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Original Research Article

Enabling Sustainable Development Platform Combined with Blockchain Technology

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ABSTRACT

The viability of implementing Blockchain technology in sustainable development platform is thoroughly explored in this study. A healthy ecosystem for all inhabitants can be built by introducing a new behavioural shift through combating harmful environmental activities. The paper outlines the benefits that the users might get from integrating tokenization technology into their regular routines. To determine whether the blockchain will be accepted by its potential users, this article employed the technology acceptance model (TAM). This research reveals that TAM's constructs have a big impact on the way people think about using blockchain-enabled solutions in a platform for sustainable development. The strategy suggests that government agencies and financial players concentrate on factors affecting residential and industrial consumers' attitudes toward adopting blockchain to provide a platform for sustainable development.

KEYWORDS

TAM, Sustainable development, Blockchain technology, Tokenization, Behaviour change.

INTRODUCTION

Cryptocurrencies have gathered a lot of attention since the birth of Bitcoin in 2009 [1]. Blockchain is a peer-to-peer distributed ledger technology invented by Satoshi Nakamoto in 2009 to serve as the public transaction ledger for the cryptocurrency bitcoin [2]. Blockchain technology has reinvented data storage by synchronizing the data across a network of participants in compliance with the agreed-upon codified rules so that each individual participant holds a copy of the record chain [3]. During the rapid development and increased interest in blockchain during the last few years, different processes that benefit from the fact that they are being implemented with blockchain technology have gained attention [4]. The blockchain technology potentially allows individuals and communities to redesign their interactions in politics, business and society at large, with an unprecedented process of disintermediation on large scale, based on automated and trustless transactions [5]. Blockchain technology has the potential to deliver a wide range of benefits through its ability to enforce trust in a trustless environment. The exponential growth of cryptocurrencies and tokens demonstrates there is an increasing acceptance of this new asset class, and the benefits of this technology are more and more recognized among financial market participants [6]. The uniqueness of blockchain lies in its capacity to store and retain person-to-person transactional history, so that chances of fraud, hacking, and third-party interference are

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eliminated [7]. During the rapid development and increased interest in blockchain during the last few years, different processes that benefit from the fact that they are being implemented with blockchain technology have gained attention. Tokenization is one of the processes on which the spotlight of blockchain popularity has landed [4]. Tokenization refers to the process of creating a token on a blockchain that represents an asset. These tokens can be representations of traditional tangible assets (such as real estate, agricultural or mining commodities, analog artworks), financial assets (equities, bonds), or nontangible assets such as digital art and other intellectual property [8]. Populations across the globe experience the digital revolution in different ways, but these early use cases can be combined with current research in identifying specific token designs that are optimal for behaviour targets, to develop appropriate and scalable behaviour change programs [9]. In the spirit of Adam Smith [10], we argue that tokenization, a technology that promotes free trade and free markets, advances a sustainable global economy [11]. Token-based interventions are a well-established approach in citizen's behaviour change towards a sustainable development, and blockchain technology offers a firm technical foundation form implementation of token economies. Behaviour change is essential for effective solutions to climate threats [12]. Addressing climate change requires profound behaviour change, not only in consumer action, but also in action as members of communities and organizations, and as citizens who can influence policies [13]. Behaviour change is a central element of addressing the climate crisis [13]. Behaviour changes tools and techniques are vital resources for councils to work with their local communities to sustain or change residents' behaviours to reduce climate change [14]. Investigate the posterity role that tokenised blockchain-based systems can play in promoting momentum towards increased adoption of sustainable environment's attitudes across the globe provides a supportive scope for research, extending from behaviour science through operationalisation of blockchain-based deployments. As technology has grown steadily in recent years, technology-related academic research and scales have also gained popularity [15]. User acceptance of technology has been an important field of study for over two decades now. Although many have been proposed to explain and predict the use of a system the technology acceptance model has been the only one which has captured the most attention of the important system community [16]. Technology Acceptance Model (TAM) has been developed by Davis (1989) is one of the most popular research models to predict use and acceptance of information systems and technology by individual users [17]. Several studies have been applying Technology acceptance model to predict use and acceptance of information systems and technology by individual users in many studies in different information systems constructs. The main objective of this paper was to apply technology acceptance model to investigate behavioural intention of citizens directly involved in climate sustainable initiatives. Numerous behavioural theories and models exist to explain and predict mitigation and adaptation actions [18]. The Theory of Planned Behaviour (TPB) [19] [20], the Value-Belief-Norm (VBN) [21]; [22] and the Trans theoretical Model (TTM) [23] are most commonly applied to mitigation behaviours while few have employed technology adoption models like the TAM to determine the factors affecting behavioural change desire to apply solutions that are block-chain based.

In addition to above, prior research has been largely theoretical on this topic, with an absence of empirical studies that explores the perceptions and experiences of citizens and or professionals involved in climate sustainable activities in developing countries. This gap in this research highlights the indispensability for a comprehensive study that examines the factors affecting the adoption of blockchain technology in enabling solutions in a platform for sustainable development towards behaviour change for citizens using the TAM model, specifically in Mozambique.

THEORETICAL BACKGROUND

Behavioral Change

Behaviour change is often narrowly conceived as individual-level consumer action (e.g., buying a low-carbon product, recycling, reducing meat-eating), but is more appropriately understood as extending across the many roles and contexts humans occupy: as members of communities, participants in organizations, and as citizens who can influence policies [24]. Addressing climate change requires profound behaviours change, not only in consumer action, but also in action as members of communities and organizations, and as citizens who can influence policies [18]. Behavior change interventions (BCIs) are understood as "Coordinated sets of activities designed to change specified behavior patterns" [25], [26]. Numerous cryptotokens fit this definition with some already being used as behavior change tools. This potentially results in significant opportunity cost and risk due to a lack of behavioral insight in current design and management practices [26]. Cryptotokens are often designed assuming that intended social behavior will emerge from a well-designed application (or "DApp"). This assumption is well known to social impact practitioners and rarely proves true and when false, it can create more harm than good [27] [26]. Computer code can mirror cryptotokens as part of an intervention and it can easily be modified. The benefit of this codification is that it lowers barriers for experimentation and understands the framework. Therefore, it demands a profound study on how these users might receive and experience the platform and adapt to Behavioral change interventions.

Blockchain

Blockchain is a secure series or chain of time stamped records stored in a database that a group of users manages who are a part of a decentralized network [28]. This helps it to record transactions through a secure and verifiable process without any intermediary [29]. In its simplest form, a block in the blockchain contains data segregated in multiple small entities called transactions, a hash of the previous block [29]. The structure is explained in Figure 1. Blockchain is based on Distributed Ledger Technology and achieves immutability by securely storing ledger copies on all the participating nodes [29]. The coherency is achieved through different consensus algorithms (consensus based on Proof of Work (PoW), Proof of Stake (PoS), etc.). The participating nodes form the Peer to Peer (P2P) network and a communication protocol is implemented among them to carry out information dissemination [29]. To avoid data corruption and unnecessary data, the blockchain is reproduced on every node in the network [30].

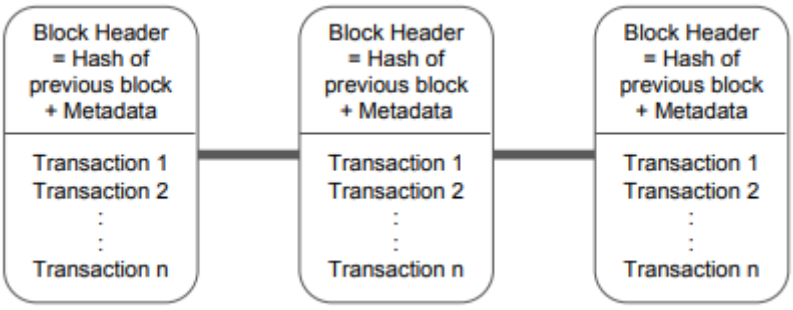

Figure 1. A basic blockchain structure [29]

The immutability of the data stored in the blockchain is secured by a hash linked list architecture. A manipulation of a block in the middle of chain would alter the header hash and therefore would break the whole hash linked list integrity [31]. To be able to manipulate data in a blockchain, one should alter all the following blocks also and have these validated in the network. Altering data is not so hard but validating them via a consensus becomes very tricky.

To be able to validate these tampered blocks, one should typically control over 50 % of the blockchain network so the validation can be agreed via the consensus algorithm. The blockchain workflow can be structured in five stages: start the transaction process, broadcasting and verifying them in the network, structure the blocks that include the transactions, validating the block (e.g. mining) and then appending these blocks to the blockchain and syncing the nodes.

Public blockchain. Public Blockchain is an open blockchain, where everyone can join and participate in the network and become one of the nodes in the network. The merged party can keep records of existing transactions [32]. A public blockchain network is permissionless, which allows all nodes of the blockchain to have equal rights to access, create, and validate new blocks of data [33]. The network typically has an incentivizing mechanism to encourage more participants to join the network. Public blockchains are decentralized and anonymous [34]. However, they imply little to no privacy for transactions [35], [34]. Public blockchains stand out by the fact that they rely entirely on the trust that we can place in the computer code that underlies the exchanges [36]. The Bitcoin and Ethereum platform are some examples of public blockchain.

Private blockchain. Private Blockchain is a blockchain that is only open to some party or organization for certain purposes. In Private Blockchain, anyone wishing to enter must be invited or validated by the one who runs the blockchain [37]. The Hyperledger Fabric is an example of a private blockchain. A private blockchain network requires invitations and must be validated by either the network starter or by participants restricted by the starter. It is generally set up as a permissioned network [38] [34]. Technically, private blockchains are consortium blockchains but applied to different units within the same company or organization [36]. The advantages of implementing these systems lie in simplifying and smoothing intra-business exchanges by substituting the control nodes of shared systems. From a private business perspective a Private Blockchain, a private blockchain cannot be accessed by just anybody behind a corporate firewall and it can be running on-premises. Users need an authentic and verified invitation to join this network.

Consortium blockchains. Consortium blockchains rely on software developed by public blockchains, but instance them in environments that we can call "privatized" [1].

As a summary, we can formalize the afore-noted features of the blockchain into a list of four core characteristics [39]:

Decentralized – (networked copies) a blockchain is stored in a file that can be accessed and copied by any node on the network. This creates decentralization.

Transparent – (full transaction history) since the blockchain is an open file, any party can access it and audit transactions. This creates provenance under which asset lifetimes can be tracked.

Immutable – (permanent and tamper-proof) a blockchain is a permanent record of transactions. Once a block is added, it cannot be altered. This creates trust in the transaction record.

Consensus Driven – (trust verification) each block on the blockchain is verified independently via a Consensus model which provide rules for validating a block, and often use a scarce resource (such as computing power) to show proof that adequate effort was made. In Bitcoin, this is referred to as the mining process. This mechanism works without the use of a central authority or an explicit trust-granting agent.

Tokenization

Tokenization is a process of transformation of asset accounting and management in which the ownership of an asset is represented by a digital token. The essence of tokenization is to create digital accounting systems for real values in order to record and process transactions reliably [40]. The transformation of original data into tokens is done through one-way

cryptographic function, which makes it impossible to reconstruct the original data without accessing the resources of the tokenization system [41]. Tokenization not only expands opportunities that were once limited by geographical or financial constraints but also enhances the accuracy and timeliness of asset pricing. Assets that were previously illiquid now experience increased trading activity [42]. Moreover, institutions explore tokenization primarily for the following reasons:

1. Significantly boosting liquidity, accessibility, and transaction speed, resulting in reduced ownership and transaction costs.
2. Enabling fractional ownership by allowing more people to participate in investment opportunities that were previously inaccessible.
3. Enhancing security through increased transparency, as tokenized assets are recorded on a blockchain, which provides a transparent and immutable record of ownership. The figure below is a generalized version of the tokenization process and is based on the PCI DSS Tokenization Guidelines (PCI Data Security Standards 2011) [41].

The tokenization process:

- The application passes the data needed to be tokenized along with the authentication information to the tokenization system;
- The tokenization system checks the validity of authentication information. If authentication fails, then the process stops and the information is sent to the event collection system. This will allow administrators to identify issues and properly manage the system. If authentication is OK, then the system goes to the next step;
- The tokenization system generates, based on one-way cryptographic algorithms, the token for the data passed and both are stored in the highly secured data vault;
- The new token is passed on to the application for further usage. The critical point of this system and the most attractive target for hackers is the data vault where the actual sensitive data is stored. The vault needs to be protected with strong encryption capabilities and an enhanced key management system which will ensure that the sensitive data will be accessed only by authorized people and applications.

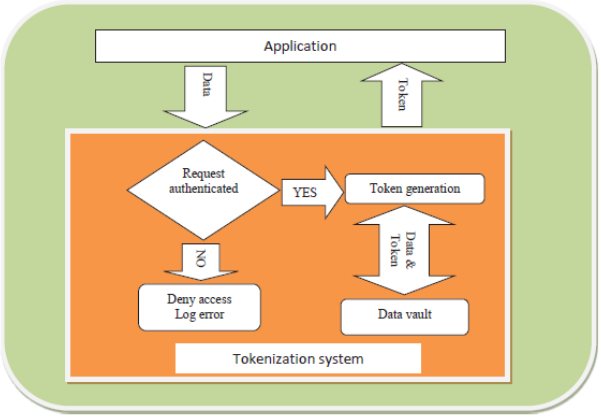

Figure 2. The tokenization process [41]

Information Systems Analysis Theories

Technology Acceptance Theory (TAM). Fred D. Davis first developed the Technology Acceptance Model (TAM) in 1985 for his doctorate proposal [43]. The goal was to understand the user acceptance processes and provide a model for the system designers and implementers to predict acceptance and usage of those systems before their implementation [43]. Davis proposed that the actual use of a system can be explained by the stimulus given by its features and capabilities that create motivation to use the system [44]. TAM uses as a theoretical backdrop the Theory of Reasonable Action (TRA), proposed by Fishbein in 1967 and analyzed

and refined by Fishbein and Ajzen in 1975 [45]. The way beliefs are specified, modeled and measured varies from TRA to TAM. Also, both behavioral intention (BI) and subjective norms are excluded from the TAM's first draft. BI was not included because Davis considered that when individuals have not formed an intention regarding a behavior, their attitude would better predict the choice than the BI [44]. However, Davis kept developing this model throughout the years and in 1989, the researcher presented a new version of the TAM in which introduces the BI variable, previously omitted in the first draft. In this first modification to TAM (**Figure 3**), behavioral intention is the main determinant of usage, being influenced by the person's attitude toward using and the perceived usefulness. The model recognizes that there may exist other factors influencing the user's decision and state them as external variables [45]. In this cognitive model, there are two constructs perceive usefulness and perceived ease of use is crucial in computer use behaviors. Davis defines perceived usefulness as the prospective user's subjective probability that using a specific application system will enhance his or her job or life performance [17]. Perceived ease of use (EOU) can be defined as the degree to which the prospective user expects the target system to be free of effort [17].

These two factors are influenced by external variables. The main external factors that are usually manifested are social factors, cultural factors and political factors [17].

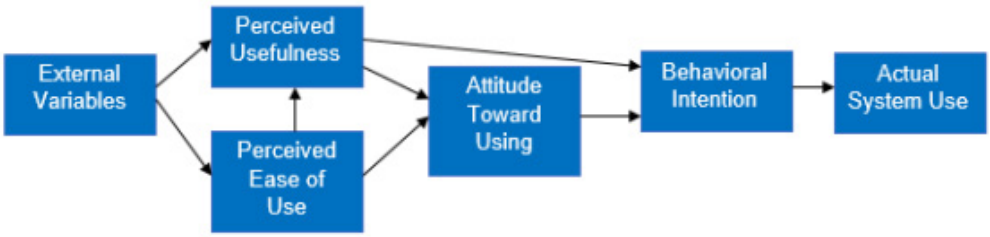

Figure 3. The Technology Acceptance Model. Adapted from Davis et al., (1989) [43]

MATERIALS AND METHODS

For the development of empirical study, this section describes the methodological procedures designed to achieve the general and specific objectives established for the research. In addition to the presentation of its typology, this section presents its analysis units, the objects and subjects of the research, the data collection instruments, the application of data analysis, and finally, the criteria for the reliability of the data.

Data Collection

For data collection, the following techniques we employed a documentary research, structured questionnaire. In parallel with the application of the questionnaire, participant observation took place. It is important to emphasize that participation in this research contributed to increasing knowledge about the subject studied, and the research findings may help in the development of future studies, as well as, through the research product itself, identify and qualify the decision-making process of the participant himself. Therefore, this is another benefit of the research, since the present study intends to contribute to improving the assertiveness of the tactical decision-making process for the introduction of Blockchain and tokenization in citizen's behavioral change and also their business. The collected data were analyzed using the SPSS software tool. The structured questionnaire was applied. The questionnaire was essentially structured with closed questions and mostly measured using a 7-point Likert scale from strongly disagree to strongly agree. The entire questionnaire was designed and developed to be easy, intuitive and quick to complete. All responses were anonymous and confidential. The research questionnaire was divided into 10 blocks of questions, where each block is based on the variables of the theory of analysis of information systems, TAM proposed by Davis (1989). This questionnaire contained a short introduction,

which briefly explained its context and purpose and, at the same time, called for the collaboration of the respondent to fill it out voluntarily. The first group of questions was related to the use of Climate Behavioral change combined with Blockchain and tokenization in the cities, the second group with the perceived usefulness, the third with the perceived ease of use, the fourth with the attitude, the fifth with the intention of using the Blockchain and tokenization in the cities and their business, the sixth with the quality of the system, the seventh with trust/security, the eighth with privacy, then general precautions and, finally, the tenth group with the characterization of the respondent. The research was directed to the group of fellows from the Ideate Cohort supported by Standard Bank, totaling 66 interviewees in a sample of 70 employees. The purpose of this fellowship was to train a group of young entrepreneurs in green business that can generate green jobs, activate green business that can support local citizens in ameliorating their daily routines activities and tackle the 2030 Sustainable Development Goals efficiently. This program is funded by the Standard Bank, E4D, and GIZ which aims to empower green entrepreneurs and incentivize sustainable services and products to citizens in developing countries. As part of the development of this work, a questionnaire was addressed to the fellows from the Ideate Cohort program, who directly participated in the daily activities of interaction with computational systems. The questionnaire was prepared by the researchers based on the consulted bibliographies, cohort's fellows' knowledge on climate behavioral change sustainable attitudes and their experience with the green business. The referred questionnaire also allowed the interviewees to report some observations relevant to the subject in question, and the content of the questions served to improve the analyzes in relation to the following items: (a) expectations of the fellows when choosing to implement the blockchain and tokenization tools in behavioral change in their business and as citizens; (b) possible benefits to be obtained with the implementation of Blockchain and tokenization tools in the better behaviours change towards a sustainable business environment and cities. The submission of documents took place between the months of May and June of two thousand and twenty-three.

Sample Determination

To determine the sample, two sampling methods were identified: probabilistic samples and non-probabilistic samples. Non-probabilistic and judgmental sampling was applied to this research. The identification of the sample was mirrored in the judgment criteria of the researchers, taking as indicators the available data regarding the population. As for the type of sample, it was intentional and the researchers' assessment predominated. The key feature of judgmental sampling is that elements of the population are intentionally selected.

Model of Research Hypotheses

In the following **Figure 4**, we can verify the proposed model that reflects the mentioned constructs, as well as the different hypotheses suggested.

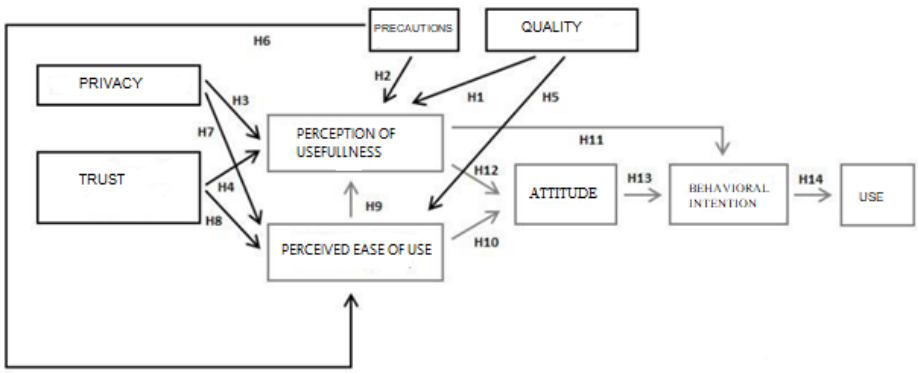

Figure 4. Model proposed [46]

The model thus created is composed of four more constructs, in addition to those already existing in the Davis model (1989), which give rise to fourteen hypotheses.

Four of these hypotheses refer to the influence of the introduced constructs on the perceived utility (PU) of Blockchain and tokenization technology in cities and business:

H1: The quality of the user's system of Blockchain and tokenization technology in cities and business influences the perceived usefulness of the system: the higher the quality of the system, the more positive the perceived usefulness.

H2: The precaution of the Blockchain and tokenization technology in cities and business influences the perceived usefulness of the system: the greater the precaution in using the system, the less positive the perceived usefulness will be.

H3: User privacy of the Blockchain and tokenization technology in cities and business is reflected in the perceived usefulness of the system: the greater the privacy, the more positive the perceived usefulness.

H4: User trust/security of Blockchain and tokenization technology in cities and business influences the perceived usefulness of the system: the greater the trust/security, the more positive the perceived usefulness. Four hypotheses concern the influence of the introduced constructs on the perceived ease of use of Blockchain and tokenization technology in cities and business.

H5: The quality perspective of the Blockchain and tokenization technology in cities and business influences the perceived ease of use in relation to this system: the higher the quality, the more positive the perceived ease of use.

H6: The user's precaution of the Blockchain and tokenization technology in cities and business influences the perceived ease of use in relation to this system: the greater the precaution, the less positive the perceived ease of use will be.

H7: The perspective of user privacy of the Blockchain and tokenization technology in cities and business is reflected in the perceived ease of use in relation to this system: the greater the privacy, the more positive the perceived ease of use.

H8: User trust/security of Blockchain and tokenization technology in cities and business influences the perceived ease of use in relation to this system: the greater the trust/security, the more positive the perceived ease of use. From the perspective of the original TAM constructs, we propose, for the context of Blockchain and tokenization technology in cities and business, the following six hypotheses:

H9: Perceived ease of use influences perceived usefulness: the greater the perception of ease of use of Blockchain and tokenization technology in cities and business, the greater the perception of its usefulness.

H10: Perceived ease of use influences the attitude towards Blockchain and tokenization technology in cities and business: the greater the perception of ease of use of Blockchain and tokenization technology in cities and business, the more positive will be the users' attitude towards it.

H11: Perceived usefulness influences the intention to use Blockchain and tokenization technology in cities and business: the greater the perceived usefulness of Blockchain and tokenization technology in cities and business, the greater the intention to use it.

H12: Perceived usefulness influences the attitude towards Blockchain and tokenization technology in cities and business, the greater the perception of usefulness of Blockchain and tokenization technology in cities and business, the more positive will be the users' attitude towards it.

H13: Attitude influences the intention to use Blockchain and tokenization technology in cities and business: the more positive the user's attitude towards Blockchain and tokenization technology in cities and business, the greater their intention to use it.

H14: Intention to use influences the use of Blockchain and tokenization technology in cities and business: the greater the intention to use Blockchain and tokenization technology in cities and business, the greater its use.

ANALYSIS AND DISCUSSION OF RESULTS

In this section we will be presenting the socio-demographic data of the chosen interviewers and seeks to interpret the results of the hypotheses according to Pearson's coefficient.

Descriptive Analysis

After collecting the questionnaires, they were concentrated in the Google Docs analysis tool, which provides quantification of the data according to the graphs presented. Regarding demographic data, they present a higher percentage of responses by the male gender (35%) than by the male gender (65%). In relation to the age group, in general, it is clear that there is a high level of maturity. Mostly aged between 20 and 35 years old. In general, the interviewees have an excellent level of education. A proportion of employees have postgraduate degrees, corresponding to 39%. The complete higher education option was selected by 61%. When it comes to the use of information and communication technologies, the majority responded that it is relatively easy, equivalent to 88%. As previously described, it was observed that most of the interviewees are over 20 years old, which may imply a greater ease of perception of the ease and usefulness of Blockchain and tokenization technology, consequently leading to greater acceptance and use of the system. Regarding the use of technology in general, 88% said it was relatively easy or very easy. In this way, there is a tendency for a large part of the interviewees, regardless of age, to also have good resourcefulness and assimilation in the use of Blockchain technology and tokenization, which is a factor that can favor better acceptance and use of the system. Another point that can contribute to better acceptance and use is the high level of education, since 82% of those surveyed have at least a higher education degree, which would increase their ability to interact with the system. Therefore, there is a tendency for most of those surveyed to have a better perception of the ease of use and usefulness of Blockchain.

Assessment of the Measurement Model

The Cronbach's alpha model was established to determine the mean of internal consistency. The measurement model applied was as described in **Table 1**, the Cronbach coefficient was between the range of 0.725 and 0.867. These reliability values indicate to be good **[47]**.

Table 1. Cronbach's alpha model

Constructs	Cronbach's alpha (α)	Number of items
Attitude (AT)	0.725	4
Behavioral intention (BI)	0.707	3
Perceived ease of use (PEU)	0.911	6
Perceived usefulness (PU)	0.780	6
Trust of system	0.845	5
Privacy	0.834	4
Precaution	0.820	1
Real use	0.834	2
Quality of the system	0.867	4

Source: Authors

In this research, the TAM method was adopted to proceed with the validation of the study, the constructs privacy, precaution, system quality, trust were added to better assess the degree of acceptance of blockchain technology and tokenization at the level of a group of participants in a Green Business Empowerment Cohort sponsored by Standard Bank, GIZ and E4D to understand their degree of acceptance of Blockchain technology in a system of rewarding

sustainable attitudes in their routine activities and in their businesses. For each of the constructs, a certain number of items were included for each construct, totaling 35 items as previously described. We performed an exploratory analysis to determine the discriminant validity of the scales. From the analysis, the construct perceived ease of use was observed with (α=0.911), indicating that Blockchain and tokenization technology appears to be easy to use. In parallel with this construct, there was a conformity in relation to behavioral intention, attitude and perceived usefulness. For a better understanding when it comes to real use, we seek to understand the institution's digital ecosystem when using unique systems previously used and currently used so that we could have an extension of the possible approach and/or understanding of employees with the implementation of a tokenization system coupled to Blockchain.

4.3 Structural Model

Regarding the structural model, an analysis of the latent variables was conducted using the Bootstraping command. This process allowed us to calculate the R^2 of the variables as the model's path coefficients. Based on this procedure, we can observe that the analysis supports hypotheses H1, H2, H3, H4, H5, H6, H7, H8, H9, H10, H12, H13, H14.

Table 2. Dependent constructs R2 values

Endogenous constructs	*R*2	*Q*2
Perceived Usefulness	0.667	0,445
Behavioral Intention	0.493	0,345
Perceived ease of use	0,587	0,457
Attitude	0,767	0,687

Source: Author

Table 3. Hypothesis validation

Hypothesis	Direct effect	*T*-value bootstrap	Hypothesis Acceptance
H1	0, 278	2,048	Yes
H2	0,244	1,890	Yes
H3	0,718	6,780	Yes
H4	0,788	7,750	Yes
H5	0,889	8,767	Yes
H6	0,434	3,546	Yes
H7	0,389	3,780	Yes
H8	0,288	3,233	Yes
H9	0,717	6,888	Yes
H10	0,679	6,070	Yes
H11	0,345	2,888	Yes
H12	0,254	2,024	Yes
H13	0,567	5,074	Yes
H14	0,989	8,453	Yes

Source: Authors
Note(s): *$p < 0.05$; **p<0, 01;***$p < 0.001$;

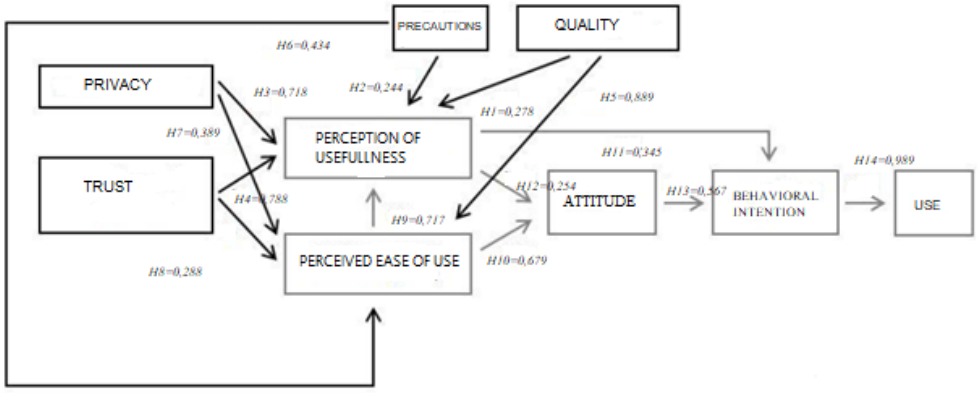

Figure 5. Structural model Source: Author

Discussion

The research analyses the usage intention, attitude, perception, attitude, of potential users towards the system while adopting information communication technologies blockchain and tokenization cryptocurrencies rewarding system in their daily routines and better environmental attitudes towards a sustainable world. Technology Acceptance Model (TAM), which postulates that the acceptance of technology is predicted by the user's behavioral intention, which is in turn determined by the perception of technology usefulness in performing the task and perceived of its use was adopted in this research. Determining the perceptions of potential users towards the tokenization platform system will support the construction of a new disruptive frameworks sustained by the government and financial agencies such as banks and other stakeholders interest in promoting sustainable behavior changes that can be adopted by citizens and companies by utilizing tokenization cryptocurrencies systems as rewarding mechanisms to reduce the negative impacts on the atmosphere originated by the incorrect attitudes of the human beings and also industrial companies. Building on this phrase, 0 says that environmental attitudes have been defined in many ways, such as "the collection of beliefs, affect, and behavioral intentions a person holds regarding environmentally related activities or issues". In spite of the fact that, the application of tokenization in rewarding mechanisms is scarce at present, it has reveal to be an essential instrument to serve as an alternative financing vehicle to supplement the exponentially reversing process that the climate scenario can illustrate if citizens alter their perspective in a digital environment that aggregates tools to this change through an incentive instrument to support government and financial agencies to accomplish the Sustainable development goals 2030. Extensively, the government and bank agencies can explore the possibility to create necessary regulations in the future to oversee the tokenization cryptocurrency system that will create a dynamic environment to interact with citizens and companies regarding cognitive attitudes in the direction of better sustainable environment manners on the citizens and business owners. The progress of innovations is growing exponentially in the information age. Since the advent of Bitcoin in 2009, the profile of blockchain – a combination of distributed ledger technology (DLT) with a variety of block-based encryption technologies – has soared. In the past ten years, blockchain has been considered as a rising reflection to the technology billed for the future. Blockchain technology has tremendously changed and inspired business models and impacted significant flutter in different industries. Repose on the blockchain, tokenization actuates as an enabler that facilitates the transition of assets with values in predominant patterns into cryptographic tokens. This evolution could ameliorate performance by orders of greatness. The continuous development of technology impacts both internet connections and devices to be better, to intensify the transaction performance of people and proportionally the time spent in the digital environment. Blockchain-based crypto money systems, tokenization are rapidly growing the number of users daily and are becoming areas where people are more interested. When the

hypotheses tests of the research were examined, the H3, H4, H5, H6, H7 and H8 hypotheses were accepted. Hypotheses H9, H10, H11, H13 and H14 were obtained from the analysis results, which were not related to the ease of use of the tokenization system of privacy and trust. The H7 hypothesis, nonetheless, did not have a direct influence, as perceived ease of use had an indirect relationship with intention. The participants' opinions about the ease of use influence the advantage they will get from the system and indirectly impact on their choices. The level of awareness of the blockchain technology and its advantages extended to tokenization in the research's participants was considerable high. Nevertheless, the genuineness that the research's participants perceive the blockchain as a bridge to achieve monetary rewards towards their sustainable attitudes in their daily professional and personal activities makes the quality an important variable. For users to tend to be influenced by blockchain technology, the system must provide quality and profound understanding of the advantages of this technology. It is observed that the applicability part of the blockchain as a transaction digital platform and rewarding feature with tokenization forthwith impacts people's perceived usefulness and intentions to use them. In this circumstance, the acceptance of the H1 and H2 hypotheses is with the crucial results of the research. The precaution that users perceive from digital transaction systems as blockchain is also very important. The use of systems users sees as a precaution with the normal systems they use is positively affected. The positive effect of precaution on the perceived usefulness of the individual is among the fundamental results of the research. Nevertheless, when the total results are examined, trust also affects the intention highlighting the requisite of showing correspondence to the previous digital habits and digital knowledge atmosphere that these users have to reconcile in a disruptive technology such as blockchain and tokenization in a practical scenario. As a result, since the interviewers are heretofore carrying out business that contributes in the direction to net zero business, it is concluded that they can easily gravitate to a digital tool such as tokenization that envisage to reduce the carbon dioxide emissions due to human activities and provide better insights to their customers and even in their daily routines as citizens. Users choose to interface in systems they trust. Resultantly, with the development of technology, the adoption of disruptive technologies such as Blockchain and the acceptance of use are thoughtfully related to the system's reliability. As is shown in the H9 hypotheses, users' finding the system secure has a direct impact on their perceived usefulness. Notwithstanding, as illustrated in the total effects table, it also influences the behavioral intention. As highlighted above, it is observed that the independent variables in the research model, quality, privacy, precaution and trust blockchain systems, are essentials aspects for people to use tokenization cryptocurrencies over a blockchain platform as a rewarding mechanism towards a sustainable environment. It was observed that the coefficient of determination in the research is a moderate effect size (R^2 values are higher than 0.70) 0. Thereupon, it is feasible to state that the independent variables included in the research model are sufficient. Nevertheless, exploring different variables in this research will certainly contribute to literature.

CONCLUSION

In the sense of remainder, the present article gave rise to five essential conclusions that can be employed by government institutions, financial agencies, decision-makers, planners of environmental behavioral change dissemination to encourage the intention to use tokenization to adopt new environmental attitudes. First, moral and ethical norms of sustainable and better environmental habits, attitude towards a better ecosystem, perceived behavioral control on using blockchain and tokenization, and understanding of transaction digital tools are four fundamental variables that have direct, positive, and substantial impacts on intention towards adopting tokenization cryptocurrencies in their daily routines and business interactions. Second, moral norms midmost the impact of abstract norms on intention. Following, validity also interferes the impact of abstract norms on intention towards using tokenization cryptocurrencies as a rewarding mechanism to incentivize citizens to adopt green attitudes. The

second and third conclusions were one of the most fundamental novel contributions of the present study that had not been explored in previous studies. Fourth, the SPSS outcomes revealed that the employment of Tokenization and TAM in the scheme of a cognitive model is a reliable and valid model to encourage the intention to use reinforce the green business, positive environmental attitudes even to each of their customers. From a practical perspective, these four conclusions can act a critical part in paving the way for encouraging behavioral change and the intention to use tokenization cryptocurrencies to reward citizens. In the present research there were three limitations, the characterization of which can one as well as the other interpret the process of the present research and lead the way for further exploration in this field. First, in the present article, this research was conducted only in Mozambique. Whereas sampling has been done scientifically and the outcomes of the data-model fit also reveal the solidness of the model, but the repetition of this study using cross-validation in other countries can reinforce the stability of the results and model in different spatial and temporal scopes. Thus, the relevancy of study results raises. Second, the conceptual framework of the present study included four (4) external variables which were precaution, privacy, quality and trust or security. Without regard to, these constructs can be readapted to different constructs that can support this research in expanding the outcomes of this investigation future researchers can rename with other external variables or socio-economic variables such as technical influential, self-promotion of the technology and etc. Lastly, in this article, the target population was entrepreneurs involved in green business.

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Author's Contributions

Cátia Joaquina Siueia wrote the entire article.

NOMENCLATURE

Abbreviations

BI	Behavioral Intention
DLT	Distributed ledger technology
DSS	Data Security Standards
P2P	Peer-to-Peer
PEOU	Perceived Ease Of Use
PU	Perceived Usefulness
PoW	Proof-of-work
PoS	Proof-of-Stake
TAM	Theory of Technology Acceptance
TRA	Theory of Reasoned Action
TPB	Theory of Planned Behavior

REFERENCES

1. D. Sobe, Token Economy – Towards Building a Sustainable Dissertation, *partial requirement for obtaining the Master's degree in Information Management*, NOVA Information Management (NOVA IMS), School Universidade Nova de Lisboa, Lisboa, Portugal, July 2022.
2. D. Uzsoki, Tokenization of Infrastructure A blockchain-based solution to financing sustainable infrastructure, Report, International Institute for Sustainable Development, Winnipeg, Canada, January 2019.

3. M. Andoni, Blockchain Technology in the Energy Sector: A Systematic Review of Challenges and Opportunities, *Renewable and Sustainable Energy,* Vol. 100, pp 143–174, February 2019, https://doi.org/10.1016/j.rser.2018.10.014.
4. Å. Dahlborn, M. de la Roche, L. Kajtazi and R. Daykin, Tokenization of Assets and Blockchain, Report, IOTA Foundation, https://blockchain-observatory.ec.europa.eu/publications/tokenization-assets-and-blockchain_en, [Accessed Oct. 19. 2025].
5. M. Atzori, Blockchain technology and decentralized governance: Is the state still necessary?, *Journal of Governance and Regulation,* Vol. 6, No. 1, pp 45-62, 2017, https://doi.org/10.22495/jgr_v6_i1_p5.
6. R. Mitta, B. Kentrup, D. Sandor, S. Mocan and M. C. Karajgi, Infrastructure tokenization: Does blockchain have a role in the financing of infrastructure?, Report, International Bank for Reconstruction and Development / The World Bank, Washington D.C., USA, 2023., https://openknowledge.worldbank.org/handle/10986/39579, [Accessed Oct. 19. 2025].
7. Blockchain Training Alliance, What is Blockchain, 2017. http://www.blockchaintrainingalliance.com, [Accessed Oct. 19. 2025].
8. A. Banerjee, I. D. Bode, M. d. Vergnes, M. Higginson and J. Sevillano, Tokenization: A digital-asset déjà vu, *McKinsey's Corporate and Investment,. Tokenization: A digital-asset déjà vu*, McKinsey & Company, August 2023, https://www.mckinsey.com/industries/financial-services/our-insights/tokenization-a-digital-asset-deja-vu, [Accessed Oct. 19. 2025].
9. I. Barclay, M. Cooper, A. Preece, O. Rana and I. Taylor, Tokenising behaviour change: optimising blockchain technology for sustainable transport interventions, arXiv. 2021, https://arxiv.org/abs/2104.01852, [Accessed Oct. 19. 2025].
10. A. Smith, *An inquiry into the wealth of nations*, Strahan and Cadell, London, 1776.
11. P. Berntsen and M. Leippold, The Monetary Benefit of Tokenizing Renewable Energy, *4th International, InsurTech & Blockchain Forum at the University of Zurich, the Review of Corporate Finance (RCFS) Winter Conference 2022 ,* September 14, 2022, https://doi.org/10.2139/ssrn.4219222.
12. Behaviour as leverage, *Nature Climate Change,* Vol. 12, p 1069, 2022, https://doi.org/10.2139/ssrn.4219222.
13. L. Whitmarsh, W. Poortinga and S. Capstick, Behaviour change to address climate change, *Current Opinion in Psychology*, Vol. 42, pp 76-81, December 2021, https://doi.org/10.1016/j.copsyc.2021.04.002.
14. Behaviour change and the environment Changing behaviours to reduce climate change and protect our environment, Local governement association, https://www.local.gov.uk/our-support/financial-resilience-and-economic-recovery/behavioural-insights/behaviour-change-and-0, [Accessed Oct. 19. 2025].
15. Y. Toraman and B. B. Geçit, User Acceptance of Metaverse: An Analysis for e-Commerce in the Framework of Technology Acceptance Model (TAM), *Sosyoekonomi: The Journal of Social Economics*, Vol. 31, No. 55, pp 85–104, 2023. https://doi.org/10.17233/sosyoekonomi.2023.01.05.
16. M. Chuttur, Overview of the Technology Acceptance Model: Origins, Developments and Future Directions, *Sprouts: Working Papers on Information Systems,* Vol. 9, pp 9–37, 2009.
17. P. Surendran, Technology Acceptance Model: A Survey of Literature, *International Journal of Business and Social Research (IJBSR),* Vol. 2, No. 4, pp 175–178, August 2012.
18. W. Lorraine, W. Poortinga and S. Capstick, Behaviour change to address climate change, *Stuart,* pp 7 6-8 1, 2021, https://doi.org/10.1016/0749-5978(91)90020-T.

19. I. Ajzen, The theory of planned behaviour, *Organizational Behaviour and Human Decision*, Vol. 50, No. 2, pp 179-211, December 1991, https://doi.org/10.1016/0749-5978(91)90020-T.
20. A. Yuriev, Pro-environmental behaviors through the lens of the theory of planned behavior: A scoping review, *Resources, Conservation and Recycling*, Vol. 155, p 104660, 2020, https://doi.org/10.1016/j.resconrec.2019.104660.
21. P. C. Stern, Toward a coherent theory of environmentally significant behavior, *Journal of Social Issues,* Vol. 56, p 407–424, 2000, https://doi.org/10.1111/0022-4537.00175.
22. T. Abel, A value-belief-norm theory of support for social movements: The case of environmentalism, *Human Ecology Review*, Vol. 6, p 81–97, 1999.
23. J. R. C. and E. K. Prochaska, The Transtheoretical Model and Stages of Change, *Health Behavior and Health Education: Theory, Research, and Practice (3rd Ed.)*, K. Glanz, B. K. Rimer, and F. M. Lewis, Eds. San Francisco, CA: Jossey-Bass, pp 99–120, 2002.
24. L. Whitmarsh, How psychology can help limit climate change, *American Psychologist,* Vol. 76, No. 1, p 130–144, 2021, https://doi.org/10.1037/amp0000624.
25. R. West, The *Behaviour Change Wheel: A Guide to Designing Interventions*, Silverback Publishing, Bream, UK, 2014.
26. I. Barclay, M. Cooper, J. Hackel and P. Perrin, Tokenizing Behavior Change: A Pathway for the Sustainable, *Front. Blockchain*, Vol. 4, p 730101, 2021 https://doi.org/10.3389/fbloc.2021.730101
27. World Development Report 2015: Mind, Society, and behaviour, Washington D.C., USA, World Bank, 2014., https://openknowledge.worldbank.org/handle/10986/20597, [Accessed Oct. 19. 2025].
28. A. Kumar K.M., *Block Chain Instructional Material*, Sri Jayachamarajendra College of Engineering (JSS Science & Technology University), Mysuru, India, https://sjce.ac.in/wp-content/uploads/2021/12/Block-Chain-notes.pdf, [Accessed Oct. 19. 2025].
29. V. Deshpande, H. Badis and L. George, BTCmap: Mapping Bitcoin Peer-to-Peer Network Topology, *IFIP/IEEE International Conference on Performance Evaluation and Modeling in Wired and Wireless Networks (PEMWN),* p 1–6, 2018, https://doi.org/10.23919/PEMWN.2018.8548904.
30. D. Tapscott, The great chain of being sure about things (n.d), *The economist,* 2018.
31. J. Saajos, Guide to Blockchain Technology, ***BSc thesis***, Information and Communications Technology, Häme University of Applied Sciences, Hämeenlinna, Finland, 2022., https://www.theseus.fi/handle/10024/703668?utm, [Accessed Oct. 19. 2025].
32. I. Bashir, Mastering Blockchain. Brimingham:, *Packt Publishing,* Mumbai, India, 2017.
33. D. Guegan, Public blockchain versus private blockhain, Centre d'Économie de la Sorbonne 17020, Université Panthéon-Sorbonne, Paris, France, No. 17020, 2017, https://ideas.repec.org/p/mse/cesdoc/17020.html, [Accessed Oct. 19. 2025].
34. Y. Tian, C. Wang, A. Asutosh, J. Woo and P. Adriaen, Blockchain-enabled tokenization for sustainable and inclusiveinfrastructure investment, Department of Civil and Environmental Engineering, University of Michigan., arXiv, 2022, https://arxiv.org/abs/2208.04709, [Accessed Oct. 19. 2025].
35. R. Lai, Blockchain–from public to private, Handbook of Blockchain, Digital Finance, and Inclusion, *Academic Press,* pp 145-177, 2018, https://doi.org/10.1016/B978-0-12-812282-2.00007-3.
36. P. L. Frings, *Blockchain: From theory to practice – The transformational challenges in adopting*, Report, CIGREF, France, 2018.

37. A. Kurniawan, W. A. Wulandari, R. E. Saragih and I. Verdian, A Review of Blockchain: How Does It Work, Applications, and Challenges, *JTI (Journal of Telematics and Informatics),* Vol. 7, No. 2, pp 69-79, Jun. 2019.
38. C. Siripanpornchana, Performance analysis of private blockchain platforms in varying workloads, *Proc. 2017 26th International Conference on Computer Communication and Networks (ICCCN) IEEE,* Vancouver, BC, Canada, pp 1-6, 2017, https://ieeexplore.ieee.org/document/8038517, [Accessed Oct. 19. 2025].
39. K. Sultan, U. Ruhi and R. Lakhani, Conceptualizing Blockchains: Characteristics & Applications, *Proceedings of the 11th IADIS International Conference Information Systems*, pp 49–57, Lisbon, Portugal, 2018, https://www.iadisportal.org/digital-library/conceptualizing-blockchains-characteristics-applications?utm_source=chatgpt.com, [Accessed Oct. 19. 2025].
40. Theory of Tokenization Version 01, Distributed Lab, https://tokend.io/downloads/Theory%20of%20tokenization%20%28Version%201.0%29.pdf, [Accessed Oct. 19. 2025].
41. F. O. Neamtiu, Tokenization as a data security, *Zeszyty Naukowe,* Vol. 2, No. 0867–2245, p 103, 2016.
42. P. Samaties, S. Steger, S. Maus and A. Biesaga, Tokenization of Real-World Assets Unlocking a New Era of Ownership, Trading, and Investment, Report, Roland Berger Middle East, 2023, https://www.rolandberger.com/en/Insights/Publications/Tokenization-of-real-world-assets-unlocking-a-new-era-of-ownership-trading.html, [Accessed Oct. 19. 2025].
43. A. Custódio, Technology Acceptance in Education The teacher-related barriers to the acceptance of the interactive M.Sc. thesis, Industrial Engineering and Management, Portugal, 2018.
44. F. Davis, A technology acceptance model for empirically testing new end-user information systems: Theory and results, Doctoral dissertation, MIT Sloan School of Management, Cambridge, 1986.
45. P. Lai, The Literature Review of Technology Adoption Models and Theories for the Novelty, *JISTEM - Journal of Information Systems and Technology Management, ,* Vol. 14, No. 1, pp 21-38, 2017, https://doi.org/10.4301/S1807-17752017000100002.
46. T. Buchanan, P. Sainter and G. Saunders, Factors affecting faculty use of learning technologies: Implications for models of technology adoption, *Journal of computing in higher education,* Vol. 25, No. 1, pp 1-11, 2013, https://doi.org/10.1007/s12528-013-9066-6.
47. S. G. Rodrigues and A. L. Freitas, Avaliacao da confiabilidade de questionario: uma analise utilizando o coeficiente alfa de Cronbach, *Proceedings XII Simposio de Engenharia de Producao*, Bauru-SP, Brazil, Vol. 12, 2005.
48. C. Shriver, Implicit connections with nature, *Journal of Environmental Pyychology*, Vol. 24, No. 1, pp 31-42, 2004, https://doi.org/10.1016/S0272-4944(03)00022-7.
49. D. S. Moore, *The Basic Practice of Statistics*, 6th ed., New York, NY: W. H. Freeman and Company, p 138, 2013.

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