BERJAYA Journal of Services & Management
ISSN: 2289-568X
Vol. 12, July 2019, 15 – 29

A CONCEPTUAL FRAMEWORK FOR INNOVATION TRAITS AND ACCEPTANCE OF THE ADOPTION OF BLOCKCHAIN IN THE STOCKBROKING INDUSTRY

Soon Wai Leong
Azman Hashim International Business School, Universiti Teknologi Malaysia.
soonwaileong@gmail.com

ABSTRACT

The term 'FinTech' which refers to the assimilation and used of information technology in finance to be more efficient and less costly in provision of services and operations as well as to enable new products to be offered in the finance industry that may be difficult to be offered previously as information technology had yet to catch up then. In the stockbroking industry, there is a need for these stockbroking firms to innovate itself so that its existence will remain relevant as it appears the more complex the technology is the less likely the technology will be adopted. One of the FinTech is the distributed ledger technology such as blockchain technology. The blockchain technologies can be applied elsewhere beyond finance. There is a dearth of research that examines how the innovative traits of blockchain itself influence its successful deployment in organisations and key determinants affecting the adoption of blockchain as well as how strategies and organisation structures are made adequate in the stockbroking industry. The purpose of this paper is to propose a conceptual framework to explore the research and application landscape of blockchain technology as well as to investigate the continuance intention to adopt blockchain technology in the stockbroking industry. The proposed conceptual framework is developed based on the Diffusion of Innovation theory and Technology Acceptance Model.

Keywords: *Blockchain, innovation traits, diffusion of innovation, successful deployment, Technology Acceptance Model.*

INTRODUCTION

The capital market is a marketplace that comprises suppliers and users of funds. Suppliers of funds include institutional investors and retail investors while users of funds are mainly corporations that require and utilise funds to expand and grow their businesses (Soon and Basiruddin, 2018). These parties are connected by intermediaries such as amongst others, the stock exchange, investment banks, insurance companies and fund management companies. The intermediaries facilitate the raising of capital by assisting firms to solicit funds from institutional investors and retail investors whilst providing advice to these investors on their investments.

The capital marketplace can exist in the forms of over-the-counter platforms or as an electronic platform such as the stock exchange. The stock exchange is an important part

of a country's economy that plays a myriad of roles in the capital market. First and foremost, the stock market connects the suppliers and users of funds by enabling the firms to tap into the capital market to access funds for future corporate exercises. Firms can then issue listed marketable securities as consideration for potential mergers and acquisitions to grow the firms in the future after their listings. A firm that is listed on a regulated stock exchange also benefits from enhanced credibility and better market positioning which is an indirect form of advertising. Lastly, the stock exchange provides an avenue for shares to become liquid assets unlike physical assets (i.e.: real estate investment) which are generally illiquid.

For stock trading or stock investment, investors have to go through intermediaries such as stockbrokers or the investment banks who are participating organisations of the stock market. These entities assist the investors to place buy and sell orders in the stock exchange. As such, there is transparency in trading prices and volume of shares traded. Despite the existence of the stock exchange, the stockbroking firms in Malaysia have found itself struggling to grow its earnings in recent years while the investment banks owned by commercial banks are expanding through mergers and acquisitions (Liew, 2015). "Many remises have yet to evolve with the times in the fast-changing stockbroking landscape, especially with online trading making investing easier" (Liew, 2015). In Asia, Singapore's DBS Group Holdings will transfer its retail equity trading business from DBS Vickers Securities to the bank which will result in brokerage firm's remises potentially losing their clients or business as the bank sought to compete in a low-cost online trading environment (Paul, 2019). Considering that the financial market has been rapidly evolving especially with the adoption of technology, the term 'FinTech' which refers to the "amalgamation of finance and innovative information technology, which can make services and operations more efficient, less costly and enable the provision of new products and services" (Karkkainen et al., 2017), there is a need for these stockbroking firm to innovate itself so that its existence will remain relevant as it appears the more complex the technology is the less likely the technology will be adopted.

One of the FinTech is the distributed ledger technology such as the blockchain technology, of which Bitcoin being the first noticeable decentralized, peer-to-peer cryptocurrency that was based on the blockchain technology (Zambrano et al., 2017). The technology enables a new world of decentralised communication and coordination by building the infrastructure to allow peers to safely, cheaply and quickly connect with each other without a centralised intermediary. There are many applications that can be implemented with blockchain besides bitcoin (Crosby et al., 2016). Beyond the finance industry which has originated the cryptocurrency, blockchain can be applied in other areas include, amongst others, supply chain management, electricity industry, government in handling public documents, land titles, electoral processes, humanitarian aids and donation via voucher system to ensure financial resources securely reach their final destination, agriculture, intellectual property rights (IRENA, 2019; Zambrano et al., 2017; Deng and Chen, 2017; Liu et al., 2015; Verhoeven et al., 2018).

However, there is a dearth of research that examines how the innovative traits of blockchain itself influence its successful deployment in organisations and key determinants affecting the blockchain technology adoption as well as how strategies and organisation structures are made adequate to adapt to the implementation of blockchain technology. Diffusion of innovation (DOI) is a theory that helps to explain the adoption process of an innovation, which is a prerequisite of successful implementation (Ahmad et al., 2016). However, it is also pertinent to note the theory of technology acceptance model (TAM) is

used to explain an individual's acceptance of an information system (Surendran, 2012). Thus, the aim of this paper is to propose a conceptual framework on the adoption as well as the acceptance of blockchain based on the integration of DOI and TAM that will serve as a guide for implementation of blockchain technology in the stockbroking industry. In addition, this paper is expected to contribute to the existing literature.

We have reviewed, analysed compared and synthesized literature pertaining to Blockchain, DOI and TAM to fulfil the aim of this paper. Section 2 of this paper comprises the literature review and conceptual design. Thereafter, Section 3 discusses our conclusion, implications, and significance of the study. Finally, Section 4 consists of the limitations and future research directions.

LITERATURE REVIEW AND CONCEPTUAL DESIGN

Blockchain Technology

Blockchain technology was successfully introduced subsequent to the global financial crisis in the year 2008 by Nakomoto (2008) when he introduced and originated Bitcoin a peer-to-peer cryptocurrency to be used to record historical transactions of encrypted digital money. "It can record transactions in a secure, transparent, decentralized, efficient, and low-cost way" (Schatsky and Muraskin, as cited in Zhu and Zhou, 2016). The blockchain technology was further researched and separated from cryptocurrency. To add depth to the knowledge of Blockchain technology, researchers researched areas of "cryptography, network topology, and consensus algorithms" (Zhu and Zhou, 2016).

The two main types of blockchains are public blockchain and private blockchain (Zambrano et al., 2017). Whereas, a hybrid blockchain is a form of public-private blockchain. Blockchain can be either permission-less or permissioned. Table 1 below summarized the blockchain types.

Table 1: The Blockchain Types

	"Permission-less"	"Permissioned"
"Public"	"All peer-to-peer network nodes have full access to the blockchain."	"Nodes need to be authenticated to get write access to the blockchain."
"Private"	"All nodes in a previously defined private network have full access to the blockchain."	"Nodes must authenticate to have read and write access to the private blockchain. Alternatively, only some authorised nodes can write to the blockchain while all others have read access only."

(Source: Adopted from Zambrano et al., 2017)

Traits of Blockchain Technology

Blockchain's key traits are privacy, pseudo-anonymity, integrity, governance, transparency, security, sustainability and open source (Zambrano et al., 2017). The decentralized structure of the database enables the blockchain to operate with high efficiency and low cost. Considering that public ledger is shared by users on the Internet which in turn ensures the security, transparency, and integrity of data, which cannot be tampered with or forged, the technology solves the need to go through an intermediary to do the relevant processing of information and accordingly reduce the costs associated with the transaction taken by the parties. This means that information stored in the database and the users' privacy based on blockchain technology is secured and protected (Zyskind et al., 2015). Lastly, considering that the blockchain is programmable, it can be used in applications beyond the finance industry and is able to increase flexibility and reliability of the applications developed by programmers to address the intended scenarios (Pilkington, 2016).

Limitation of Blockchain Technology

In regard to the limitation of this technology, limitations can be classified in technical, business and regulatory (Lewis et al., 2017). IRENA (2019), Zambrano et al. (2017) and Lewis et al. (2017), noted several factors that will hinder the advancement of blockchain technology from technical and business perspectives.

The first and second limitations are the scalability factor and the block size factor which state that a new block of transactions can only be added on the blockchain every ten minutes or so which can be expressed as low volume of transactions per second, a significantly low volume compared to the traditional transactional networks such as VisaNet, the processing service for the international Visa network which could handle more than 65,000 transaction per second (Visa, 2018) and that the original bitcoin source code defined the block size as one megabyte which can only accommodate 2,200 transactions. Nevertheless, promising areas of research to tackle scalability is the use of parallel interoperable chains, or "sidechains". The use of sidechains reduces the computer processing load on a single chain by way of delegation of some other computational responsibility to parallel and subordinate chains, to report and notarize their results to other chains to achieve consensus (IRENA, 2019). Furthermore, the approach to further increase the speed and scale issues is to employ alternative consensus platform (i.e. change 'proof of work' to 'proof of stake' or 'proof of authority') and to also have certain data be stored off blockchain or frozen, thereby allowing enhanced processing time (IRENA, 2019).

The third and fourth limitations are high costs and environmental factors. At the moment, blockchain technology uses a substantial amount of power and computing resources by the distributed system due to the requirement of transaction validation and network consensus achievement (Swan, 2015) compare to the traditional channel. The energy resources inefficiency because of a mean of reaching consensus using the 'proof of work' method has an impact on the environmental. In China, the government bans crypto mining because the government believes that crypto mining is a waste of energy resources and brings pollution such as noise pollution and global warming as crypto mining requires computers to run non-stop without switching off (Korwin, 2019). Nevertheless, according to IRENA (2019), new means of reaching consensuses such as 'proof-of-stake' and 'proof-of-

authority' are currently being developed and is expected to greatly reduce power consumption as they are adopted and thus reduce the pollution impact to the environment.

The fifth, sixth and seven limitations are usability, complexity and cryptography factors. Blockchain technology requires the secure management of public and private keys by end users and nodes and that losing private keys is still a serious risk (Zambrano et al., 2017). Presently there are no solutions to address physical theft and only a few can protect users from malware. Advancement in the blockchain technology is also hindered by its complexity as only blockchain practitioners will understand the technology (Zambrano et al., 2017). The use of cryptographic tools is still incipient and the average internet user cannot be expected to embrace its use in the short term (Zambrano et al., 2017). Karkkainen et al. (2017) identified that there is a need to bridge finance and technology education gap in university studies to prepare graduates which in turn is expected to reduce the skills shortages as identified by firms and experts. Cedefop (2015) predicted that in Europe, by 2020 there will be a skill shortfall in related jobs by 9,000,000 positions.

The eight, nine and tenth limitations are centralizations of mining nodes, internet bandwidth and Immutability as liability factors. Mining is now centralized with a few nodes controlling a large share of the market. Antpool, F2Pool, Bit Furry, BTCC Pool and BTCTOP control more than 50% of the market as at 1 April 2017 (Zambrano et al., 2017). The access to the right internet bandwidth is required to order for the nodes to function properly considering that the current size of the blockchain is over 120 gigabytes (Zambrano et al., 2017). In the event that the blockchain is hacked or the software code has a bug that allows a particular exploit, then its immutability can, in fact, become a liability. Examples include hacking the blockchain and mistake made on the transactions which can only be reversed, or changed by submitting an equal and offsetting trade.

There are others technical, business and regulatory limitations that were identified by Lewis et al. (2017) as identified in Table 2.

Table 2: Additional Technical, Business and Regulatory Limitations

Other limitations	Description
"Standardization"	"There is also a lack of standardization of blockchain network designs, which can cause major issues in their implementation and acceptance by businesses. Many national and international organizations are trying to establish generally accepted technical standards."
"Interoperability"	"Current businesses will face challenges related to the interoperability of blockchain platforms with their existing internal systems. Externally, it remains to be seen how blockchains from multiple businesses might operate with each other."
"Legal uncertainty"	"Currently, firms do not have clarity over the laws and regulations that will apply to distributed ledger technology implementations in cases of fraud, bankruptcy, and other failure scenarios. This is especially a problem for firms that operate in multiple jurisdictions."
"Security"	"While the reduced reliance on a central authority and the fact that copies of the ledger are stored in more than one place ameliorate the single point of failure problem present in many legacy systems, blockchain's distributed nature also creates security concerns. The more participants in the network, the more points of attack there are for cybercriminals to target. If cybercriminals are able to steal the information of a user necessary to submit a trade, they could create fraudulent, and immutable, transactions."
"Privacy"	"Blockchain's potential impact on the confidentiality and speed of information transfer about record changes may also be of concern to some users. For example, in finance, the acquisition and analysis of data are key to a firm's competitive advantage. Some firms may be reluctant to participate in a shared database in case of information leakage that could cost the firm's business."
"Intellectual property"	"Blockchain technology may be subject to legal challenges and costs that could impede innovation. Industry participants involved in blockchain research are increasingly patenting blockchain-related technologies; the number of blockchain-related patents filed doubled between January and November 2016. The patents could make firms working with blockchain technologies vulnerable to legal challenges and prevent new firms from entering the market."
Regulatory challenges uncertainty	"There is currently uncertainty over rules across various regulatory agencies. Existing regulations may be major hurdles for distributed ledger technologies. To enable innovation, regulatory agencies should work alongside distributed ledger technologies firms as they test new products and services."
"Currency control"	"Central banks will have to find ways to maintain control over digitized currencies. If central banks were to allow commercial banks to place money in special accounts and then digitize the money on the bank's blockchain, regulators would need a mechanism for overseeing its use and ensuring that the digital currency issued did not exceed the amount held as central bank reserves."

(Source: As adopted from Lewis et al., 2017)

While we have noted that the blockchain community itself is already working on potential solutions to address some of these limitations, it is also crucial to note that governance of the blockchain is important. Regulators need to take the initiatives to set proper controls, laws, rules and regulation to govern the use of blockchain which in turn will further the adoption and acceptance blockchain technologies by the people.

Current Development of Blockchain Technology Application Related to Stockbroking Industry

Swan (2015) presents three categories of potential applications in Finance. The three categories are the currency, smart contracts and social applications beyond currency and financial markets. In currency, Swan (2015) discussed the usage of blockchain technology for currency transfer, remittance, and E-payment systems. The second category is the smart contracts, whereas, the third category includes applications, such as a digital identification, notary, voting, and healthcare applications (Swan, 2015; Pilkington, 2016). The application of blockchain technology can be extended and be adopted in business models that work based on the concept of sharing economy (Huckle and White, 2016). Sharing economy is a term used for a new business model that distribute products and services compared to the traditional method by corporation hiring employees to sell their products and services.

"The most promising applications exist where transferring value or assets between parties is currently cumbersome, expensive and requires one or more centralized organization" (CPA Canada and AICPA, 2017, p8), (i.e. digitalisation of physical assets such as real estate and stock certificates into digital assets to reduce the settlement time taken to complete the transaction as the time taken to verify relevant documents is lengthy). Financial services practitioners believe that blockchain technology can disrupt the financial services industry as technology advances are expected to "transform the industry and its workforce by automating many of the activities currently performed by humans" (CPA Canada and AICPA, 2017, p8).

Many central banks and stock exchanges research on blockchain and its applications in the financial industry (Walport, 2016; Yifei, 2016). Stock exchange such as Nasdaq Inc. is piloting a blockchain platform that enables the issuance and transfer of private securities. Nasdaq Inc. pioneered the adoption of blockchain technology by introducing blockchain for private securities (Nasdaq Linq, a private equity market platform developed using the blockchain technology to support the digitized confirmation of equity rights, significantly saving time and paper, assets management and payment of securities (Nasdaq, 2015; 2016).

In relation to the digital asset management, Nasdaq Inc. developed a blockchain application for asset management companies whereby these companies join a shared and trusted distributed database that records all transactions and ownership changes in real time. This technology enables enable asset management companies to keep track of its mutual funds' trading and records as well as to reduce the operating costs associated with manual work. The streamlining of processes will also reduce the risk of errors. At the same, time, individual investors will benefit from faster response time such as faster mutual fund purchases and sales time.

A specific activity attracting significant interest is securities settlement, whereby financial intermediaries aim to reduce settlement time among themselves. The adoption of blockchain-based for payment transaction for securities is expected to reduce the processing time of the swift record of submissions and their confirmation drastically. The reduction in the settlement time may promote and increase securities trading liquidity which in turn may promote better capital usage. An example of a blockchain settlement processing system is the collaboration between Nasdaq and Citigroup to put Citi's business-payment services on Nasdaq's distributed ledger developed based on the blockchain technology (Nasdaq, 2016). The Nasdaq's distributed ledger automatically reconciles transactions in real time consistent with the transmission and payment instructions. This enables the service providers to improve its financial performance due to the significant savings and revenues from the adoption of the blockchain for payment systems. The advantage of such adoption includes service provider able to use this payment system as a backup system in the event the traditional payment system is offline due to maintenance or disrupted, and is able to collect a fee on blockchain based transactions. This means that the adoption of the blockchain payment system could further enhance the existing settlement and credit risk management systems and also lower the transaction costs which in turn encourage more market participants to trade shares more frequently. However, in order for the system to work, "liquidity, funds and assets must be in proper form and location for such expedited settlement" (Lewis et al., 2017). Barclay et al. (1997) found that higher transaction costs significantly reduce trading volume. While this is an older study, a more recent study by Lo et al. (2004), found that inability to trade more frequently reduces the agents' asset demand and in equilibrium gives rise to a significant illiquid discount in assets prices. In other word, transaction costs influence the trading volume which will affect the prices of the listed securities on the stock exchange. Likewise, an increase in trading volume will generate more income to financial intermediaries such as stockbroking firms and the stock exchange.

Premised on the above, we noted the various blockchain technology initiatives taken by major organisations. The collaboration among these interested people is expected to advance the knowledge, adoption and acceptance of this technology which will in turn increase the use of this technology in the stockbroking industry as it can potentially demonstrate the benefit of the increase in trading volume outweigh the reduction in transaction fees to be charged by securities firm to its clients as well as the reduction in settlement risks.

Diffusion of Innovation (DOI) Theory

The diffusion of innovation theory (DOI) to help understand the adoption process of innovations and to explain how and why new ideas and technologies spread was proposed by Rogers (1995). According to Rogers (1995), Karahanna et al. (1999), and Agarwal et al. (2000), DOI research has been widely applied in various fields. Innovation is defined as "an idea, practice, or object that is perceived as new by an individual or another unit of adoption" while diffusion is defined as "the process by which an innovation is communicated through certain channels over time among the members of a social system" (Roger, 1995). According to this theory, prospective users of the technology make decisions either to adopt or reject the innovative technology based on beliefs that they form regarding the innovation (Karahanna et al., 1999; Lou and Li, 2017). Therefore, researchers can use DOI to predict the likeliness that the technology will be adopted as well as the rate of adoption of an innovation (Lou and Li, 2017; Chen et al., 2002). DOI includes five

significant innovation factors that are used to explain the adoption of new technology by users at each stage (i.e. innovators, early adopters, early majority, late majority and laggards). The five factors are compatibility, relative advantage, complexity, and trialability and observability.

Relative advantage is defined as "the degree to which an innovation is considered as being better than the idea it supersedes" (Roger, 2003, p229). Compatibility refers to "the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters" (Roger, 2003, p.15). Complexity is "the degree to which an innovation is perceived as relatively difficult to understand and use" (Roger, 2003, p15). Trialability refers to "the degree to which an innovation may be experimented with on a limited basis" (Roger, 2003, p16). Observability is "the degree to which the results of an innovation are visible by others" (Roger, 2003, p16).

Based on the review of past papers, we have noted that DOI was used in the studies of big data which is technology to treat ways to analyse, systematically extract information from, or otherwise deal with data sets that are too large or complex to be dealt with by traditional data-processing application software (Ahmad et al., 2016; Soon et al., 2016). DOI can also be integrated with more than one theory. Sun et al. (2016) studied factors affecting the organisational adoption of big data based on DOI, the institutional theory and the technology-organisation-environment framework of which they have explored 26 factors that affect organisational big data adoption and integrated the results into a single big data adoption framework. Considering that blockchain technology is similar to big data technology whereby both are new technologies in the market, this paper proposes to apply DOI theory to study the adoption of blockchain technology.

Technology Acceptance Model (TAM)

Technology acceptance model explains whether the "information technology is actually accepted by its intended users" (Dillon and Morris, 1996). TAM presents two factors that are important determinants of users' acceptance: perceived usefulness and perceived ease of use (Davis, 1989). The fundamental principle of TAM, according to Davis (1989), the adoption rate of the technology will be higher if the users perceive that the technology will enhance their performance and it is effortless to learn and also easy to use the technology We have noted from our review of past literature, Soon et al. (2016) and Liu et al. (2015), had studied on big data initiative which is related to innovative technology. Soon et al. (2016) discovered that perceived usefulness and perceived benefit have an influence in adopting big data when analysing the determinants of big data adoption. However, the perceived ease of use was not a relevant predictor. Liu et al. (2015) found that social influence such as the shared opinion of a group of individuals may influence the successful implementation of big data initiatives.

We noted that it was recommended that research based on TAM model should be integrated with "other theories or models to cope with radical technological change and improve the quality and explanatory power" (Carter and Be´langer, 2005; Legris et al., 2003 as cited in Lou and Li, 2017, p300). The study based on TAM and DOI complements each other to examine the adoption of new technology (Lee et al., 2011). Lou and Li (2017) noted that prior studies by researchers found that the model developed based on the integration of these two theories provide a better understanding to guide researchers and it is proven to be

a better model than either standing alone. Therefore, this paper proposes to study blockchain based on the integration of DOI and TAM.

Conceptual Framework

This research proposes an integrated model based on the theory of DOI and TAM. The two basic TAM factors are perceived usefulness and perceived ease of use and five important factors for innovation based on DOI are a relative advantage, compatibility, complexity, trialability and observability, are included as the major determinants in our integrated framework (see Figure.1). In regards to the study of blockchain based on DOI, we have noted that Lou & Li (2017) proposed to study only the relative advantage factor, compatibility factor and complexity factor based on the "prior researches of the meta-analysis of 75 diffusion articles conducted by Tornatzky and Klein (1982), found that only relative advantage, compatibility and complexity were consistently related to the adoption of technical innovations" (Tornatzky and Klein, 1982, as cited in Lou & Li, 2017). The proposed research represents an extension of Lou & Li (2017) research model after we have considered that trialability and observability should be also tested since they are also factors influencing the adoption of innovation based on the DOI.

Based on the review of past literature (Lou & Li, 2017; Al-Rahmi; 2019), we have noted the positive and negative effects of the factors of the adoption of innovative technology based on the DOI theory. According to Sahin (2006), relative advantage, compatibility, and trialability and observability factors are expected to be positively correlated with the rate of adoption of an innovation and complexity factor is expected to be negatively correlated with the rate of adoption of an innovation. The proposed model based on the integration of DOI and TAM theory is an attempt to understand and reveal how these factors influence the acceptance intentions by the practitioners and their usage behaviour of blockchain technology in the stockbroking industry. The proposed model will be tested based on the following hypotheses, of which validity and applicability tests need to be conducted.

H1: Users' behavioural intention had a positive effect on his or her actual use the blockchain technology.

H2: Users' attitude toward using blockchain had a positive effect on his or her behavioural intention to use the blockchain technology.

H3: Users' perceived usefulness had a positive effect on his or her behavioural intention to use the blockchain technology.

H4: Users' perceived usefulness had a positive effect on his or her attitude toward using the blockchain technology.

H5: Users' perceived ease of use had a positive effect on his or her attitude toward using the blockchain technology.

H6: Compatibility had a positive effect on perceived usefulness of the blockchain technology.

H7: Compatibility had a positive effect on perceived ease of use of blockchain technology.

H8: The relative advantages had a positive effect on perceived usefulness of the blockchain technology.

H9: The relative advantages had a positive effect on perceived ease of use of blockchain technology.

H10: Complexity had a negative effect on perceived usefulness of the blockchain technology.

H11: Complexity had a negative effect on perceived ease of use of blockchain technology.

H12: Trialability had a positive effect on perceived usefulness of the blockchain technology.

H13: Trialability had a positive effect on perceived ease of use of blockchain technology.

H14: Observability had a positive effect on perceived usefulness of the blockchain technology.

H15: Observability had a positive effect on perceived ease of use of blockchain technology.

In conclusion, the proposed structure based on the integration of DOI and TAM theories is represented by H1-H15 as shown in Figure 1.

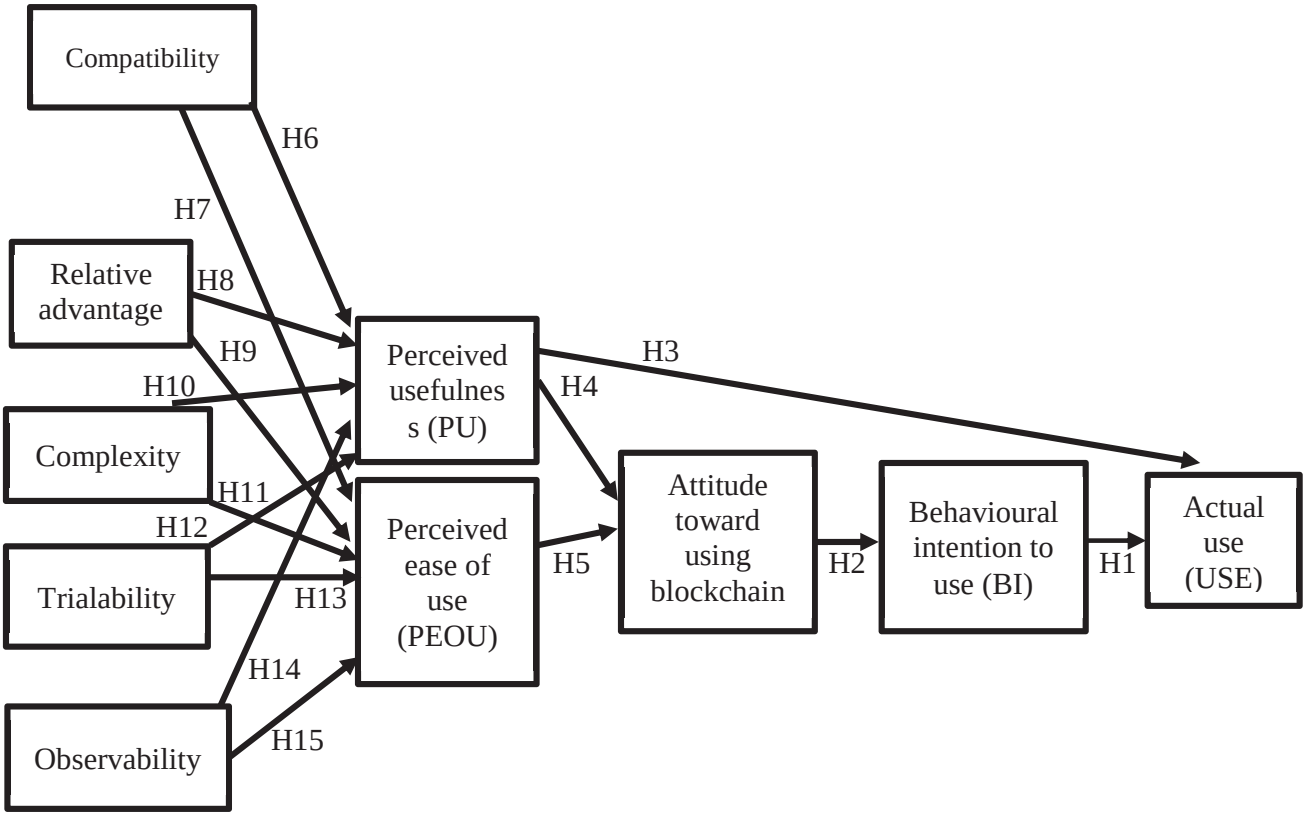

Figure 1: The Proposed Research Model

CONCLUSIONS, IMPLICATIONS AND SIGNIFICANCE

We followed the approach of Ahmad et al. (2016) in proposing a framework to base on DOI but it has been extended to also apply the TAM theory as researched by Soon et al. (2016). Blockchain technology can disrupt the stockbroking industry as the technology itself is a solution that can achieve, amongst others, efficient and low-cost equity registration, equity transaction and transfer, and shareholder voting (Zambrano et al., 2017; Nasdaq, 2015 & 2016). Blockchain can also be applied to other businesses beyond finance. There are many whitepapers pertaining to the application of blockchain technologies in other industries (Whitepaper Database, n.d.).

While this technology is still at its infancy and is hindered by challenges, it is important to note that economic benefits, including work efficiency, can be derived through technical innovation and applications (Zhu and Zhou, 2016). In this regard, we have also noted the importance for firms to collaborate to advance the blockchain technology in the capital market such as the implementation of blockchain technology by Nasdaq and Citibank to deepen our understanding of blockchain technology, its value, its opportunities, and its risks.

The integration of DOI and TAM may be vital as we expect that it could to provide us with a framework to deepen our understanding on the adoption and utilisation of blockchain technologies by the various stakeholders within the stockbroking industry. We hope that the conceptual framework will provide guidance to accelerate the adoption of blockchain technology as well as to address the limitation and challenges in the adoption of blockchain technology.

Limitations and Future Research Directions

The limitation of this study is that the facts are limited to the papers reviewed and analysed. The research scope for this conceptual model could be extended with respect to theory. Researchers are encouraged to adopt a qualitative research design approach to gather information within a real-life context to build the theory. Considering that blockchain research by academics is still in the infancy stage (Matsuura, 2019), the lack of existing research, open qualitative interviews may be an option such as the Delphi method used by Holutiuk et al. (2017). Another example of a qualitative research design approach noted from the papers is the case studies approach by Verhoeven et al. (2018). Alternatively, researchers may examine it empirically through a quantitative approach where researchers may use questionnaires to collect data.

REFERENCES

Agarwal, R., Sambamurthy, V. and Stair, R. M. (2000). The evolving relationship between general and specific computer efficacy: An empirical assessment. *Information Systems Research, 11*(4), 418-430.

Ahmad, A., Ahmad, R. and Hashim, K. F. (2016). Innovation traits for business intelligence successful deployment. *Journal of Theoretical and Applied Information Technology*, *89*(1), 96-107.

Al-Rahmi, W. M., Yahaya, N., Aldraiweesh, A. A., Almari, M.M. Aljarboa, N. A., Alturki, U. and Aljeraiwi, A., (2019). Integrating Technology Acceptance Model with Innovation Diffusion Theory: An empirical investigation on students' intention to use e-learning systems. *IEEE Access*, *7*.

Cedefop (2015). *Skills, Qualifications and Jobs in the EU: The Making of a Perfect Match? Evidence from Cedefop's European Skills and Jobs Survey*. Luxembourg: Cedefop Reference Series Publications Office.

Chen, L. D., Gillenson, M. L., and Sherrell, D. L. (2002). Enticing online consumers: An extended technology acceptance perspective. *Information and Management*, *39*(8), 705-719.

CPA Canada and AICPA (2017). *Blockchain Technology and Its Potential Impact on the Audit and Assurance Profession*. Deloitte Development LLC.

Crosby, M., Nachiappan, Pattanayak, P., Verma, S., and Kalyanaraman, V. (2016). BlockChain technology: Beyond Bitcoin. *Applied Innovation Review*, 2, June 2016.

Davis, F D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319-340.

Deng, A. and Chen, Z. (2017). Managing online supply chain finance credit risk of "Asymmetric Information. *World Journal of Research and Review*, *4*(1), 29-32.

Dillon, A. and Morris, M. (1996). User acceptance of new information technology: theories and models. In M. Williams (ed.), *Annual Review of Information Science and Technology*, 31, Medford NJ: Information Today, 3-32.

Holutiuk, F., Pisani, F. and Moormann, J. (2017). The impact of blockchain technology on business models in the payments industry. *13th International Conference on Wirtschaftsinformatik*, St. Gallen, Switzerland.

Huckle, S. and White, M. (2016). Socialism and the blockchain. *Future Internet, 8*(49).

Karahanna, E., Straub, D.W., & Chervany, N. L. (1999). Information technology adoption across time: A cross-sectional comparison of pre-adoption and post-adoption beliefs. *MIS Quarterly*, 23, 183-213.

Korwin, A. (2019, April 09). China new anti-crypto move: Ban Bitcoin mining to save environment. Retrieved January 4, 2019, from *https://ethereumworldnews.com/chinas-new-anti-crypto-move-ban-bitcoin-mining-to-save-environment/*

Lee, Y. H., Hsieh, Y. C., and Hsu, C. N (2011). Adding Innovation Diffusion Theory to the Technology Acceptance Model: Supporting employees' intentions to use e-learning systems. *Journal of Educational Technology & Society*, *14*(4).

Lewis, R., McPartland, J. W. and Ranjan, R. (2017). Blockchain and financial market innovation. *Economic Perspectives*, *41*(7).

Liew, J. (2015, February 27). Stockbroking industry faces tough times. Retrieved from *https://www.theedgemarkets.com/article/stockbroking-industry-faces-tough-times.*

Liu, X., Zhou, L. and Wu, Y. (2015). Supply chain finance in China: Business innovation and theory development. *Sustainability*, 7.

Lou, T.F. and Li, E.Y. (2017). Integrating innovation diffusion theory and the technology acceptance model: The adoption of blockchain technology from business managers' perspective. In *Proceedings of the 17th International Conference on Electronic Business* (293-296). ICEB, Dubai, UAE, December 4-8.

Matsuura, K. (2019). Token Model and interpretation function for Blockchain-Based FinTech applications". *IEICE Trans Fundamental*, Vol (E102-A).

Nasdaq (2015). Nasdaq LINQ enables first-ever private securities issuance documented with blockchain technology. Retrieved August 17, 2018, from *http://ir.nasdaq.com/releasedetail.cfm?releaseid = 948326.*

Nasdaq (2016). Building on the blockchain. Retrieved August 17, 2018, from *http://business.nasdaq.com/marketinsite/2016/Building-on-the-Blockchain.html.*

Paul, B. (2019). Revamp of DBS Vickers a sign of things to come; can brokerages, remisiers maintain their relevance? Retrieved from *www.theedgesingapore.com/revamp-dbs-vickers-sign-things-come-cand&brokerages -remisiers-maintain-their-relevance*

Pilkington, M. (2016). Blockchain technology: Principles and applications. *Research Handbook on Digital Transformations*.

Rogers, E. M. (1995). *Diffusion of Innovations* (4th ed.). New York: Free Press.

Rogers, E.M. (2003). *Diffusion of Innovations* (5th ed.). New York: Free Press

Sahin, I. (2006). Detailed review of Rogers' Diffusion of Innovations Theory and educational technology-related studies based on Rogers' Theory. *The Turkish Online Journal of Education Technology*, *5*(2).

Soon, K, W. K., Lee, C. A. and Boursier, P. (2016). A study of the determinants affecting adoption of big data using integrated Technology Acceptance Model (TAM) and diffusion of innovation (DOI) in Malaysia. *International Journal of Applied Business and Economic Research*, *14*(1), 17-47.

Soon, W. L. & Basiruddin, R. (2018). A Conceptual Framework for a Corporate Finance Valuation Method. *Business Management and Strategy, 9*(2).

Sun, S. Cegielski, C., Hall, D. J. (2016). Understanding the factors affecting the organisational adoption of big data. *Journal of Computer Information Systems*.

Surendran, P., (2012). Technology Acceptance Model: A survey of literature. *International Journal of Business and Social Research*, *2*(4), 175-178.

Swan, M. (2015). *Blockchain: Blueprint for a New Economy*. Beijing: OReilly.

Tornatzky, L. G. and Klein, K. J. (1982). Innovation characteristics and innovation adoption-implementation: A meta-analysis of findings. *IEEE Transactions on Engineering Management*, *29*(1), 28-43.

Visa Incorporated, (2018). Visa actsheet. Retrieved January 11, 2019 from *https://usa.visa.com/dam/VCOM/download/corporate/media/visanettechnology##//aboutvisafactsheet.pdf*

Walport, M., (2016). Distributed Ledger Technology: Beyond blockchain. *UK Government Office for Science, Tech. Rep*, 19.

WhitepaperDatabase. (n.d.). Whitepaper database. Retrieved May 4, 2019, from *https://whitepaperdatabase.com/*

Yifei, F., (2016). On digital currencies, central banks should lead. Retrieved May 4, 2019, from *https://www.bloomberg.com/opinion/articles/2016-09-01/on-digital-currencies-central-banks-should-lead*

Zambrano, R., Seward, R. K. and Sayo, P. (2017). *Blockchain: Unpacking the Disruptive Potential of Blockchain Technology for Human Development*. Ottawa, Canada: International Development Research Centre.