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Blockchain Factors for Consumer Acceptance

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Abstract
The study we present aims to explore several factors pertaining to Consumer Acceptance of business technology as it related to Blockchain. Identifying and developing the relevant measures is of importance to business technology managers and software development managers today. We ask the important question of "what measures best represent the established constructs of the technology acceptance model?" In order to address this issue, it is important to identify the key measurements that help us to understand the proposed constructs as they relate to blockchain technology as well as confirm their validity in isolation and in combination with each other. In this study, the factors we explore are perceived reputation, risk, and usefulness and transaction intentions. A survey was used whereby the methodology adapted previous measurements from related works and new measurements pertaining to usefulness and risk were developed in order to adhere to blockchain's consumer acceptance framework. 268 students completed the questionnaire and an exploratory factor analysis was used in order to analyze the constructs and their measurements. Through the results we were able to identify and validate the relevant measurements as well as the proposed constructs.

Keywords: Reputation, Risk, Transaction Intentions, Perceived Usefulness, Blockchain

I. Introduction

The past decade has seen a tremendous growth in the world of digital commerce [1]. The introduction of the iPhone as well as a host of other devices capable of harnessing the advantages of the internet has led to a global proliferation of intelligent devices. This technological revolution further propelled by the expansion of the World Wide Web and the multitude of services available has opened the door for changes in the traditional structures of businesses and commerce. In particular, the introduction of ecommerce facilitated the exchange of good, information and financial services at a local, regional and global level, threatening the established structure of traditional brick and mortar stores as online sales increase.

The introduction of crowdfunding technologies as well as cryptocurrencies and other forms of decentralized transactions between users, coupled with innovations in mobile payment technology such as apple and android pay are helping to reduce the friction normally involved in transaction processing[2]. A natural evolution in the realm of digital transactions is the introduction of the internet of things. Under the new promised paradigm, users would be able to not only transact and fulfill exchanges, but to disintermediate themselves from the process by enabling the devices to transact on their behalf. Through the internet of things, a multitude of smart devices containing sensors and other data collection components would be able to transfer useful and real time information seamlessly throughout the network, allowing for more intuitive and intelligent decisions from their users. Furthermore, the interconnected nature of the technology is likely considered as the catalyst for the future evolution of technology including but not limited to the expansion of artificial intelligence by leveraging the various devices and sensors recording data, the introduction of autonomous driving through the use vehicle x to x communication and the streamlining of global supply chain mechanisms via the use of automated device information exchanges [3].

Another area standing to benefit from the improvement of information technology is the healthcare sector. Through the prevalence of wearable devices containing sensors able to record data ranging from step tracking to sleep to heart rates and possessing the needed technology to communicate data directly to other systems and information hubs, healthcare stands to amass a trove of health information that will better the quality of life for future generations. Furthermore, the digitization and standardization of information and medical records coupled with the reduction in the cost and increase in capability of computing power will allow patients greater access to medical records as well as the ability to share their medical information with other parties [4].

In the energy sector, the introduction of green technology coupled with the move to more personalized and sustainable energy sources open the door for private households and individuals to become simultaneous energy producers and consumers. The ability to generate electricity in excess will open the door to resell power back into the grid and subsidize energy needs at various national levels, thereby creating energy micro grids. Furthermore, the user of green energy generation technology will allow for direct government subsidies in the repurchase and exchange of energy between citizens [5][6].

The world of financial services, already improved through the advent of credit cards and digital transactions as well as payment processing stands to gain through the replacement of cash and hard currencies by smart devices capable of conducting financial transactions directly and efficiently, thereby reducing friction and allowing for greater liquidity security among financial institutions. Finally, the digitization of commerce, securities and currencies will allow for more efficient markets and a greater access to wealth creation tools across the modern world [7].

Finally government areas and services will be able to offer better services to their citizens and enable a greater level of decentralization from capital cities and government agencies through the use of online systems and portals of service. The introduction of digital ID will streamline government communication with citizens while digital voting systems will remove the hassle of traditional voting while adding a greater layer of security and accountability while reducing the risk of fraud and tampering [8].

However, these technological enhancements to existing industries do not occur in a vacuum, benefits and improvements give way to concerns and issues, particularly pertaining to privacy, security and data centralization. With the increased proliferation of information, privacy risks becoming a thing of the past, personal data can be tagged to individuals and the need to share information can be offset by the loos of control over ones information. Smart devices can share more about you than you may feel comfortable, your neighbors can spy on your energy consumption and production, every transaction and purchase you conducted can be made public to various institutions and a centralized medical record system can impede medical data privacy and doctor patient confidentiality [9].

Meanwhile the spread of information and its presence in multiple locations will increase the risk and probability of data theft. Data breaches are not a rare occurrence in the modern age, and the increased expansion of information size, quality and breadth can increase the temptation and potential reward of breaching user's data. Smart device networks can be hacked to obtain sensitive information, while financial accounts lead to credit card and financial fraud. Compromises in government systems can open the door to identity fraud even in cases of traditional brick and mortar services, the risks are compounded in relation to online exchanges.

There also the inherent risk of centralizing the information in the hands of trusted third party entities. To this day, the digital revolution has been led by third party organizations looking to offer enhanced products and services by leveraging the internet and technological innovations in order to interact remotely and virtually with their consumers. This movement has led to an improvement in the number and quality of services offered to customers across the world. From ecommerce to banking and social media and networking, technology companies have allowed a greater connection and an easier approach to accomplishing tasks than was possible. However, with the increased interaction between users and technology companies there was an equivalent increase in the amount of data held about consumers and users. This has led to new business models whereby the user themselves as well as their data and their interaction with the company is a sufficient justification of the company as an ongoing concern and a creation of value. This poses a risk of abuse as companies can leverage customer information not only to provide better products and services but also to identify user tolerances and price sensitivities thereby allowing for greater price customization.

Introduced to the masses in 2008 as the underpinning technological infrastructure to the first global cryptocurrency Bitcoin; Blockchain technology allows for the validation and synchronization of content among users directly without the intervention of intermediaries and trusted third parties. This is due to the allowance of trustless mechanisms whereby all users are able to hold and maintain a copy of the information system for themselves and validate its authenticity against other versions to ensure all information is kept authentic and valid[10].

The introduction of asymmetric encryption allows for the existence of both private and public keys whereby the user interacts with the community using the public key while the private key remains unknown to other users [11]. This advent in turn enables user to transact in complete privacy by making the ability to locate the identity of a particular user within the network exceedingly difficult.This enhancement of privacy allows blockchain users to utilize internet of things devices free of the concern of losing privacy; while financial transactions can be conducted without concern over the nature of the transaction and its implications opening the door to repercussions on the part of the user. In the healthcare sector, the protection of privacy will allow greater access to medical records without concerns over privacy violations and maintaining the anonymity of the data.

The use of cryptography also allows the security of the information. While traditional databases suffer from the prospect of data proliferation as it renders the information more difficult to maintain securely, blockchain's distributed ledger ensures that there is no central repository of data that can prove attractive to a hacker in order to steal pertinent information, each user holds a part of the whole that is the block chain [1]. Through the encryption of information as well as the immutable aspect of blockchain whereby transactions recorded in the ledger cannot be modified or removed, only added upon, internet of things can operate safe of the risk that information will be tampered with or stolen without user consent, healthcare practitioners and patients can share information without concern over data theft and unauthorized access to medical records. Local energy suppliers will be able to ensure that the micro grid energy exchange system can operate without the risk of shutdown and tampering. Furthermore, financial companies can ensure that user accounts containing sensitive financial and personal information cannot be easily accessed and subverted. Finally, government can rust in a robust IT infrastructure that can withhold manipulation.

Blockchain technology also allows the decentralization of information through the mechanisms described above, this ensures that central authorities and third party companies do not own user's personal data but are instead privy to its content for the purposes of greater services, products and the greater good. Devices supporting internet of things can be used without adhering to a centralized structure where the data is held by a single company, furthermore, devices would be able to proliferate updates and needed software improvements without a mandated intermediary. Financial accounts and transactions would be conducted directly between individuals thereby circumventing financial institution and democratizing the financial system rendering it similar to the cash and free exchange market. Hospitals and insurance providers will also lose any monopoly and hold over patient's medical records and information, allowing healthcare customers to seek out and capitalize on the best opportunities and services. Finally, government programs and services such as digital ID and voting systems can exist without concerns of a third party company holding individual identity records and the removing the risk of voting manipulation and fraud.

Blockchain technology is not perfect, like all nascent systems, it suffers from several issues and constraints that threaten its viability [9] from the perspective of sustainability and scalability in particular. However, these points will not be discussed as they fall outside the scope of the current study. While research on blockchain technology has increased significantly in the past two years, much is left to be said concerning the acceptance of blockchain and its place within the existing literature of technology acceptance.Blockchain technology's features and promised advancements will not translate to applicability if the technology itself is not accepted by its users. User acceptance or lack thereof is a constant impediment to the adoption and proliferation of new information systems. Blockchain systems aim to decentralize information and transactions by shifting the focus and power to the users themselves, thereby posing the issue that the system by design cannot subsist solely on the adoption of trusted third parties and organization but on the very end users it aims to serve.

While the technology acceptance model was initially designed to measure the usage of information technology at work, it has since been adapted and heavily used in various areas of ecommerce and remote transaction assessments in order to determine user's intention to use and recommend the technology. The technology acceptance model enables researchers to discern between the various internal and external motivations can lead to modifications in beliefs, behaviors as well as attitudes. By leveraging these aspects to account for a user's attitude towards a system in particular rather than a random object, the technology acceptance model (TAM) has proven to be of consistent value in determining the outlook and adoption of various technologies, its implementation within the context of blockchain is therefore a natural progression of the subject's study [12].

The lack of research on the topic of blockchain acceptance leaves much to be discovered. As it stands, there is an inherent dearth of supporting content to enable a proper analysis and research into the application of TAM to blockchain. This stems from two major causes; the first is the relative novelty of blockchain technology, particularly within the framework of an independent framework. While blockchain has existed within the context of bitcoin since 2008, much has been to done to study its properties and strengths as it relates to the sustainability and scalability of cryptocurrencies in general, however only recently has blockchain started to be considered as an independent technology in its own right, therefore necessitating further study into user's perceptions of blockchain in isolation from their attitudes and acceptance of cryptocurrencies. The second factor is the lack of exploratory research pertaining to blockchain acceptance; this has led to a lack of identifiable constructs and reliable measurements that can be used to investigate the relationship between blockchain and overall user acceptance. This study aims to alleviate this deficit through the development and verification of items designed to measure the appropriate constructs of the TAM. Specifically, we deal with the development of measures for perceived usefulness, perceived risk, transaction intentions and reputation.

In the case of blockchain, this contribution should prove significant to the technology's evolution due to blockchain's unique potential to interact with the various TAM constructs mentioned earlier. The elimination of intermediaries and methods of recourse coupled with a unique reliance solely on technology and cryptography as arbitrators for transactions between strangers generates uncertainty around the technology's use, this is further fueled by the relevant infancy of the field, the hype surrounding blockchain technology as well as its dynamic and constantly evolving nature. Furthermore, the abstract nature of such a system coupled with the anonymity of other parties and openness of the platform itself makes risk a notable component. Finally, the early association of blockchain with cryptocurrencies in general and Bitcoin in particular will pose an interesting question in relation to user attitudes and acceptance.

II. FACTORS IN BLOCKCHAIN ACCEPTANCE

In this section we elaborate on the various constructs and discuss their significance to the overall literature of technology acceptance and to blockchain technology as well as the decision leading to the development of the items needed to leverage the technology acceptance model as well as other models of consumer acceptance.

Consumer do not make their decisions in a bubble, they are often confronted by choice situations that are far less than ideal with regards to risk and uncertainty [12]. The introduction of trusted intermediaries in commerce serves to establish trust by building on the reputation of the transacting parties and leveraging the public aspect of the transaction. All else equal, consumer will tend to choose the less risky options. However, risk is not the sole motivation driving the personal decision-making process of the consumer as perceived usefulness contributes to the positive aspects of the choice and will work to offset the negative attributes of risk. The balance between the two will translate to the appropriate transaction intentions depending on the overall risk / usefulness structure as well as the personal risk aversion and usefulness functions of the consumer [13].

2.1 Blockchain Reputation

Reputation is considered an affect-based trust antecedent. In previous literature [14], reputation was used as a moderator to trust and the other constructs of the technology acceptance model. Reputation measurements include items such as knowing a specific website as well as determining its perceived reputation along with that of the vendor that operates within it and the overall familiarity with the website itself. Unfortunately, given that blockchain is an underlying technology meant to support existing systems and brands, it is difficult for blockchain to establish a reputation for the technology on its own without a brand name or independent from the cryptocurrency or site that leverages its potential [15]. This is further reinforced by the overall discrepancy in awareness of cryptocurrencies vs blockchain, even though blockchain provided the underpinning to cryptocurrencies. As such, we set out to convert the items presented in previous reputation research into those that would apply to blockchain technology.

2.2 Blockchain Perceived Risk

There are various types of risks associated with blockchain technology that can range from privacy, security, overall transaction risk as well as the overall risk of the system itself as a sustainable model for its users. Given that the main advantages and offerings of blockchain technology are the increased security and privacy offerings that it offers its users in relation to conventional transaction mechanisms. We believed it better to focus on items involving overall transaction risk of blockchain (BRI) as well as the risk of blockchain as a business model and system of daily use (BCPRB) [16]. This is due to the premise that blockchain technology suffers from a lack of recourse in the case of fraudulent transactions or stolen account. Furthermore, the current issues plaguing blockchain relate heavily to government regulation and efficiency concerns regarding power consumption which jeopardize its standing as a long-term sustainable system. Unfortunately, the unique nature of blockchain meant that the types of risks presented to the user were unconventional and therefore were not represented in the current literature. As such new items were added to measure blockchain system risk [14] .

2.3 Blockchain Perceived Usefulness

Little research has been conducted on the overall used and application of blockchain technology. a review of the literature indicates a focus of blockchain on key areas of energy, internet of things, finance, government and healthcare. These areas all stand to benefit from the technology due to the inherent advantages that its structure offers. These include greater control over your own information as well as a removal of intermediaries, high speed of information transfers, low costs of data transfer, high security, international scope and improved trust among stakeholders. While previous research has been conducted on perceived usefulness in relation to technology systems, the disintermediation and global effect of blockchain does not lend itself to conventional benefit characteristics. As such, new items were added in order to measure the construct based on previous surveys regarding blockchain and cryptocurrencies [14].

2.4 Blockchain Transaction Intentions

Traditional research methods would incorporate an aspect of pre and post purchase or transaction of an item in order to identify the overall attitude in using the technology itself. However, due to the previously mentioned underlying nature of the technology in that it is currently inseparable from cryptocurrencies, the use and trade of which is likely subject to immense regulation and scrutiny; a measure of actual transactions and purchases is not possible, this is especially true given the decentralized and anonymous nature of cryptocurrencies and blockchain based systems. We therefor contented with the measurement of overall transactions intentions [17].

III. Methodology

Past research has studied the impact of the various technology acceptance model measurements on consumer acceptance. Established constructs such as intention to transact, perceived usefulness, perceived ease of use and perceived risk have emerged as principal components the combination of which forms the basis for the technology acceptance model (TAM) [18].

Various works have mapped out different items designed to measure the different constructs influencing users during their interactions with a given system. There have also been extensions to the basic TAM model through the use of antecedents, namely affect and cognitive. Examples of these includes trust whose own antecedent is the affect-based reputation as well as cognitive antecedents such perceived privacy, security protection and information quality. These previous works when applied to systems such as ecommerce and credit card payments allow for a better understanding of the underlying motives behind user acceptance and open the door for improvement both to the methodology of identifying user acceptance as well as the system itself [14][12].

Blockchain technology is an emerging innovation originally introduced as the underlying enabler to the first widely recognizable cryptocurrency known as Bitcoin. This initial exposure has resulted in both advantages and disadvantages to the evolution and recognition of blockchain as a technological platform. On one hand the increased exposure received by Bitcoin in the media as well as by financial institutions and regulatory organizations has shed light on the underlying engine that enable the encryption, anonymity and immutability of the distributed ledger thereby creating the avenues of research and development for blockchain current being explored. On the other hand the association of blockchain with bitcoin since its inception is likely to impact the reputation and trust experienced by consumer with regards to blockchain adoption [1].

While research has begun to emerge focusing on blockchain technology, the emphasis has been on the strengths and weaknesses of blockchain as a solution as well as proposals to solve the various technical problems encountered by the technology. Far less has been studied however, concerning the implementation and application of blockchain within the various themes and uses to the economy [19]. In order to achieve this, work must be done in relation to not only the application of blockchain itself but also in relation to its acceptance by consumers. The integration of blockchain and its analysis within the context of the technology acceptance model will allow for a cross comparison of blockchain's perception in relation to other systems such as ecommerce and credit card processing. However, in order to achieve this, measurements must be developed pertaining to the appropriate constructs thereby rendering researchers able to quantify with validity, reliability and confidence the relationships discussed in the TAM.

In this paper we develop measurements allowing the study of consumer acceptance and attitudes towards blockchain technology. We leverage existing measurements where applicable and consult parallel and relevant studies of bitcoin and blockchain in order to mine quantitatively measurable items from qualitative results. Specifically, we generate measurements for the core constructs of intention to transact, perceived usefulness, perceived risk as well as trust through its affect-based antecedent of reputation [14].

The measurements are aggregated in a survey which we pass through a three stage process. The first stage involves a distribution of the survey to a committee of experts and academics for review and suggestions for modification and improvement. The second stage is a limited release of the survey to a group of 6 students during a personal Q&A session designed to elicit feedback and constructive criticism as well as suggested modifications to the measurements themselves. The third stage concludes with the wider release of the survey to an online classroom of business technology management students [20].

Following the receipt of the survey from the respondents, we follow an exploratory factor analysis approach in order to test the validity of the various factors in blockchain acceptance. We run each factor independently in order to determine the appropriate factor loadings of the relevant items as well as to ensure that all items load on one factor with eigenvalue greater than one and that all items are loading properly. We then run the analysis for Cronbach's alpha in order to determine the reliability of the data. Once complete, we use the EFA mathematical criteria in order to create a factor model from the dataset. This simplifies the structure of the data by allowing the various items to group together if more efficient under common factors.

3.2 Implementation

In order to test the validity of the items and their relation to the relevant constructs, we examined the overall perceptions and attitudes of online university student course participants in relation to blockchain technology and its various uses, features, risks and intentions. The respondents were bachelor students who were offered to complete the survey for extra credit as part of a course on the fundamentals of business technology. This is appropriate as current university students and young adults are likely to contribute disproportionately to the target market of blockchain technology and cryptocurrencies. Previous studies have made use of students in research, acknowledging their participation and role as useful representatives of the population. This holds particularly true with regards to online behavior as education and age are important factors when determining the amount of engagement and interaction with online transactions. 86 In our results, over 35% of respondents indicated having heard of blockchain beforehand and knowing what blockchain represents through various forms and mediums[14] [21]. This is in line with previous polls and studies by coindesk and gizmodo placing the overall knowledge of people of blockchain between 27% and 41% [22]. While their average knowledge on a set of 11 blockchain related knowledge questions were 6.05.

The students were asked to visit a link to a webpage explaining the basic concepts of cryptocurrency and delving a little deeper into blockchain technology properties. They were then asked to answer the survey to the best of their abilities. Questions that necessitated an objective answer were qualified with an "I do not know" option in order avoid skewing the data. The participants were then asked to go to the discussion section of the course website and input their thoughts on blockchain technology and its uses as well as to comment and engage with other student's impressions of the topic.A total of 268 respondents were received after eliminating partial completions and unanswered questions. These responses were then included in the construct validation and testing [14].

IV. Results and Discussion

4.1 Student feedback on reputation

Fig. 1 represents the student feedback on reputation. The reputation reported by the sample student population is not positive. While the majority of the responses from the students are neutral, this is likely due to the lack of familiarity and exposure with blockchain technology. Furthermore, there is a lack of a brand or solid seal available to assist in the building of identity and reputation for blockchain which likely dissociates users from overall trust and impressions. For those who did have an opinion, the results skewed negatively for the questions, this is likely due to the lingering association between blockchain technology and the cryptocurrencies on which it was based. Given the results, it is unlikely that reputation will be a prominent factor in the EFA model [14].

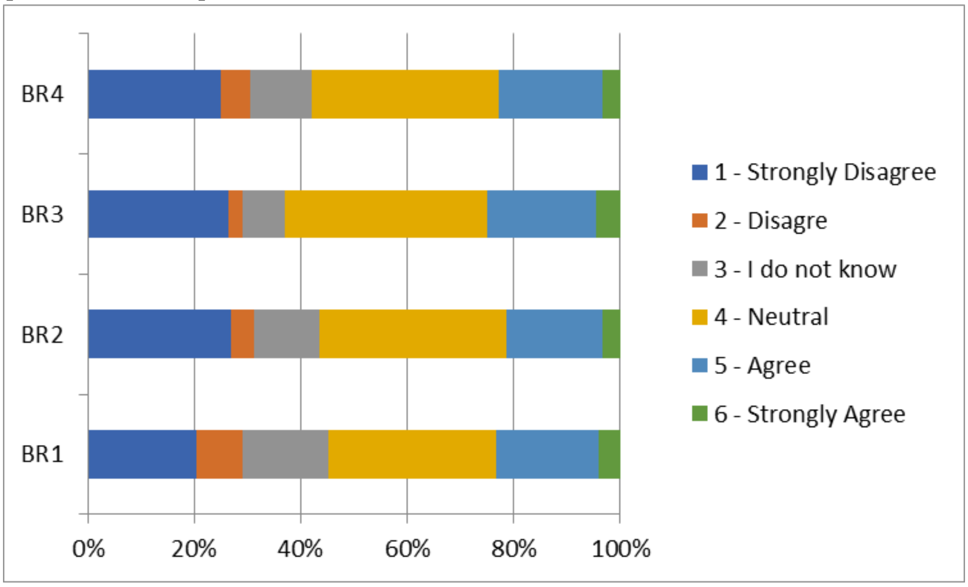

Figure 1: Student feedback on reputation

4.2 Student feedback on perceived transaction risk

Fig. 2 represents the student feedback on transaction risk; the overall response from students had been negative with roughly 30% disagreeing that blockchain technology posed less risk than conventional transactions in comparison to the roughly 20% of student who agreed with the statement. This response is likely due to several factors, first of which is blockchain's lack of familiarity among students which increased the levels of perceived risk. Furthermore, blockchain's relative infancy and lack of widespread acceptance and adoption further transaction risk considerations. Finally, the association with cryptocurrencies and in particular those of bitcoin could lead to negative perceptions of transaction risk [23].

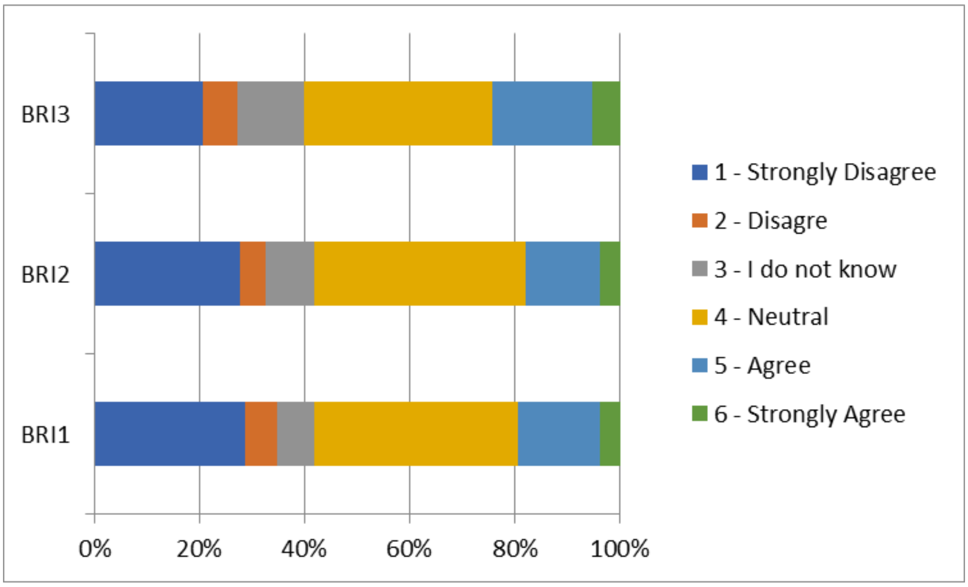

Figure 2: Student feedback on perceived transaction risk

4.3 Student feedback on perceived technology risk

Fig. 3 represents the student feedback concerning technology risk. Of the factors measured in our study, technology risk is the most negative of the group with roughly 36% of students responding to the survey disagreeing that blockchain technology is a safe and secure platform for use and transactions, this stands in high contrast to the 20% of student who responded positively. In particular, questions regarding association with illicit activity, fraud and privacy loss were more negatively weighted than the rest of the questions. The representation is likely due to the association between blockchain and cryptocurrencies, specifically to the negative connotations of illicit activities and bitcoin as well as the prevalent cases of account theft and fraud via cryptocurrency. We expect that measures identifying a student's ability to distinguish between bitcoin and cryptocurrencies and their underlying technology of blockchain will likely impact the distribution of the answers [23].

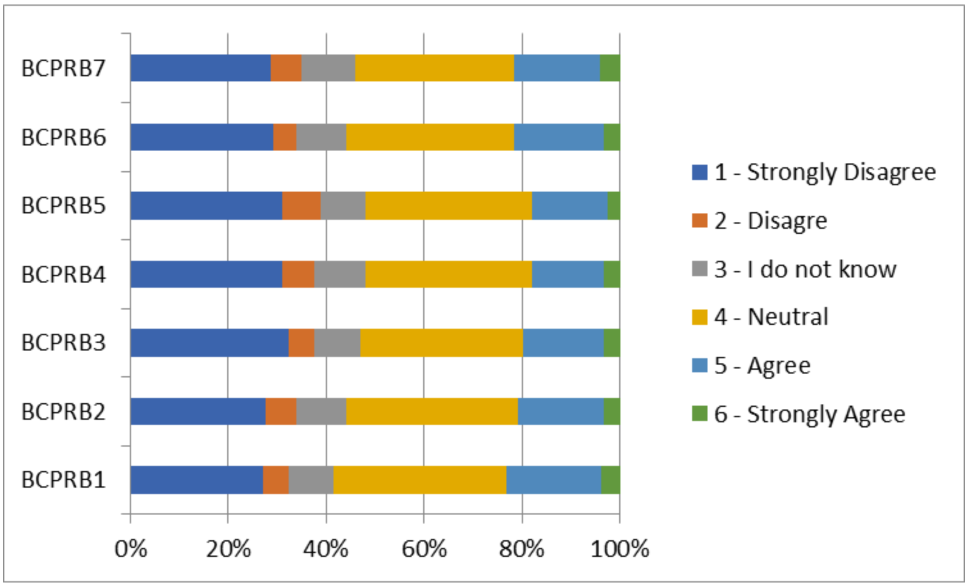

Figure 3: Student feedback on perceived technology risk

4.4 Student feedback on perceived usefulness

Fig. 4 represents student feedback regarding perceived usefulness. While the overall impressions regarding blockchain usefulness are negative, it stands out from the rest of the factors as being with one of the least discrepanciesbetween positive and negative survey respondent attitudes towards blockchain technology. Roughly 33% of respondents disagreed on the overall usefulness of blockchain in relation to 25% who agreed. This might be due to the lack of implementation and adoption of blockchain technology within the industry and the inability of students to experience its advantages. Furthermore, the current proliferation of modern and advanced services and systems indicates that the relative usefulness that blockchain is able to provide at the present level is unsubstantial when compared with that of established companies and systems.

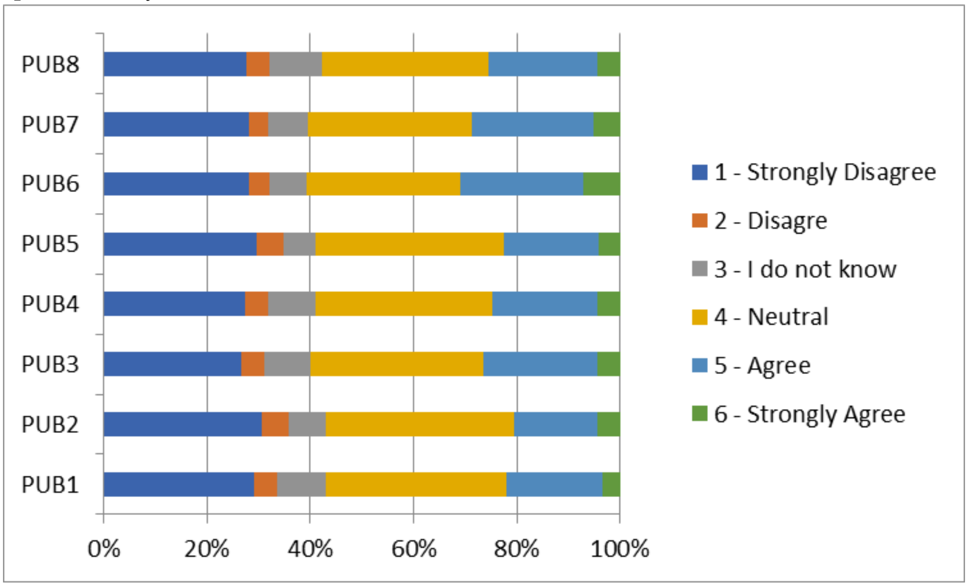

Figure 4: Student feedback on perceived usefulness

4.5 Student feedback on intention to transact

Fig. 5 represents the student feedback on intention to transact and the response from the students was largely negative. As we know from previous research regarding consumer acceptance models, perceived risk is negatively related to intention to transact, with reputation and perceived usefulness being positively related to overall consumer intentions. Given that the survey results have shown a perception of both higher transaction and technology risk of blockchain technology as well as a lower reputation and perceived usefulness in relation to traditional technology platforms, it is understandable to see an overall negative intention to use.

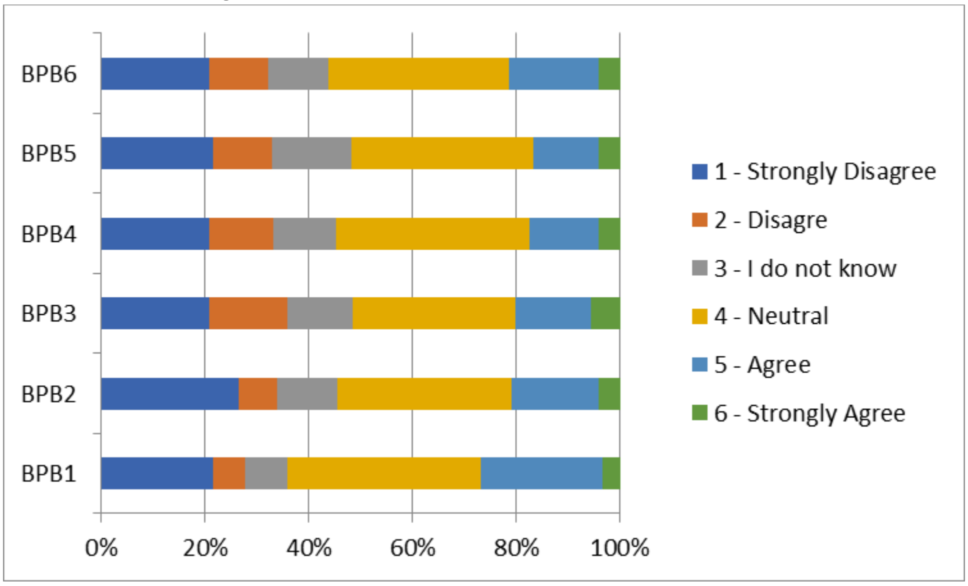

Figure 5: Student feedback on intention to transact

4.6 Reliability and validity of the factor analysis

Table 1 shows Cronbach's Alpha and Eigenvalue for each Construct. The Cronbach reliability coefficients proved to be consistently higher than the established cutoff score in the literature [24]. In the case of Cronbach's alpha, the assumption is that each item carries an equivalent weight in relation to the other which is suitable for the purposes of this study. Furthermore we can see that the lowest Cronbach's alpha observed was that pertaining to transaction risk with 0.87 which would still be considered a significant value.

In order to test the construct validity, there are two major components to consider, the first is the eigenvalue of the factor itself, and the second are the factor loadings. Table 1 shows the Eigenvalues of each construct as measured individually against its items. As expected, the factors performed very well with all items loading on one factor which had a high significance. The lowest eigenvalue observed is that of transaction risk at 2.2, this likely due to the presence of BRI3 in transaction risk which was found to be loading on the technology risk factor in tables 3 and 4. While this was also the case for other factors, we believe the limited number of 3 items in the case of transaction risk is what the cause is likely to be. Regardless, it is important to note that all scores are significant and exceed the required minimums needed for significance.

Table 1: Construct Cronbach's Alpha and Eigenvalue

Construct	Cronbach's Alpha	Eigenvalue
Reputation	0.93	3.05
Blockchain Transaction Risk	0.87	2.2
Blockchain Transaction Intentions	0.95	4.61
Blockchain Perceived Risk	0.97	5.62
Blockchain Perceived Usefulness	0.97	6.31

Table 2 shows the individually run factor loadings for all items and their respective factors. In order to examine convergent validity, all items pertaining to a construct should load with a factor greater than 0.5 and they must load on only one factor whose eigenvalue is greater than one [25]. Table 1 confirms the eigenvalues of the relevant factors, whereas table 2 highlights the factor loadings for the individual factor item models. All items are represented with a factor loading greater than 0.5. Furthermore, we can note than BRI3 has the lowest factor loading in the group though still significant.

Table 2: Individual factor loadings for measurement items and constructs

Construct	Variable	Measurement Item	Loading	Source
Reputation	BR1	Blockchain technology is well known	0.90557	[26]
	BR2	Blockchain technology has a good reputation	0.93011	[26]
	BR3	Blockchain technology has a reputation for transparency	0.88566	New item
	BR4	I am aware of the transactions that I make which use the blockchain technology	0.79772	New item
Transaction Risk	BRI1	Blockchain technology transactions would involve more risk than transactions on a centralized system	0.92975	[26]
	BRI2	Blockchain technology transaction would involve more financial risk than those made on a centralized system	0.95641	[14]
	BRI3	Overall, I would rate my perception of risk from blockchain technology as very low	0.64984	[27]
Transaction Intentions	BPB1	I think transacting via blockchain-based systems is convenient	0.78288	[28]
	BPB2	I can save money by using blockchain-based payment systems	0.82424	[14]
	BPB3	I have done transactions that use systems based on blockchain technology	0.88598	New item
	BPB4	I am likely to recommend the use of blockchain-based transaction systems to a friend	0.92967	[26]
	BPB5	I am likely to recommend the use of blockchain-based transaction systems to a family member	0.9289	[26]
	BPB6	I am likely to conduct further transactions based on blockchain technology in the future	0.8993	[26]
Technology Risk	BCPRB1	Blockchain technology is a viable long-term solution	0.89095	New item
	BCPRB2	Blockchain technology poses little security risk	0.90564	New item
	BCPRB3	Blockchain technology has limited third party service failure risk	0.89675	New item
	BCPRB4	Blockchain technology has limited user error	0.90297	New item
	BCPRB5	Blockchain technology has little association with illicit activity	0.87713	New item
	BCPRB6	Blockchain technology has little risk of privacy loss	0.91144	New item

	BCPRB7	Blockchain technology has limited risk of counterparty fraud	0.88968	New item
Blockchain Perceived Usefulness	PUB1	Blockchain technology allows me control over my own information	0.85593	New item
	PUB2	Blockchain technology allows for disintermediation	0.86027	New item
	PUB3	Blockchain technology allows for high speeds of information transfer	0.90022	New item
	PUB4	Blockchain technology allows for a lows cost of data transfer	0.91889	New item
	PUB5	Blockchain technology allows for high security in information transfers	0.8895	New item
	PUB6	Blockchain technology has an international scope	0.85005	New item
	PUB7	Blockchain technology lowers overall data transfer costs	0.9134	New item
	PUB8	Blockchain technology increases user trust requirements	0.91781	New item

4.7 Exploratory factor analysis model

In order to ensure that we arrive at the proper results, it is important to select the proper factor analysis method. We implemented an exploratory factor analysis using the iterated PAF extraction method and Oblique rotation when needed for the multiple factor models. The individual factor tests are run without rotation as the total number of factors is 1. We also use the squared multiple correlation matrix for estimation of the initial communalities in order to be able to conduct the EFA. Once each factor was assessed and the appropriate items kept / removed, we combine all items and factors into a singular EFA assessment in order to assess the correlations and commonalities among the various factors and their impact on our ability to measure the construct appropriately [18].

Our first iteration was run with 5 factors, to reflect the different constructs established throughout the study. The results indicated that there were no significant loadings on the fifth factor. We expanded the analysis through the eigenvalues and determine that the first factor showed an eigenvalue of roughly 16 indicating high significance with the rest of the factors below 1. However, when inspecting the scree plot we could observe an inflection point around the fourth factor. As such we eliminated the fifth factor and reran the analysis with 4 factors as we considered transaction risk and technology risk to be heavily related so as to load on one factor in the model.

The results confirmed the assessment regarding the presence of 4 factors as there were significant loadings on the 4th factor. However, rather than having risk load on the same factor with the removal of the 5th, we observed a loss in significance for items pertaining to the reputation factor as all items were either showing insignificant loadings or significant cross loadings. Furthermore, PUB2 and BPB1 showed weak loadings in relation to their cross loadings while PUB5 showed relative cross loading. In order to ensure this was not due to extending too many factors, we attempted to remove one factor and rerun the model; the results indicated an increased loss of significance for factors loadings of construct items. As such, the 4 factors were retained and we proceeded to eliminate factor items by least significance.

All items loaded significantly from the initial model, we therefore proceeded to identify items with cross loadings equal to roughly 50% or more of the highest factor loading. Table 3 highlights in grey items with significant cross loadings for removal. Of notice is in the table is reputation, which has all relevant items cross loading on the various factors. We therefore proceed to remove the cross loading items based on the spread between the loadings.

We remove BR2 and rerun the analysis; the results indicated that BR1 and BR3 had lost significance with BR4 still cross loading. We then removed BR1 and after the results indicated no change for BR3 we then removed it as well and reran the test. Once all items pertaining to reputation were removed with the exception of BR4, the variable was still loading with 0.42 on factor 4 and 0.41 on factor 3, we therefore concluded that in the context of the EFA model reputation would not constitute a significance factor and removed BR4 and reran the results in absence of any reputation items.

The outputted result showed that PUB2 which was previously cross loading but significant had lost significance, the same was true of BPB1 whereas PUB5 was still cross loading but significant. We eliminated PUB2 which showed a greater amount of cross loading for PUB5 which we then proceeded to remove. Once we reran the test, the final item to be removed was BPB1 which was still cross loading at a higher than 50% threshold.

Table 3: Initial EFA factor model

	Technology Risk	Usefulness	Intention to Transact	Transaction Risk
BR1	0.32797	-0.07947	0.26869	**0.4266**
BR2	**0.42419**	0.005	0.15491	0.3881
BR3	0.17085	0.29295	0.04569	**0.45071**
BR4	-0.07898	0.16743	**0.41134**	**0.47359**
BRI1	0.09598	0.10193	0.11325	**0.68601**
BRI2	0.14991	0.10805	0.00436	**0.69399**
BRI3	**0.40266**	0.15546	0.13051	0.14082
BCPRB1	**0.66979**	0.15028	0.17038	-0.05362
BCPRB2	**0.79781**	0.06547	0.07682	-0.02099
BCPRB3	**0.90095**	-0.05572	-0.01716	0.07603
BCPRB4	**0.95789**	0.03131	-0.11248	0.02657
BCPRB5	**0.74585**	-0.10403	0.1451	0.14192
BCPRB6	**0.6666**	0.2346	0.03801	0.02481
BCPRB7	**0.53497**	0.15274	0.22327	0.06019
PUB1	**0.5803**	0.2254	0.09869	0.03975
PUB2	0.31315	**0.41178**	0.13086	0.09223
PUB3	0.13121	**0.65354**	0.1512	0.02101
PUB4	0.25361	**0.69575**	0.05053	-0.05657
PUB5	**0.52933**	0.3244	0.02937	0.09547
PUB6	0.00782	**0.71327**	-0.03643	0.26328
PUB7	0.01516	**0.80974**	0.05896	0.09331
PUB8	0.07255	**0.74566**	0.19195	-0.04335
BPB1	**0.40358**	0.22324	0.19475	0.08285
BPB2	**0.57045**	0.11729	0.22105	0.01808
BPB3	0.09632	-0.00066	**0.67647**	0.18853
BPB4	0.06875	0.06361	**0.83445**	0.00034
BPB5	0.02103	0.00931	**0.95704**	-0.03958
BPB6	0.02438	0.11655	**0.74186**	0.06684

The final results are displayed in table 4, there are several observations to be made. All items that were originally identified as cross loading were removed by the final output and all the other items remained, this indicates that the outcome of the item removal process is likely robust to deviations in the elimination path. Second, all items continued to load in their respective factors before and after the removal of the cross loading items, this indicates that the loadings of the items on the factors are robust to minor changes in variance. Furthermore, we can see transaction risk and technology risks do not load consistently on the same factor with BRI1 and BRI3 loading on factor 4, this indicates that more items are needed to ensure the proper measurement and validation of transaction risk. We also notice that the only other transaction risk item BRI2 loads on the same factor as technology risk, looking close at the nature of the question, we can see that BRI2 deals with both transaction and financial transactions risk relative to a centralized system, this might help to explain the nature of the loading itself. PUB1 also loads on the first factor, when assessed it seems that the control over information value presented in the item is related to technology risk with regards to information privacy and security. BPB2 is also loading on the first factor, examining the question reveals that the inclusion of a financial aspect is likely to have shifted the loading into factor 1.

Table 4: Final EFA factor model

	Technology Risk	Usefulness	Intention to Transact	Transaction Risk
BRI1	0.04426	0.03439	0.12816	**0.80568**
BRI2	0.07113	0.07281	-0.00124	**0.83554**
BRI3	**0.41966**	0.16445	0.1124	0.11301
BCPRB1	**0.7051**	0.1249	0.1499	-0.05295
BCPRB2	**0.80988**	0.03008	0.05446	0.02937
BCPRB3	**0.94535**	-0.08256	-0.02625	0.05609
BCPRB4	**0.97866**	0.02607	-0.13219	0.02289
BCPRB5	**0.75862**	-0.09965	0.15667	0.10264
BCPRB6	**0.71192**	0.22035	0.02022	-0.00308
BCPRB7	**0.56727**	0.15053	0.20621	0.03479
PUB1	**0.61937**	0.18309	0.07982	0.05573
PUB3	0.14258	**0.65539**	0.12078	0.02233
PUB4	0.25611	**0.6914**	0.02553	-0.03929
PUB6	0.01363	**0.71322**	-0.04092	0.24283
PUB7	-0.03459	**0.89184**	0.02852	0.08731
PUB8	0.05036	**0.81273**	0.154	-0.06129
BPB2	**0.57829**	0.11243	0.21289	0.01471
BPB3	0.11504	-0.0247	**0.65978**	0.21288
BPB4	0.03706	0.0751	**0.83825**	0.02773
BPB5	-0.00163	0.01682	**0.96304**	-0.02099
BPB6	0.05742	0.09747	**0.70953**	0.08164

V. Conclusion

Technology has evolved and grown considerably over the past decade, the latest iteration of which is the introduction of cryptocurrencies and the advent of blockchain technology. Blockchain's unique characteristics of enhanced security through the immutability of the ledger, privacy through asymmetric encryption and democratization of data from third party companies through the distributed ledger opens the door for major changes in existing business models as well as fortifications and improvements to existing technologies and platforms [2].

These uses can range across industries, impacting particularly government through the decentralization of databases and computing power; finance through security and anonymity for financial transactions; energy by creating efficient anonymous micro power grids capable of withstanding security attacks; healthcare through the democratization of data and promotion of medical research and innovation and finally internet of things through the security and anonymization of private information while enabling quick communication and updates across devices.

Blockchain however poses a new challenge due to the lack of consumer awareness as well as the overall barriers surrounding its use coupled with the overall hype built around its dependent system of cryptocurrencies isolates the user from directly experiencing the technology itself. Furthermore, the decentralized nature of blockchain poses a radically different advantage / disadvantage combination from previous electronic commerce implementations. The increased anonymity and security at the expense of reputation and trust through an intermediary is likely to reverse the traditional value proposition of most systems.

Therefore, there is a need to establish measurements of perceived usefulness, risk, reputation and intention to transact in order to allow research on blockchain technology acceptance to continue. This is especially pertinent due to the inability to conduct studies pertaining to blockchain acceptance without the prevalence of such measures. In this study, we set out to develop the items needed to quantitatively evaluate and identify user perceptions and attitudes towards a particular factor.

We develop the measures by consulting the literature and proceed through a rigorous process to ensure the clarity and consistency of the proposed items. The survey is then run across an online classroom of students and the results are assessed through exploratory factor analysis. Our study was able to successfully identify relevant items pertaining to the top factors in technology acceptance models, namely perceived usefulness, reputation, perceived transaction and technology risk as well as intention to use. These measures should make a study of technology acceptance with regards to blockchain technology a feasible endeavor. We offer these measurements in the hope that they will serve to generate representative and accurate models for blockchain uses and implementations.

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