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Willingness of Users to Adopt Blockchain Technology on Construction Projects

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Abstract

This paper examined the main factors that influence the willingness and intention of construction project practitioners to adopt and use Blockchain technology in Nigeria. The examination has been done with reference to the UTAUT2 model and against the challenges identified in the general literature as being inherent in a developing country like Nigeria. [This seems redundant]. A quantitative approach and data surveyed from information and communication technology-savvy practitioners with regards to construction projects in Imo state, Nigeria, was utilized. Data analysis was achieved via Structural Equation Modeling (SEM) with the aid of IBM SPSS Statistics 25.0. The study's findings provide a framework which depicts the "intention to use and adopt" behaviours of practitioners in the Nigerian construction industry. Consequently, this study highlights trust, habit, perceived security, price value, and effort expectancy as the main constructs influencing users' willingness to adopt Blockchain technology in construction projects. This study provides an empirically based model of the factors influencing the intention to use and adopt Blockchain technology. The findings of this study provide impetus for decision-making in both the public and private construction project service sectors in terms of policy development and practical implementation as a catalyst to achieving better project outcomes in developing country scenarios where project performance remains most critical to economic development and growth.

Keywords

Blockchain, Construction projects, Technology, UTAUT2, Willingness of users to Adopt/Use.

1. Introduction

Blockchain technology, which emerged as a popular decentralised transaction and data management technology, enables the distribution of digital information without tampering (Trivedi, Mehta & Sharma, 2021; Wang, Wu, Wang & Shou, 2017). In a typical construction environment, data is accessed from a myriad of points via a central database. Hence, the main issue in this context is the issue of security, as the transaction data can be compromised by an intruder. According to Tezel, Papadonikolaki, Yitmen, and Hilletofth (2020), distributed ledger technologies (DLTs), of which Blockchain is a component, are continuously being explored by researchers and practitioners alike as a credible solution to the myriad of challenges hampering the performance of the construction industry. Business transactions should be less prone to disputes. There should be more transparency in collaboration, safeguards for private information, secure data storage and retrieval systems, and more secure and traceable data storage and retrieval systems.

As a compendium of existing technologies with new ways of looking at an existing phenomenon, the ideas behind digital signatures, hashing, cryptography, open-source and distributed systems, as critical components of blockchain (as applied to bitcoin cryptocurrency), are not new (Eze, Eziokwu & Okpara, 2017). However, what is of interest is how they could be deployed in the decentralisation and control of proof of ownership for both tangible and intangible assets. As opined by Grover, Kar and Janssen (2019), blockchain has the potential to entrench a lot of transformations in the socio-economic and political environment. A lot of people are talking about it now, but its main use and spread has been in the finance industry. Other industries are starting to think about its potential and how it could change their businesses for the better.

Information on technology adoption is important for making an informed decision when investing in a competitive venture. In light of the preceding assertion, studies on technology adoption exist, resulting in theories to provide information on the strength (s) and relationships among interacting factors (Awa, Ukoha, & Igwe, 2017). A synthesis of existing models on technology adoption (acceptance) has been carried out by researchers like Venkatesh, which gave birth to the unified theory of acceptance and use of technology (UTAUT) model (Venkatesh, Thong & Xu, 2012). The model synthesised existing components from the following models: theory of reasoned action, motivational models, TAM and TPB models, PC utilisation model, theory of planned behaviour, innovation diffusion theory, and the social cognition theory (Ajzen & Fishbein, 1980; Ajzen, 1991; Davis, 1989; Rogers, 2003). Not satisfied with the outcome of the UTAUT, an extended investigation was carried out with the view of ameliorating previously articulated constructs which later metamorphosed into the UTAUT2 model. The UTAUT2 was developed from the initial UTAUT model and was adjudged to be convenient for the user's intention or willingness to adopt. The ability to predict an individual's reactions and temperament towards various types of technology was found as a component embedded in UTAUT2 (Tamilmani, Rana, Prakasam & Dwivedi, 2019; Venkatesh et al., 2012).

As shown in the literature, Blockchain technology has begun to gain more ground in other industries compared to the construction industry (Belle, 2017). The willingness of users (practitioners) in the construction industry to deploy this technology specifically to the Nigerian environment has not been established. Accordingly, this study intends to empirically study and validate, amongst other important aspects, the user's perceived satisfaction and security towards Blockchain technology adoption on construction projects, hence filling the gap and doing so using construction projects within Imo State of Nigeria. As a result of these and other factors, Imo State was chosen. Imo State is located at the crossroads and represents the construction industry in Nigeria's "Niger Delta," which is a group of states. It is also known as the "Eastern Heartland."

Next, we explain the theoretical framework and conceptual model. Then, we show how we used structural equation modelling (SEM) to look at the data. Finally, we talk about some of the limitations of the study and suggest ways to improve it in the next section, which is called "Theoretical Framework and Model."

2. Literature Review

A blockchain is defined as a distributed public ledger that records all transaction data exchanged between parties within the system. As a result, it offers a consistent and coordinated record of transactions for all parties involved in a business network. To complete a data transaction, the confirmation of all system participants is required. The blockchain ledger records every sequence of transactions from beginning to end, resulting in certain, verifiable, and immutable records of all transactions ever made (Ahmadisheykhsarmast & Sonmez, 2018). While Shojaei, Flood, Moud, Hatami, and Zhang (2020) identified Blockchain as a Distributed Ledger Technology (DLT) that is simply a transaction database, Blockchain transactions are stored on multiple network nodes, making the system completely decentralised.

Transactions are synchronised on a regular basis, ensuring that the scheme is always up-to-date. Satoshi Nakamoto, the creator of the cryptocurrency Bitcoin, invented blockchain technology (Grover et al., 2019). But what is being watched today in all parts of the world is not only the power of crypto curriculars that are changing global business and finance, but also the potential behind the fundamental technology behind Bitcoin, known as blockchain technology (San, Choy, & Fung, 2019), which many other industry experts are interested in attempting to discover and develop.

As Li, Greenwood and Kassem (2019) say, the unchanging, transparent nature and redefining of trust relationship by offering fast, stable and publicly or privately sourced solutions are key advantages. Blockchain has been described as an "internet of value", and its effect over the next 10 to 20 years may be close to that of the internet due to its decentralization and irrevocable existence (Li, et al., 2019).

It can alter the way applications are created, productivity is generated, and digital transformation is done in many industries, maybe all of them, including the construction industry. Distributed ledger technologies (DLTs), such as blockchain, are being looked at more and more as a way to improve the efficiency of the construction industry. These technologies could help with open communication, safe and traceable data storage and retrieval, smoother business transactions, and protected privacy and intelligence (Tezel et al., 2019).

2. 1 Blockchain in Construction

According to a study conducted by Research and Markets (2018), more than 80% of new construction activities will incorporate at least one form of emerging technology or related smart building technologies. At this point, the commercial smart building market is projected to expand almost tenfold to more than $51 billion globally by 2023 over the next five years. Owing to its inefficiency, low productivity, and automation, the construction industry is frequently criticised (Hamma-adama et al., 2020; Shojaei, 2019; Teisserenc & Sepasgozar, 2021).

The construction industry's disaggregated structure, its sequential existence where work needs to be performed in a sequential and chain-like framework, and the number of stakeholders involved in each project with different interests are defined as the root causes of its problems. They address the disintegrated structure of the construction industry, the order in which the work must be carried out in a sequential and chain-like manner, and the number of stakeholders involved in each project with different interests. As a result, manual reporting has become difficult and costly to coordinate all the operations, contract management, claims, and supply chain management needed. In the case of project design and management in a Block Chain Building Information Model (BIM) integrated with a self-imposing intelligent contract supplied in a larger circular economy by selected suppliers controlled through a blockchain network, blockchain may provide a direct solution to each of these problems or a holistic framework (Shojaei, 2019). As Faraji (2019) says, blockchain technology can revolutionise all of the construction industry's numerous stakeholders.

In any relationship, it can potentially bring several benefits, such as building trust, transparency, decentralization, transparency, immediacy, intermediary elimination, transaction automation, unchangeable records, democratising and distributing transactions, network sharing principles, and reading only reports (leaders). Moreover, blockchain technology makes transactions much more transparent than centralised networks do. However, disseminated network-based trust (i.e., other Blockchain users) is not used to execute transactions (Hamma-adama et al., 2020). As noted by Hewavitharana, Nanayakkara, and Perera (2019), one of the notable advantages of blockchain technology is its use to make payments without evidence and enforce trust.

Intelligent contracts use technology to eliminate delays and interruptions, as well as reduce paperwork in construction contract decision-making processes. Belle (2017) also reiterated that today, DLT and smart contracts are driving the growth of business models in sectors that depend heavily on financial transactions and information sharing, and if successful, not only services and products will change profoundly, but also the way work is organized. Compliance with trust in the construction industry is always difficult, and the use of blockchain in contractual construction management is one sure way of maintaining trust between all parties (Shojaei et al., 2020).

2. 2 Theories for Technology Adoption- A UTAUT2 Approach.

To solve problems, Awa et al. (2017) claim that the use of technology is dependent on information. Recent decades have seen a surge in interest in the adoption, purpose, and use of ICT (Merhi, Hone, & Tarhini, 2019; Venkatesh et al., 2012). Users' tolerance, acceptance, and satisfaction with technology have been extensively studied in the academic literature. Ajzen (1985), Davis (1989) and Venkatesh et al. (2003) have all proposed TPB (Ajzen, 1985) and TAM (Venkatesh et al., 2012) theories. This paper's final section discusses UTAUT 2. People use ICT for planning, as well as adoption and implementation. TAM was also mentioned by Venkatesh et al. (2003) as a common way to study how people like new technology.

Due to TAM's shortcomings, a lot of research has gone into developing new constructs and models (Benbasat & Barki, 2007). UTAUT was developed to address the shortcomings of later theories and models (Hujran, Abu-Shanab, and Aljaafreh, 2020). People's behavioural intentions (BI) are influenced by four key predictor variables. Effort expectancy, social influence, perceived expectancy, and facilitating conditions are the main designs. Existing theories have benefited from UTAUT's essence. When compared to previous theories, UTAUT can detect roughly 70% of variances in adoption intention (Tamilmani, Rana, & Dwivedi, 2019; Venkatesh et al., 2003; Hujran et al., 2020).

On the other hand, UTAUT's methodology lacks parsimony and power to justify its use (Casey & WilsonEvered, 2012; Van, Raaiji, & Scheppers, 2008). This led to the creation of UTAUT 2 by Venkatesh et al. Recent updates focus on variables that influence individual customer or user behaviour. Hedonic motivation and price appreciation are involved. For organisations and customers/users, this inclusion has increased the approach's generalisability. UTAUT 2 described more differences in people's attitudes toward technology than UTAUT did.

Perceived protection and privacy as key components of technology adoption issues were recognised in the current study model by Gutierrez et al. (2018) and Chopra, Korfiatis, Sivakumar, and Lytras (2018). These factors are shown and explained in great detail in the next parts of this work, which is based on the UTAUT 2 model.

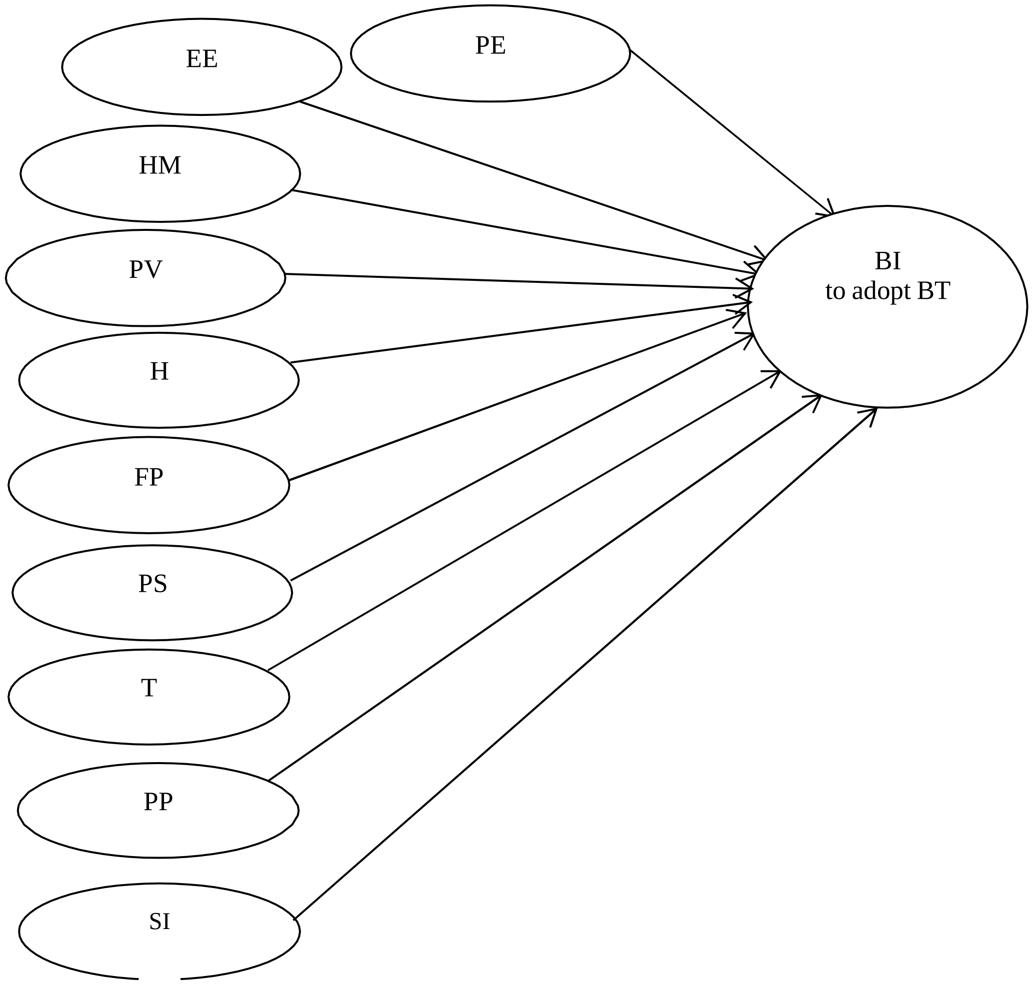

Fig. 7. Conceptual framework model.

Performance expectancy (PE)

Performance expectancy is the degree to which a client accepts that a thing will give them an advantage in performing specific tasks using a new innovation (Alazab, Dick, and Maleki Far, 2020; Venkatesh & Davis, 2000). Earlier literature on technology adoption and appropriation found this construct to greatly influence users' goal of embracing technology. Thus, clients may be happier with Blockchain technology if they perceive it as more beneficial and profitable in their job functions. Also, the following hypothesis is proposed:

H1: Performance expectancy will affect user's readiness to adopt BT on construction projects.

Effort expectancy (EE)

Effort expectancy is associated with ease of use of IT. If clients believe they can use IT without major issues and can do so purposefully, they are more likely to achieve normal performance (Zhou, Lu, & Wang, 2010). The following hypothesis is proposed:

H2: Effort anticipation will affect client's eagerness to receive BT on development ventures.

Hedonic motivation (HM)

It is particularly important in decisions involving new technologies and interpersonal interaction tools (Brown & Venkatesh, 2005). Venkatesh et al. (2012) define hedonic motivation as pleasure and enjoyment gained from using specific technologies. So, here's the hypothesis:

H3: Hedonic motivation will affect user's eagerness to embrace BT on construction projects.

Price Value (PV)

Prices of goods and services have varying effects on users' choices. Venkatesh et al. (2012) link user satisfaction to the cost of implementing new technologies like blockchain. Similarly, users will not be fully satisfied with their BT experience if the apparent benefits do not match the financial costs. As required, the following hypothesis is proposed:

H4: Price value will affect user's readiness to adopt BT on construction projects.

Habit (H)

Habit is a factor that influences users' ability to select and use IT services. Repeated movement or action can lead to a daily routine or habit (Ajzen & Fishbein, 2000). Adults, according to Venkatesh et al. (2012), rely on their habits, abilities, and schedules. As a result, the following hypothesise:

H5: Habit will affect user's ability to adopt BT on construction projects.

Facilitating conditions (FC)

The assets and backing available to perform a certain behaviour are described by Brown and Venkatesh (2005; Venkatesh et al. (2003) as "facilitating conditions." Using technologies, such as mobile shopping apps, requires certain assets and skills, such as using a phone or tablet, connecting to the internet, installing apps, and knowing a lot about mobile service transporters and security, according to Chopdar et al. (2018). A good set of enabling conditions will therefore encourage more people to use shopping apps. The following hypothesis is advanced:

H6: Facilitating conditions will affect user's readiness to adopt BT on construction projects.

Perceived security (PS)

The user's perception of danger is based on their vulnerability or fear of the consequences of their actions. Slade, Williams, and Dwivedi (2013) discovered that perceived security/danger is the second most important indicator of behavioural intentions. Merhi, Hone, and Tarhini (2019) agree that security flaws were frequently considered to prevent customers from accessing sensitive data online. Furthermore, mobile security breaches impacted mobile technology adoption rates. The hypothesis is as follows:

H7: Perceived security will affect user's ability to adopt BT on construction projects.

Trust (T)

Trust is an emotional belief that someone will keep their promises, and it plays a big role in questionable financial transactions where the system's clients are vulnerable to financial loss. According to Slade et al. (2013), trust is higher in electronic exchanges due to anonymity and lack of meaningful gestures. Thus, trust is assured when a domain has sufficient capacity, consideration, and respectability (Merhi et al., 2019). Trust, due to its opposite relationship to risk, was discovered to be an important influencer of embracing technology. Thus, greater trust in an innovation reduces perceived risk and influences the social goal. The hypothesised theory is:

H8: Trust will affect user's readiness to adopt BT on construction projects.

Perceived privacy (PP)

In this context, perceived privacy refers to a person's right to control the collection and use of personal data. In addition, it prevents unauthorised data exposure (Merhi et al., 2019). The following theory is proposed:

H9: Perceived privacy will affect user's readiness to adopt BT on construction projects.

Social Influence (SI)

Venkatesh et al. (2003) claim that social influence reflects how much an individual believes the importance of others will empower others to accept the use of new technology. They define social influence as the impact of a person's circle of friends or climate, including reference groups, family, companions, and partners, on their desire to receive an IT facility. Also proposed is the following hypothesis:

H10: Social influence will affect user's ability to embrace BT on construction projects.

Behavioural Intentions (BI)

Behavioural intentions depict an individual's willingness to engage in a specific action (Ajzen, 1991). Due to the fact that intentions are frequently viewed as preceding conduct, it is generally agreed that intentions have a huge impact on usage conduct (Gupta & Dogra, 2017). They also stated that people will generally participate in specific activities if their intentions are positive.

3. Materials and Methods

This study's population included users of Blockchain technology on construction projects in Imo State, Nigeria. The population is made up of professionals from various fields. Practitioners are concerned about rising IT demand and internet use in the construction industry, both formal and informal.

The study used non-probability sampling to find Blockchain users in Imo state. Purposive sampling was chosen for this study because it increases the likelihood of receiving accurate and reliable information. This study was conducted in Imo state from June to October 2020. It included data collection from built environment professionals. A self-administered questionnaire was given to the targeted participants.

The objects were rated on a five-point Likert scale. View, action, and attribute are the three types of data variables used in this study's questionnaires. The principal model constructs were calculated using previously validated scale items. For example, the UTAUT2 system has been adopted (Venkatesh et al., 2003; Venkatesh et al., 2012). Items for perceived privacy and protection were created to match the function that best describes users' understanding of Blockchain technology. So far, 232 of the 250 questionnaires have been returned, and 211 are useful for further statistical analysis. This is a 92.8% response rate. Prior to the main survey, a small sample of 30 practitioners was used to test the survey's reliability. All Cronbach alpha values were above the recommended level of 0.70 (Su & Yang,2010). The aim of the empirical study was to apply structural equation modelling to the adapted UTAUT2 model (SEM). SEM has become the dominant method for testing social science theories in research related to information systems and technologies. To use constructs in indicator variables while accounting for measurement errors (Amade et al., 2019; Memon et al., 2013). SEM was developed to help clarify the cause-and-effect relationship between dependent and independent constructs in exploratory science. The method also aids in predicting a set of relationshipshypothesised to better understand dependent variables' contradictions (Memon et al., 2013).

3. Results

3. 1 Results and analysis

A CFA was used to estimate the measurement model's fit. The findings were based on common model-fit measures (Su & Yang, 2010). The CFA model fit results are shown in the tables below. The measurement model's adequacy was assessed based on the results of reliability, convergent validity, and discriminant validity. First, composite reliability (CR) values were examined. Table 1 shows that all values are above 0.7, indicating the composite's sufficiency and reliability (Memon et al., 2013). The average variance extracted (AVE) for all variables was higher than the threshold value of 0.5, indicating the scale's convergent validity (Memon et al., 2013). The AVE of each latent factor is compared to the squared correlation coefficients between potential variables to determine discriminantvalidity (Amade et al., 2019). Table 2 shows that the squared correlation coefficients between possible variables are less than 1, indicating discriminant validity. SEM was used to test hypotheses using IBM SPSS Statistics 25.0. Thus, determining the model's goodness-of-fit for each variable is critical before evaluating the hypotheses via path coefficients using SEM. Thus, the goodness-of-fit metrics (X2 = 477.612, df = 210, p = 0.000, CMIN/df = 2.274, RMR = 0.052, GFI = 0.875, NFI = 0.855, IFI = 0.924, CFI = 0.918, RMSEA = 0.053) were identified. Table 3 shows the results of the hypothesis testing for each variable. PE (t = -10.278, β=-0.831, p = 0.082) had no significant positive impact on practitioners' behavioural intentions to adopt BT, thus not promoting H1. H2 was found to be enhanced by the use of the EE (t=2.254, β= 0.138, p=0.025). The HM (t = -4.06, β=-0.234, p = 0.069) had no significant impact on BT intentions, thus denying H3. PV (t = 8.790, = 0.641, p = 0.000) has a positive effect on the purpose of use, supporting H4. The H (habit) (t = 10.482, β= 0.907, p = 0.000) agreed with H5. FC (t = -7.570, β=-0.707, p = 0.078) harmed the purpose of continuous use, thus rejecting H6. As shown in t = 8.443, p = 0.000, perceived security (PS) influences the purpose of use, H7 is proposed. The purpose for continuous use was not influenced by trust (T) (t = 9.457, β= 0.999, p = 0.000). The effect of perceived privacy (PP) (t = -6.789, β=-0.438, p = 0.087) on the purpose of continuous use supports H9. SI (t =-8.732, β=-0.334, p = 0.064) had no effect on BT intention, ruling out H10.

Table 10. Measurement level.

Variable Item	Average Variance Extracted	Construct Reliability	Standardized Loading
PE	.848	.854	.886
EE	.804	.911	.903
HM	.881	.854	.833
PV	.755	.808	.824

H	.811	.934	.929
FC	.750	.806	.753
PS	.747	.817	.816
T	.906	.780	.917
PP	.852	.700	.892
SI	.648	.718	.785

Table 2. Discriminant validity amongst variables.

	PE	EE	HM	PV	H	FC	PS	T	PP	SI
PE	1.000									
EE	.352	1.000								
HM	.249	.303	1.000							
PV	.210	.236	.676	1.000						
H	.720	.148	.100	.021	1.000					
FC	.151	.152	.625	.471	.254	1.000				
PS	.017	.032	.498	.591	.473	.646	1.000			
T	.143	.427	.831	.656	.006	.555	.483	1.000		
PP	.507	.013	.220	.422	.545	.003	.152	.060	1.000	
SI	.117	.188	.472	.167	.225	.370	.409	.689	.466	1.000

Table 3. Path coefficient and level of significance.

Variable Item	Beta	t-value	p-value	Decision
PE-BI	-.831	-10.278	.082	Not supported
EE-BI	.138	2.254	.025	Supported
HM-BI	-.234	-4.067	.069	Not supported
PV-BI	.641	8.790	.000	Supported
H-BI	.907	10.482	.000	Supported
FC-BI	-.707	-7.570	.078	Not supported
PS-BI	.640	8.443	.000	Supported
T-BI	.999	9.457	.000	Supported
PP-BI	-.438	-6.789	.087	Not supported
SI-BI	-.334	-8.723	.064	Not supported

Note: Critical t-values. $p<.05$

4. Discussion

We found a link between BT willingness and trust, habitus, perceived security, price value, and effort expectancy. We found that trust influences willingness and intention to adopt BT (supporting the H8 hypothesis). This matches most other studies (Merhi et al., 2019; Slade et al., 2013). Trust is a key ingredient in all construction contracts. If practitioners must use BT on their projects, they must be assured that BT is trustworthy.

The willingness of practitioners to use/adopt BT was found to be significant (supporting hypothesis H5). The findings of this study suggest that perceived security influences practitioners' willingness to use/adopt BT (accepting hypothesis H7). This result contradicts other recent IT studies (Chen et al., 2020; Kwateng et al., 2018; Hujran et al., 2020), which never integrated security with emerging technology adoption. Those considering BT need assurances that unauthorised access and data theft are prevented. This is vital. Moreover, our findings show that price value influences willingness to adopt BT (accepting hypothesis H4), which is supported by previous research (Kwateng et al., 2018; Merhi et al., 2019).

As a result, prospective users of emerging technologies will never be satisfied with their experience if the perceived benefits outweigh the financial costs. This finding confirms that professionals in construction projects prioritise BT price over other factors. Finally, the willingness to adopt and use BT influenced effort expectancy (accepting hypothesis H2). Several previous studies found effort expectancy to be a barrier to BT adoption (Merhi et al., 2019; Kwateng et al., 2018). However, in the study by Chen et al. (2020), the outcome supports theirs. As a result, practitioners perceive BT as simple to learn and apply on their construction projects.

5. Conclusions

Using the UTAUT 2 model, the paper examined the effects of users' intent to adopt Blockchain technology on their construction projects. This study filled a gap in the literature by focusing on Blockchain adoption on construction projects in Imo State, Nigeria.

Perceived security, trust, privacy, social influence, and performance expectancy were examined theoretically and empirically in relation to users' behavioural intentions to adopt blockchain technology. The findings reveal five major influences on a user's willingness to adopt Blockchain technology. For example, expectancy of effort and trust. They describe a situation where a user feels comfortable using Blockchain applications because practitioners and clients trust each other. The model produced stable results that supported most of the proposed constructs. The study's findings add to the existing literature by revealing the willingness to adopt Blockchain technology. From a consumer perspective, this study adds to the body of knowledge on how people view common technology in construction.

As this paper focused on Blockchain technology, future research studies will need to expand the model with additional constructs to provide a more detailed view. Further research could examine the direct and indirect effects of normative values on usage behaviour. This study also did not examine the moderating effect of certain characteristics, which could theoretically alter the model's relationships. Future studies may also test the model in new locations, helping to generalise the findings.

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