya et al. (2020), as international partnerships and contracting among construction professionals become more common, the complexity of construction projects needs to be simplified. This has been facilitated by the introduction of technologies like blockchain and Building Information Modelling (BIM) into the construction industry. Xie (2023) emphasized that BcT is so crucial to the construction industry that it has been recommended as a solution for clearing and disbursing budgetary resources. As noted by Wang et al.(2017), BcT applications have been extensively utilized in various areas of development within the construction industry in most developed countries; such as recording and validating transactions (Elghaish et al., 2020), authenticating transactions, updating public ledgers, supply chain management (Tezel et al., 2021), BIM and project management (Obim, et al., 2023, Kiu et al., 2025).

In emerging market economies worldwide, the current construction process and administration face several challenges, including trust issues, time overruns, delays in the construction process, a lack of activity computerization, and inadequate information sharing (Okanlawon, et al., 2025). Moreover, the contemporary agreements and relationships in the construction industry, which are major drivers of increased project costs, are largely based on a lack of trust in contract documentation. For decades, lack of trust and accountability has been a significant threat in the construction industry, leading to crushed net revenues, and compelling various construction firms to seek compromises (Selvanesan, 2023).

To address these challenges Adilieme, et al. (2025) believed that BcT can significantly help construction companies reorganize contract exchange and information administration, attracting growing interest from both academia and industry regarding its potential benefits. Selvanesan (2023) opined that the combination of blockchain and the catalogue properties of a BIM model provide a dynamic and perceptible chain of "evidence of trust". This trust is crucial for creating innovative value for construction clients and all stakeholders in the industry. Within the construction sector, BcT can enable disintermediated data exchange, allowing every professional and expert in the construction framework to access the same information. This essential feature maintains information without being controlled by any governmental or organizational entity (Ojukwu, et al., 2024). Given these issues, this study investigates the implementation level and benefits of BcT as one of rising innovations in the Nigerian construction industry. The findings of this research will help in understanding the positive impacts of BcT and its modern applications in the building industry among developing countries.

2. LITERATURE REVIEW

Xie (2023) described blockchain as an automated, cryptographically protected distributed ledger that tracks business activities chronologically, indefinitely, and without modification. The performance and cost of blockchains depend on various factors, including the choice of consensus mechanism and permission status. According to Al-Saqaf & Seidler (2017), BcT is evolving, with versions ranging from Blockchain 1.0 to Blockchain 4.0. Blockchain 1.0 is primarily known for digital currencies, while Blockchain 2.0 is widely used for digital banking and smart contracts. Blockchain 3.0 was developed for Dapps and applications in modern culture, and the latest, Blockchain 4.0, is intended for general industrial use (Ebekozien, *et al.*, 2024).

Despite the availability of BCT, the construction industry continues to face frequent challenges related to inefficiency and poor performance (Ojobor, *et al.*, 2022). This is attributed to a disaggregated building process and a hierarchical structure where work is done linearly, which has prompted the implementation of blockchain (Xie, 2023). The application of BcT in the construction industry cannot be overemphasized. It has been implemented in many sectors of the global economy (Lohry, 2017). "Smart contracts" are one of the most significant applications of the BcT protocol. Gronbaek (2017) defined them as "computer protocols that integrate the (human-readable) words (source code) and conditions of a contract that is assembled into a networked computer code". Unfortunately, smart contracts have not been fully implemented in the construction industry in developing nations. Another application of BcT is the provision of services like insurance and equity (Onyekwere, *et al.*, 2023). It has also been suggested as a method for settling and clearing financial assets. Many construction professionals use it effectively for distributing stored sensor data from buildings (Ebekozien, *et al.* 2024).

Lohry (2017) suggested that blockchain can be a valuable tool in the building industry for monitoring and tracking BIM model improvements throughout the feasibility, design, construction, and maintenance stages. This can be achieved by using smart contracts to control modification rights and maintain a permanent public record of all model improvements. Additionally, Odu, (2022) highlighted several construction activities where BcT adoption would be highly beneficial, including record-keeping of digital properties, cryptographically signed activities or transactions serving as a real-world information depository, and smart contracts paired with multi-signature transaction authentication. It is also envisioned for automated conflict resolution, smart cities, and real estate investments (Onyekwere, *et al.*, 2023). However, Adegbembo et al., (2023) found that in Nigeria, some aspects of blockchain are known, but its application by construction stakeholders is low.

Lory (2017) also proposed BcT as a resource for managing and documenting improvements to BIM models throughout all design and construction processes, using smart contracts to manage editing rights and preserve a permanent public record of all model improvement. This was also emphasized by Amaludin, *Radzif & Taharin* (2018), who noted that BcT could bring several advantages to the construction industry, including automated real property data, timestamped transactions, multi-signature transfers, and smart contracts that track and manage situations. These are real-world database applications used alongside smart enterprises. Furthermore, blockchain has been widely utilized for automated conflict resolution and intelligent cities (Okanlawon, *et al.*, 2024), and for smart innovations in real estate (Onyekwere, *et al.*, 2023).These applications can support and boost the efficiency, accountability, and responsibility of the process among all construction stakeholders.

There are numerous potential techniques, applications, and benefits that BcT can bring to the construction business, as reviewed in this section. Therefore, many features of this technology can be applied exclusively to the construction industry and other sectors to implement capital construction programs in a more customized manner. The advancement of technology has necessitated the adoption of modern technologies to meet the growing demands of construction work (Azogu, *et al.*, 2019). Blockchain technology has proven to be one of the essential modern technologies for construction activities (Okanlawon, *et al.*, 2024). Several research studies have been conducted on blockchain technology to promote its adoption in areas where its use is limited or non-existent.

As stated by Ojobor, *et al.* (2022), blockchain offers several benefits, including the elimination of intermediaries in contracts, reduction of prices and time, lowering of entry barriers in many sectors, and assurance of secured technical structures. Wang et al. (2017) and Mazlan *et al*. (2025) further identified blockchain as a tool to help resolve confidence gaps and inadequate knowledge communication in the construction industry. Based on these reviews, the benefits of BcT include facilitating decentralized peer-to-peer networks, enhancing accountability through tracking and traceability, providing transparent, accurate, and shareable transaction ledgers, decreasing transaction costs through disintermediation and automation, supporting competitive pricing, promoting investment and issuer market access, and enabling active monitoring, auditing, and compliance of non-traditional assets. For the purpose of this research, the following are some highlighted benefits of BcT in the construction industry:

i. **Precision and Uniformity:** For many stakeholders in the construction industry, blockchain technology promises much more than anticipated, ensuring its importance for future generations (Azogu, *et al.*, 2019; Ye *et al.,* 2025). Therefore, a top benefit of blockchain technology is its ability to deliver a more reliable and standardized product consistency compared to goods produced by seasoned workers(Olawumi & Chan 2021). Consequently, construction benefits from a more precise and uniform quality of work (Selvanesan, 2023).

ii. **Displacement of Labor:** The implementation of blockchain technology in construction has led to a decrease in the need for manual labor (Ibrahim, et al., 2021). These technologies can perform various tasks that would otherwise be assigned to a workforce, leading to a displacement in the number of laborers required for construction work (Singh et al, 2023). The cost of construction remains high, with labor costs being greater than in most industrial companies. Labor tends to increase the actual cost of construction work. Nevertheless, potential labor shortages and difficulties in hiring are exacerbated by a decline in the number of entry-level staff and the physically strenuous nature of the job since the baby boom era (Azogu, et al., 2019; Kumi et al., 2025).

iii. **Less Human Error***:* In construction, there is a high tendency for errors to occur when each stage is handled by labor alone. The adoption of BcT helps to reduce the various errors that are prone to arise in any construction work (Ying et al., 2018; Bandara et al., 2025). Furthermore, Table 1 highlights some benefits to be gained from the full implementation of blockchain technology in the construction industry and authors' views on these benefits based on their findings. Twenty (20) benefits of blockchain technology were compiled from various literature and later filtered through various journals. These journals were carefully selected based on their solid research and a significant number of citations in blockchain technology publications.

Table 1: Benefits of blockchain technology in the construction industry

Code	Variables	References										No
		Onyekwere et al. (2023)	Okanlawon et al. (2023)	Jimoh et al. (2019)	Singh et al (2023)	Adilieme et al. (2025)	Ebekozien et al (2023)	Tezel et al. (2021)	Zilin (2023)	Wang et al (2017)	Hunhevicz et al. (2020)	
BCT1	Precision and Uniformity	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
BCT2	Enhances proper project management	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	9
BCT3	Efficiency in construction project administration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
BCT4	Enhances easy payment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
BCT5	Reduction in production time	✓	✓	✓	-	✓	✓	✓	✓	✓	-	8
BCT6	Less human error	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
BCT7	Transparency in construction process	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	9
BCT8	Perform task beyond human capabilities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
BCT9	Increase in productivity	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	9
BCT10	Direct transactions	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
BCT11	Increases collaboration	-	✓	✓	-	✓	✓	✓	✓	✓	✓	8
BCT12	Trust among construction experts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
BCT13	Reduces paper work	✓	✓	✓	-	✓	-	-	✓	✓	✓	7
BCT14	Enhances completion of project	✓	✓	✓	-	✓	✓	-	-	✓	✓	7
BCT15	Accelerates infrastructure development	✓	-	✓	✓	✓	-	-	✓	✓	✓	7
BCT16	Advances expertise and experience	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
BCT17	Improves quality of services	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
BCT18	Achieving of value for money	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
BCT19	Increase in sustainability	✓	✓	-	✓	-	✓	✓	✓	✓	-	7
BCT20	Increased safety	✓	✓	-	✓	✓	-	✓	✓	✓	✓	8
	Sub total	19	19	18	14	18	17	17	19	20	18	

The limitation to twenty benefits was not an arbitrary cap, but the practical outcome of a satuation-based literature review**.** The process was designed to identify core, recurrent, and consensus-driven benefits of blockchain in construction, rather than an exhaustive list of all possible mentions. Moreover, study conducted a systematic identification and consolidation process in two main phases. First, a comprehensive compilation was done through a broad-scope review of academic databases (e.g., Scopus, Web of Science) using keywords like "blockchain," "construction industry," "benefits," "advantages," and "applications." Second, deduplication and thematic synthesis were carried out on the outcomes. The twenty (20) benefits presented in Table 1 represent the final, distilled set that emerged from this synthesis.

3. METHODOLOGY

The primary aim of this paper is to explore the importance of BcT as recently introduced technology in the construction industry of an emerging market. A quantitative research design was employed, using a questionnaire survey method. This involved developing research instrument, collecting data, then modeling and analyzing the obtained data (Chan et al., 2019). A detailed literature review from relevant sources such as journals, the internet, and published books on BcT was used to gather necessary information for this study (see Table 1). The administration of questionnaires was the primary instrument for collecting data to address the research problem and objectives. This is in accordance with Kothari *et al* (2004), who stated that questionnaire surveys consist of a series of questions designed by the investigator to elicit specific information on a particular matter.

These questionnaires were administered through both physical (one-on-one) and electronic means (e-questionnaires) to construction industry professionals in Nigeria. The selection criteria for these professionals were based on their contemporary involvement in the delivery of public construction projects and adequate knowledge of BcT. This approach helped in obtaining adequate and reliable results for the study. The data collection technique used was the census sampling method. A total of 307 questionnaires were distributed, and 222 were retrieved, which was deemed suitable for analysis. This represents a response rate of about 72 percent. According to Akintoye (2000), a high response rate ensures that the results are not considered biased.

The questionnaire data were analyzed using SPSS Version 22 and Excel sheets. The analysis was conducted in two separate statistical tests. First, the rankings of the benefits were analyzed through Mean Item Score (MIS) and Standard Deviation (SD). Second, the factors were analyzed, investigated, and arranged for better understanding using explanatory factor analysis (EFA). To identify the factors that represent the benefits of BcT in the construction industry, all the BcT benefits used in the study were extracted from the literature review (see Table 1). After extracting the benefits, respondents were asked to rank these factors based on their perceived level of importance on a 5-point Likert scale, from Very High (5) to Very Low (1). Verifying the reliability of the data collection method is crucial, which is why Cronbach's α test was utilized. The test indicated a Cronbach α value of 0.90, which strongly supports the instrument's high reliability, as a value closer to 1 indicates a higher degree of precision.

3.1 General information of respondents

Table 2 shows the demographics of the respondents. The South-Western part of the country had the most sampled construction professionals with 63 respondents, followed by the South-South (42), North-Central (35), and South-East (31) respectively. From the data retrieved and analyzed, 27.9 percent of the respondents were quantity surveyors, while other construction professionals such as architects, engineers, builders, and others (project managers and skilled laborers) represented 26.6, 23.9, 16.2, and 5.4 percent of the survey respondents, respectively. Based on the type of firm, 81 respondents (36.5 percent) were from contracting firms, 127 (57.2 percent) were from consulting firms, and the remaining 6.3 percent represented NGOs and government parastatals. According to

Table 2, the average years of experience of the sampled construction professionals was 10.2, which is considered good and reliable for this study.

Table 2: Respondents' demographics

Characteristics	Frequency	Percentage	Characteristics	Frequency	Percentage
Respondents			**Type of firm**		
South-East	32	14.5	Consulting	81	36.5
South-South	42	19	Contracting	127	57.2
North-East	19	8.6	Others	14	6.3
North-West	31	13.9	**Total**	**222**	**100**
North-Central	35	15.7			
South-West	63	28.3			
Total	**222**	**100**			
Profession			**Years of experience**		
Quantity surveyors	62	27.9	0–5	66	29.7
Engineers	53	23.9	6–10	53	23.9
Builders	36	16.2	11–15	37	16.7
Architects	59	26.6	16-20	31	14
Others	12	5.4	20 – above	35	15.7
Total	**222**	**100**	**Average years of experience**	**10.2**	**100**

4. RESULTS AND DISCUSSION

This section presents the data analysis results and discussions on the benefits of BCT in an emerging economy.

4.1 Descriptive analysis of the benefits of BcT in the construction industry

The analysis of the data for the benefits of BCT in the construction industry as shown in Table ranges from M= 4.21 (SD=0.816) for BCT1 – "*precision and uniformity*" to M= 3.71 (SD=0.889) for BCT16- "a*dvances expertise and experience*" at a variance of 0.5. Benefit factors with the same mean score item are ranked based on their SD value, wherewith an higher rank is assigned to the factor with a lower SD value (Olawumi & Chan, 2021). The mean values and rankings are shown in decreasing order in Table 3.

Table 3: Mean Analysis for the Benefits of BcT in the Construction Industry

Code		Mean	Std. Deviation	Ranking
BCT1	Precision and Uniformity	4.21	0.816	1
BCT3	Efficiency in construction project administration	4.11	0.906	2
BCT4	Enhances easy payment	4.08	0.777	3
BCT2	Enhances proper project management	4.08	0.862	4
BCT12	Trust among construction experts	4.04	0.841	5
BCT5	Reduction in production time	4.00	0.928	6
BCT14	Enhances completion of project	3.99	0.890	7
BCT15	Accelerates infrastructure development	3.93	0.977	8
BCT10	Direct transactions	3.90	0.915	9
BCT17	Improves quality of services	3.90	1.056	10

BCT9	Increase in productivity	3.89	0.936	11
BCT7	Transparency in construction process	3.88	0.912	12
BCT13	Reduces paper work	3.88	1.013	13
BCT20	Increased safety	3.86	0.887	14
BCT19	Increase in sustainability	3.85	0.844	15
BCT18	Achieving value for money	3.85	1.063	16
BCT6	Less human error	3.84	0.928	17
BCT8	Perform tasks beyond human capabilities	3.81	0.981	18
BCT11	Increases collaboration	3.79	0.912	19
BCT16	Advances expertise and experience	3.71	0.889	20

The highest-ranked benefit of BcT implementation is "*precision and uniformity"* (M= 4.21), which was considered the most important benefit derivable from the use of BcT in the construction industry. With the aid of BcT, each participant in the construction industry has easy access to the same information—including financial details, smart contracts, construction processes, and project management activities—for a particular project. These findings correspond with study by Adilieme, *et al*. (2025), which state that BcT brings accuracy, straightforwardness, and reliability to decision-making. This simplifies the construction process and makes it easier for parties to trust each other without needing a large number of intermediaries. Consequently, resolving any disputes that arise among construction professionals during the construction process can be conducted fairly and easily.

Moreover, the factor BcT3 – "*efficiency in construction project administration*" (M= 4.11) was also ranked among the top advantages of BcT in the study area. In an emerging economy like Nigeria, construction activities are time-consuming, which increases the likelihood of human errors and often requires more intervention from third parties when using conventional paper-heavy processes. With the introduction of BCT, transactions can be performed more easily and effectively by simplifying and automating them with this technology.

Furthermore, the factor BCT4 – "*enhances easy payment*" (M= 4.08) is also ranked among the top-three benefits of BCT implementation in the construction industry. This finding corroborates Obim, *et al.* (2023) and Elghaish *et al.* (2020), who found that BcT is capable of streamlining tedious construction processes, saving time and money. This can be achieved by automatically triggering contractors' payments based on digitally agreed-upon jobs, contractual terms, and smart contracts. According to Okanlawon, *et al*. (2025), smart contracts enabled by BCT will help construction firms reduce or eliminate uncertainty and overpriced payment gaps by transforming the distribution and reimbursement of smooth contracts with logistics providers, streamlining processes across companies and partners. Therefore, based on the findings from the study area, the full implementation of BcT in the construction industry will reduce job capital demands and improve financial processes, leading to optimum supply chain sustainability.

In addition, if BCT is properly implemented in an emerging economy like Nigeria, it will significantly enhance proper project management from inception to the final stage of construction. As identified by Wamba *et al.* (2018), BcT can be used in real-time to monitor project performance and expenditure in any sector of the economy. Moreover, conditions in a smart contract can be activated each time a milestone or task is accomplished, which eliminates many operational procedures and paperwork. This allows for smaller cash payments to be made, improving cash flow. Therefore, each smart contract can be visually represented on the model to efficiently track the development and spending on the project.

4.2 Exploratory factor analysis of the benefits of BcT in the construction industry

In addition to descriptive analysis, the study adopted an Exploratory Factor Analysis (EFA)146. EFA is generally considered sufficient and appropriate when the number of variables is between 20 and 50. According to Hair *et al.* (1998), extraction becomes imprecise when the number of variables is less than 20 or more than 50. For this study, the 20 BcT benefit variables used were deemed appropriate for factor analysis.

The Kaiser-Meyer-Olkin (KMO) test was conducted to ascertain sample adequacy. KMO measures variable uniformity and is a standard metric to check if partial differences between variables are minimal. For a strong and reliable factor analysis, the KMO index should range from 0 to 1. Tabachnick and Fidell (2012) proposed 0.6 as the lowest acceptable value. Pallant (2005) also indicated that the Bartlett's Test of Sphericity (BTS) at $p < 0.05$ should be considered appropriate for factor analysis. The results of the KMO and BTS tests showed a KMO value of 0.816, which indicates excellent variance, and the BTS analysis showed an adequate test statistical value (chi-square = 944.280) and a small significance value ($p = 0.000$; df = 190). This means the correlation matrix is not an identity matrix. This result aligns with the 0.908 reliability check performed using the Cronbach α test, which demonstrated that the data collected and used for this study is appropriate and satisfactory for factor analysis.

EFA was conducted by analyzing the principal components, followed by a varimax rotation. This analysis was carried out to determine the components to be retained and extracted. As indicated in Table 5, the results show that six extracted components with eigenvalues greater than one were selected, representing 76% of the total variance explained, which is greater than the minimum threshold of 60%. For the underlying factors under each component, only factors with factor loadings of 0.4 and above were selected. The higher the factor loading of an underlying factor, the higher its significance within its component.

Table 4: Factor structure of the varimax rotation on the BcT's benefit

Code	Benefits of BCT implementation	Factor loading	Eigenvalue	Percentage of variance explained	Cumulative percentage of variance explained
Factor 1 – Process automation and value for money			9.024	45.121	45.121
BCT18	Achieving value for money	0.837			
BCT13	Reduces paper work	0.830			
BCT20	Increased safety	0.691			
BCT2	Enhances proper project management	0.683			
BCT19	Increase in sustainability	0.498			
BCT6	Less human error	0.453			
Factor 2 – Efficiency, transparency, and trust			1.509	7.544	52.665
BCT7	Transparency in construction process	0.804			
BCT10	Direct transactions	0.751			
BCT9	Increase in productivity	0.690			
BCT14	Enhances completion of project	0.650			
BCT12	Trust among construction experts	0.621			
Factor 3 – Collaborations and optimization of tasks			1.402	7.010	59.675
BCT11	Increases collaboration	0.802			
BCT8	Perform tasks beyond human capabilities	0.780			
BCT5	Reduction in production time	0.657			
Factor 4 – Homogeneousness and effectiveness in project management			1.265	6.327	66.002
BCT1	Precision and uniformity	0.760			
BCT3	Efficiency in construction project administration	0.685			
BCT4	Enhances easy payment	0.648			
Factor 5 – Stakeholders upskill and infrastructure development			1.046	5.228	71.230
BCT15	Accelerates infrastructure development	0.858			
BCT16	Advances expertise and experience	0.580			
Factor 6 – Improves quality of services					
BCT17	Improves quality of services	0.843	1.024	5.122	76.352

4.3 Discussion of factor extraction

The extracted components (clusters) were given identifiable labels, which, as suggested by Sato (2005), represent a subjective interpretation of the underlying factors that make up each component. These six principal clusters explained 76 percent of the total variance. The varimax rotation and grouping of these principal factors with their related variables were also carried out (see Table 4). The interpretation and naming of the groupings were based on the researchers' opinion and experience. This section focuses on discussing the identified factor clusters.

4.4 Process Automation and Value for Money

From Table 4, the first factor accounts for the highest total variation at 45 percent. This component integrates six variables: achieving value for money, reducing paperwork, increasing safety, enhancing proper project management, increasing sustainability, and reducing human error. This result aligns with Ying *et al.* (2018), who examined the benefits of BcT in the building industry. Their findings concluded that blockchain technology maximizes productivity by automating multiple transaction processes using smart contracts, reducing complexity, and increasing accuracy over the construction period. For instance, bank transfers typically take many business days and incur costs. However, since the introduction of BcT to the construction industry, transactions have become smooth and instantaneous without needing to consult third or fourth parties. This further demonstrates that BcT is now a major potential innovation in the construction industry. Moreover, it delivers better value for every penny invested in construction. This result affirms that in an emerging market economy, one of the key potential benefits of BCT is achieving value for money through project administration, optimization, and automation of construction processes (Cheng*, et. al.,* 2021; Nwabuike, *et al*., 2020).

4.5 Efficiency, Transparency, and Trust

This is the second principal component, which accounts for 7.5 percent of the total variance extracted. It comprises five BcT benefits: transparency in the construction process, direct transactions, increased productivity, enhanced project completion, and trust among construction experts. According to responses from construction workers who have adopted BCT, transaction histories are becoming more transparent, especially among clients, stakeholders, contractors, and subcontractors. This is due to the fact that BcT is a distributed ledger where network participants can share the same documentation, in contrast to the traditional method where individuals have different copies. This corroborates the studies by Wamba *et al.* (2018) and Effiong, (2020) which demonstrated that the main advantage of this technology is the reliability and transparency of a shared version of documents, which can only be changed by consensus among the parties.

4.6 Collaboration and Optimization of Tasks

This factor cluster accounts for 7 percent of the total variation. It includes BcT benefits such as increased collaboration, performance of tasks beyond human capabilities, and reduction in production time. The construction industry is one of the most diverse sectors, heavily influencing other parts of the world economy. Its main characteristics include complex projects with increasingly scattered, distributed, and complicated supply chains for capital infrastructure globally. The introduction of blockchain has provided solutions to these problems. This affirms the findings of Ojobor, *et al.* (2022) and Cheng et al. (2021), which reported that the application of BcT offers significant opportunities and efficiencies to construction businesses. This enhances the reputation of e-commerce within construction companies and facilitates the maximum implementation of the Internet of Things (IoT) to make operations more effective (Zilin, 2023). In emerging economies like Nigeria and other countries, BcT can intensify solid collaboration among construction professionals by saving time and costs through robust, undiluted alliances between clients, stakeholders, contractors, and subcontractors in e-commerce partnerships (Adilieme, *et al*., 2025).

4.7 Homogeneousness and Effectiveness in Project Management

This fourth principal component contributes 6.33 percent of the overall variance and includes three variables: precision and uniformity, efficiency in construction project administration, and enhanced payment. These findings align with the study by Cheng *et al.* (2021), which noted that construction projects involve a variety of partners and organizations, and the nature of such projects can trigger technical and operational heterogeneity problems. For example, during the construction process, building drawings and financial plans may be released at different levels and must be communicated to all stakeholders. However, as stakeholders work in different organizations, a sequence of problems typically arises, such as identifying the current set of drawings and announcing the latest version. All of this can be addressed by implementing BcT (specifically Blockchain 2.0) through the full implementation of smart contracts, as new information concerning the construction process will be modified and made available to each group (Laroiya et al., 2020).

4.8 Stakeholder Upskilling and Infrastructure Development

This fifth factor cluster makes up 5.23 percent of the total variation. It encompasses BcT benefits such as advancing expertise and experience and accelerating infrastructure development. The acceleration of infrastructure development in any developing country is a key driver of economic growth (Olawumi & Chan, 2021). Rapid delivery of this infrastructure is a cornerstone of the construction industry. To make this vision sustainable, technological advancements like BcT, BIM, and IoT play a vital role. Many studies on BcT have been conducted to simplify the maximum utilization of this technology in areas where its use has been constrained, including the construction industry(Okanlawon, *et al*., 2025). Accordingly, these advantages are derivable from the use of blockchain technology, which also includes the enhancement of stakeholders' skills and expertise and improvement in infrastructure development (Amaludin *et al.,* 2018).

4.9 Improves Quality of Services

This factor cluster represents 5.12 percent of the overall variation. It consists of only one BcT benefit: improving the quality of services within the construction industry. Late payments and sluggish cash flow are chronic problems in the construction industry in developing countries, which affects the quality of service rendered by professionals. Furthermore, this decelerates the construction process and reduces the quality of service provided by contractors. This was affirmed by Ebekozien, *et al.* (2023), who reported that total payment periods often reached one hundred and twenty days for construction firms (both small and medium-sized enterprises), leading to low-tempo operations, thereby affecting service efficiency and lowering operational standards. Based on the study's outcome, construction professionals in an emerging market believe that the standard of service will be more reliable, accurate, and straightforward with the full implementation of BCT compared to the current paper-heavy processes.

5. CONCLUSION

While Blockchain technology is new and there are early hurdles to overcome, the opportunity to reshape the construction sector for the better is too significant to ignore. As revealed in this study, the building industry in an emerging economy is in the early stages of its BcT journey and still faces some minor obstacles to full implementation. Despite these challenges, most firms in the construction sector have an exciting chance to become more effective, open, transparent, competitive, and sustainable when BCT is fully implemented. Consequently, BcT has recently attracted substantial interest from construction professionals in emerging economies regarding its potential benefits. This motivated the present study to review the current and future benefits of BcT in the building sector of an emerging economy. As this study has well-established, BcT is extremely advantageous for productivity in modern-day construction activities in developing countries. In developed countries, extensive research has been conducted on blockchain technology, which has promoted its adoption and full implementation across all economic sectors. In emerging economies, similar research is limited, which has had a negative effect on the level of BcT implementation in all sectors. The study revealed a low level of implementation among construction professionals in the industry.

Through this technology, the construction industry in an emerging economy like Nigeria could achieve better value for money, increased transparency in construction processes, intensified collaboration among professionals, greater homogeneity and effectiveness in project administration, and finally, improved quality of services rendered by professionals. Based on these outcomes, the study recommends extensive training for construction professionals on ways to incorporate the latest technology into construction activities. In emerging economies, more research needs to be conducted on BcT to increase its level of awareness in all sectors of the economy.

Despite the fact that this study investigated the implementation level and benefits of BcT in the construction industry, a few limitations exist, as in any research. The limited functionality and expectations of BcT in construction activities were responsible for these restrictions. The following are some limitations and assumptions in this study: firstly, it was assumed that a greater percentage of the construction professionals (respondents) are familiar with this technology. Secondly, BcT was treated as an autonomous technology in this paper. Although, BcT is not an autonomous system; it relies on the Internet of Things (IoT) and other technologies like BIM and large-scale computing for maximum utilization. The study also presumed that the government supports and regulates BCT in all sectors of the economy. Therefore, future studies could include a comparative analysis of the government's stance on its implementation in the construction industry and other sectors. Moreover, the drivers and barriers facing the full implementation of BCT in an emerging economy could also be investigated. The research area of this study is limited to Nigeria; further studies could be carried out in other developing countries.

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