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Blockchain Adoption Model for the Global Banking Industry

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1. Introduction

Blockchain has been the buzz word for the last decade, ever since Nakamoto (2008) released the first seminal paper talking about the invention of Bitcoin as a response to the world financial crisis in 2008. According to Kelly (2019), Craig Write, the founder and CEO of the blockchain company nChain, has been fighting to prove that he is the Bitcoin creator. And although he has been granted the copyright registration for the Bitcoin white paper and the original Bitcoin code by the US Copyright Office on Tuesday 21st of May 2019, the Financial Times' Kelly (2019) argues that Satoshi Nakamoto is still anonymous. Kelly basis her argument on the fact that a copyright is not a proof of identity as it is the case of a patent, since no identity investigation is required for obtaining a copyright, as was confirmed by the US Copyright Office according to her.

Although Bitcoin disrupted the norm with the new concept of cryptocurrency, it is the blockchain infrastructure behind it that has proved to be the real breakthrough. Blockchain, also known as the distributed ledger, by definition deals with financial transactions. An increased interest and adoption of the technology is expected from the global banking industry, which is a major part of the global financial system. IBM (2016) surveyed 200 banks from 16 countries and found that by 2020 about 66% of banks are expected to have adopted the new technology, and that the blockchain adoption is accelerating quicker than estimated. Accenture (2016) interviewed 32 commercial banks professionals and found that 9 out of 10 participating banks are already exploring using blockchain in payments. This highlights the industry's positive view of the technology and its urgent need of an adoption model to smooth the adoption process.

According to Gangwar et al. (2014), proposing an adoption model for new technology will identify the variables influencing the adoption behaviour of the organisations in order to accept and use the new technology innovations, and the relationship of these variables with the organisations' adoption behaviour. In addition, the new proposed adoption model will help in overcoming the challenges that are currently hindering the adoption of the blockchain technology in the global banking industry (Hassani et al. 2018).

However, for a tightly regimented industry with high compliance and risk requirements, adoption should be guided and in line with the regulations of the legislator bodies along with best practice guidelines from the industry's practitioners. Hence, this research will text mine the banking legislator bodies' published papers to identify the adoption model factors which will then be analysed to propose an appropriate adoption model.

Different research of blockchain in banking has been done in the past couple of years. Wang et al. (2016) investigated the maturity model of the blockchain technology adoption. Their research focused on the maturity measuring model of the technology in general and not in a specific industry as a preliminary step for the adoption decision. Woodside et al. (2017) researched the blockchain adoption status measuring the managerial acceptance of the technology in general against the Diffusion of Innovation (DOI) model. Their research identified the technology's status of adoption at the time as the innovation stage without specifying an industry. Similar work was done by IBM (2016) by surveying 200 banks to measure the blockchain's banking adoption level. Iansiti and Lakhani (2017) compare blockchain to the internet, viewing both as foundational technologies. They provide a blockchain transformation framework as they see that the new technology still has decades to fully mature. Hassani et al. (2018) researched blockchain's big data effect on the banking industry applications. However, according to Hassani et al. (2018), from an academic perspective, research is still lacking with a gap in blockchain adoption in the banking industry, fearing that this gap may affect the development and adoption of blockchain technology in banking. For this reason, this paper, differing from the others, proposes an appropriate banking adoption model of the new technology, in hopes of increasing the banking adoption and development of blockchain banking applications.

The paper is structured as follows. First, a review of the literature covering blockchain in banking, including an appraisal of blockchain adoption factors, is presented, followed by a discussion on why an adoption model is required. Next, the research's methodology is explained. The findings and analysis are then discussed, which form the basis of the proposed blockchain adoption model for the banking industry.

2 Blockchain in Banking

Hassani et al. (2018) declare that there is evidence of blockchain adoption resistance in the banking industry, where some do not see any potential of blockchain in the core business or focus on embracing other technologies, like the cloud, at the expense of blockchain. While Crosby et al. (2016) argue that banks no longer view blockchain as a threat to the traditional business models of the banking industry, particularly that its advantages dwarf the regulatory and technical challenges. While Hassani et al. (2018) think that blockchain may be viewed as a threat to the already established industry models, they also confirm that blockchain is the future of the banking industry by providing unaltered real-time accessed data with consensus verification, especially in the area of digital payments. According to them, the banking industry is moving into the blockchain technology, as evident by the emerging bank-based blockchain projects and partnerships and is expected to change the financial industry significantly.

Underwood (2016) shows that the potentials of the blockchain technology surpasses its initial cryptocurrency usage to the improvement of current applications and creating totally new ones that were not possible before, it has proven beneficial in developing countries and markets with its financial inclusion, such as the World Food Programme project, Building Blocks, for the Syrian refugee camps in Jordan (WFP 2019). Underwood (2016) also speculates that blockchain could prevent a repeat of the 2008 financial crisis as it provides a secure and trustworthy solution with fast and transparent transactions. Zheng et al. (2017) speculate that blockchain can enhance the efficiency and decrease the cost of maintaining a ledger-based financial system. They tribute that to the characteristics of the technology, being decentralized, persistent, anonymous auditable and transparent.

Maity (2016) review of Capgimini reports, estimates that retail banks will be able to save between $3 and $11 billion annually in US and UK only by adopting blockchain smart contracts which will lower the processing costs of loans and mortgages, Know Your Customer (KYC), Anti Money Laundry (AML) and Foreign Account Tax Compliance Act (FATCA). At the same time, investment banks can shorten their loans trading settlement process from 20 to 6-10 days with estimated future growth in demand of 5%, increasing the income and decreasing the operational costs, in addition to lowering the regulatory capital requirements and risks.

The emergence of the blockchain technology was concurrent with the banking and financial industry convergence to mobile payments, branchless banking, and digital-value exchange, promising disruption of the financial systems globally (Eagar 2016; Arnold and Jeffery 2016). Eagar (2016) foresees that this convergence from the legacy financial systems will provide more suitable offerings for different evolving markets and will benefit both the worldwide banked and unbanked consumers (estimated at 2 billion according to The World Bank (2015) report) promoting better financial inclusion of the unbanked consumers. Eagar (2016) also sees that the consumers will have a more active role in deciding which offering variations best suit them according to the provided customer experience. This is shifting the business model to be more customer-centric where customers and users are becoming the new co-creators of value. while Arnold and Jeffery (2016) predict that technical-savvy new entrants to the financial sector threaten incumbent banks by leading the new blockchain disruption, requiring banks to act fast to adopt the new technology.

Many financial vendors are already in the process of developing and providing new blockchain-based financial and banking solutions. According to Underwood (2016), Deloitte is developing solutions including Smart Identity, which banks can use to support client onboarding and KYC processes. R3, a new FinTech consortia backed up by over 40 banks, is working on a standardised architecture for private ledger using blockchain that could cut the cost of transactions and settling time significantly. Linux and IBM’s HyperLedger project is also building the foundation of a standardised production-grade digital ledger. Banks and financial institutes are looking into implementing the blockchain technology in a number of business areas like payment, stock trading, transaction-based processes, remittances and online payment (Beck and Müller-Bloch 2017; Zheng et al. 2017; Accenture 2016). Referring to table 1, it is noticeable how banks from different countries across the globe are using blockchain for various purposes and experimenting with possible new applications. These early adopters of the technology may be shaping the new financial landscape, although one might argue that the financial system may go through several changes before fully maturing, as in the case of the Internet.

Table 1 Blockchain in Banking Usage Examples

No.	Application Category	Applying Banks	Country	Year	Source
1.	Bitcoin Trading	• Goldman Sachs	• UK	2018	• Hassani et al. 2018
2.	Bond Transactions	• HSBC • State Street Banks	• UK • USA	2016	• Shen 2016
3.	Central banks currency swap (cross-border, cross currency using Central Banks Digital Currencies CBDC transfer)	• Bank of Canada [1] • The Monetary Authority of Singapore [2]	• Canada • Singapore	2019	• [1] Alexander 2019 • [2] Huang 2019
4.	Check Issuance	• Bank of Dubai	• United Arab Emirates	2018	• Hassani et al. 2018
5.	Considering the implementation of blockchain technology despite Cryptocurrency ban	• The Reserve Bank of Zimbabwe [3] • The Central Bank of Jordan [4]	• Zimbabwe • Jordan	2018	• [3] Hassani et al. 2018 • [4] CBJ 2019
6.	Currency Funds and order processing	• BNP Paribas	• France	2015	• Hassani et al. 2018
7.	Experimenting	• Bank of America in partnership with Microsoft	• USA	2016	• Shen 2016
8.	Improved KYC	• Deutsche Bank • HSBC	• Germany • UK	2018	• Curry 2018
9.	Improved Settlement	• The South Africa Reserve Bank (settling the country's typical 70,000 daily transactions within 2 hours with full anonymity)	• South Africa	2018	• Hassani et al. 2018

10.	Integrating Real Time Gross Settlement RTGS systems with blockchain	• Bank of England (proposal)	• UK	2018	• Hassani et al. 2018
11.	Loan Granting	• Agricultural Bank of China	• China	2018	• Hassani et al. 2018
12.	Remittances	• Cross-border Payments: ○ UBS ○ Santander UK (using Ripple) • Remittances competing with SWIFT using Ripple: ○ Over 60 Japanese Banks (80% of Japanese banking industry)	• Switzerland • UK • Japan	2018	• Hassani et al. 2018
13.	Smart Contracts	• The Commonwealth Bank of Australia	• Australia	2018	• Hassani et al. 2018
14.	Trade Finance	• Using IBM's Batavia [5]: ○ Bank of Montreal ○ CaixaBank, ○ Commerzbank ○ Erste Group • Using R3 [5]: ○ HSBC • Internal trade deals using India Trade Connect [6]: ○ 14 Indian Banks (responsible for around 50% of India's internal trade) including ICICI Bank and Yes Bank	• Canada • Spain • Germany • Central and Eastern Europe • UK • India	2018	• [5] Hassani et al. 2018 • [6] Satija and Antony 2018
15.	Various Transactions	• Over 12 Chinese Public Banks	• China (Blockchain was included in 2016's 5-year plan)	2018	• Hassani et al. 2018

2.2 Blockchain Adoption Factors in the Banking Industry

WEF (2015) sees that traditional roles will have to change in light of the blockchain technological and digital advancements, governments specifically will adopt an engaged facilitator rather than a commander role. While financial systems will adopt blockchain, changing the legacy pricing and exchange rate models. The main blockchain adoption supporting factors are referred to through literature as opportunities or benefits of using the new technology. These factors are based on the business value they provide to the financial and banking sectors. The identified supporting factors by this research are:

Enhanced data exploration: According to ENISA (2016), blockchain will enable banks to predict and mitigate liability risks due to its standardised recording mechanism. Higginson et al. (2019) state that blockchain's anonymity, cryptography, security, and the ability to store large volumes of data can enable banks to view any data on the distributed ledger network entered by other banks or members of the network. This will provide the banks with customers' data, banked and unbanked alike, resulting in more informative and fast decision making and credit-allocation process, retrospectively lowering banks' credit risks.

Regulatory compliance: ENISA (2016) states that blockchain will enhance the level of compliance automation and improve transactions authorisation accuracy. Accenture (2017) estimates 30-50% savings on compliance by using blockchain. ENISA (2016) also list that for the adoption to take place effectively, the financial system players should make sure to comply with what they refer to as the "governance toolkit": regulations, audit, internal controls and used technology.

Improving the KYC process: Lang (2017) argues that blockchain cryptography secures the shared data, which allows creating a central shared "repository" of always up-to-date customers identity data between banks. This will enhance the KYC process and respectively the AML process, increase the interoperability among different banks across countries, decrease administrative costs, and most importantly, decrease duplication of data which will reduce the needed infrastructure cost. Hassani et al. (2018) cite Reuters in estimating the KYC up-keep of 60-500 million USD per annum. Also, the Fourth EU Money Laundering Directive requires constant monitoring and updating of the consumers data, while the General Data Protection Regulation (GDPR) requires consumers security to have strict internal controls. Hassani et al. (2018) see that blockchain will be extremely useful to comply with these standards, if implemented correctly, yet argue that KYC blockchain-based registries won't probably get all banks buy-in as they will refuse to rely on third parties' verification of data.

Improved transactions speed: Smith (2018) sees that the verified and promptly available blockchain's data will substantially improve the transactions settlement time efficiency. Smith also sees that although traditional roles like intermediaries will be challenged, yet new advisory functions will be introduced. Lang (2017) foresees the possibility of direct transacting for both individuals and corporates enabling faster, simpler and more secure payments due to the certainty blockchain offers. Hassani et al. (2018) state the average blockchain transaction rate to be 1,000-2,000 transactions per second (TPS), yet there is no agreement in the banking industry regarding blockchain transaction capacity. Marr (2018), however, believes that due to the complexity, encrypted and distributed features of blockchain it is expected to be slow and cumbersome especially with time as it grows in size. He recommends advancements in engineering and processing speed as a solution yet to be developed. Accentrue (2017) foresees 50% cost saving on operational processes.

Smart contracts: Smith (2018) argues that by using blockchain's smart contracts, conventional contracts execution and resolution issues will be reduced with substantial efficiency and cost improvements, as well as introducing new automated contractual processes. According to The Accenture Technology Vision report, as cited by Hassani et al. (2018), 60% of surveyed executives believe that blockchain and smart contracts will be critical over the next three decades. Hassani et al. (2018) also warn that banks should implement smart contracts solutions in order not to lose their role in contracts management in the future.

Increased transparency: Smith (2018) demonstrates that with encryption, consensus and timestamp security elements of the blockchain, auditing can be enhanced to become continuous in real-time instead of only historical and can examine 100% of the transactions versus random statistical sampling used traditionally. He foresees a more involved role for the auditors in data security policies and decision-making processes. Hassani et al. (2018) sees that blockchain technology has the means to make the banking processes more transparent and secure compared to present highly secretive processes. By locking the blocks, full historical data access, authorisation privileges, and changes publicly visible to all parties, high levels of unprecedented transparency are achieved. This will enable real-time auditing, automated financial reporting, swift action regarding compliance violation, and real-time communication between banks and regulators.

2.3 Adoption Barriers or Hindering Factors

The main blockchain adoption barriers, referred to through literature as challenges or risks, that were identified by this research are:

Scalability: ENISA (2016) sees that data storing, sharing, and reconciliation costs in infrastructure and required transaction time will be reduced, challenging the current legacy systems. Hassani et al. (2018) recommend cost/benefit analysis to ascertain blockchain implementation feasibility. They also see that the cost will be reduced due to enhanced trust, reduced or eliminated settlement time, elimination of intermediaries' charges, and reduced administrative costs due to data sharing across banks. They expect a 30% infrastructure cost reduction by using blockchain technology. More detailed blockchain cost saving available from Cocco et al. (2017). Accenture's (2017) study on the top 8 largest banks in the world estimates 70% savings on central finance reporting, 50% savings on centralised operations, and a total average of 30% potential annual savings by using blockchain. Zheng et al. (2017) argue that with the daily number of transactions added to the blockchain, it will grow in size over time, especially as this data will have to be stored at every node for validation. They also highlight that the block size and generation time interval restrictions would not be able to meet the need to process millions of transactions in real time manner. In addition, they caution that miners might neglect small transactions in favour of large ones with higher fees. Hassani et al. (2018) refer to the 'scalability trilemma'; which states that only two out of three characteristics are achievable at the same time in systems: decentralisation, security, and scalability. They believe that by ensuring decentralisation and security, blockchain had to compromise on scalability making it one of the main hurdles for blockchain adoption. In addition to some central banks seeing the new technology as unsuitable for the current payment infrastructure due to scalability restrictions on large volumes of transactions. They demonstrate that blockchain will contribute to increasing the size of big data in banking, therefore, banking blockchains will need sturdy and reliable software and hardware to handle the growing big data as it should insure maintaining a steady accessibility speed for users.

Energy Consumption: According to Marr (2018) and Hassani et al. (2018), blockchain encryption feature, used to establish consensus in the network, runs complex algorithms to determine if a user has access permission. This requires large amounts of computing power and is energy draining. The energy consumption level is much smaller for organisations internal blockchains compared to public blockchains like Bitcoin, yet environmental impact should not be ignored. For the banking and financial sector, blockchains may be intra- organisation, owned and access by a single organisation or inter-organisations such as the KYC proposed blockchain between banks. This means that large energy consumptions are expected, yet to be objective it should be compared to the currently running systems energy consumption.

Currency stability: As Hassani et al. (2018) state, most bankers are against the use of Bitcoin as a currency. Blockchain payments adoption will depend largely on the stability of its underlying cryptocurrency considering the high volatility of the cryptocurrency market. Currency stability ensures that both trading parties would not suffer any losses due to price fluctuation. They suggest using a “stable coin” with low price volatility as it’s secured to an underlying fiat currency. Also, a central bank digital currency, once approved and legalised globally, will provide a relatively stable and controlled cryptocurrency to use in banking.

Legislations and regulations: According to Marr (2018) there is a lack of regulatory oversight for the blockchain networks sector creating very volatile environments. Marr (2017) sees the blockchain need to comply with current and future privacy regulations and ensure its data’s safety as a hurdle for adopting the technology in the financial sector. Hassani et al. (2018) see that policies should be standardised across banks to make most of blockchain, such as a shared KYC standardised network across banks. Unless addressed, the lack of industry standards could seriously hinder the adoption of blockchain technology across the banking sector. Hassani et al. (2018) point out the importance of establishing regulatory sandboxes to enable regulatory guided innovation. They argue that GDPR and privacy laws would not enable full utilisation of blockchain in banking fearing disruption and adoption blocking by lobbyists. Iansiti and Lakhani (2017) state that adoption should occur for every single part of the monetary transaction imposing further challenges for governments and institutions. They also see the need for a regulated central bank cryptocurrency to be used for interbank transacting.

Governance: Bruce Weber, dean of Lerner College and business administration professor and Andrew Novocin, professor of electrical and computer engineering, both from University of Delaware, believe that Governance is the biggest challenge for decentralised organisations as blockchain members may have misaligned incentives leading to undesirable outcomes (Wharton 2018). “Distributed organizations serving an open community need to take care to design their governance systems, incentive structures and decision-making processes to create consensus without unduly slowing down the decision-making,” said Weber and Novocin (Wharton 2018). As per ENISA (2016), coding the governance structure into the distributed ledger is challenging especially at the systemic level where institutions may have specific engagement rule.

2.4 Adoption Circumstantial Factors

Reviewing the literature revealed factors that can be either supporting or hindering or sometimes both depending on the case, use, and provided business value. This research refers to these factors as circumstantial factors and identifies the following three:

Costs: As mentioned in the Energy Consumption barrier, Marr (2018) and Hassani et al. (2018) see that the high energy consumption levels are costly. The cryptocurrency transaction cost is high, so banking with cryptocurrencies will also be costly, whether it is trading with public or regulated cryptocurrencies (Hassani et al. 2018). Another cost source is storage across the distributed network, in addition to the middleman charges; usually collected by banks for their financial services; being threatened and, in some cases, might even be eliminated leading to losses in banks' revenue (Hassani et al. 2018). It is still arguable whether the blockchain cost will outweigh the current operational costs especially when looking at registries across banks and eliminating data duplications, as per Hassani et al. (2018) recommendation, cost/benefit analysis is needed on a wide scope and by case.

Security: Due to its immutability, decentralisation, distribution, and consensus, blockchain provides enhanced security (Hassani et al. 2018). They see that historical data alteration will not be possible, and real-time new data will be hard to manipulate as it is shared between all blockchain nodes with alteration easily detected, tracked and monitored preventing fraud and misuse. Blockchain can provide both security and privacy. Marr (2017) sees that the legacy banking systems worldwide are built on centralised databases with single point of failure increasing their vulnerability to cyber-attacks, he also believes that the decentralised nature of blockchain technology will eliminate some of the current crimes against financial institutions estimated at 45% of financial intermediaries annually. According to Hassani et al. (2018), banks are reluctant to let their data reside outside their firewalls due to cyberattack risks. And although miners can verify the daily transactions records, yet the immutability of the blockchain will make these transactions irreversible making the correction of manual entry errors extremely hard and problematic. Also, Nakamoto (2008) refer to the '51% attack', in which if half of the network's nodes tell a lie, it will be considered the truth through the network. However, this risk will require collaboration of at least half of the collaborating parties in the network, which becomes less likely the larger the network gets; however, the possibility exists. Two other concerns in the data privacy according to Hassani et al. (2018) are: pattern recognition by tracing meta data patterns will negate the anonymity of the blockchain, and the anonymity of the blockchain will allow for untraceable transactions that will challenge the banks and regulators in terms of taxations and AML criminal activities. Yet with all the existing risks, blockchain is more secure than the current centralised systems. ENISA (2016) raises the concern that the blockchain network might be more trustworthy than the devices used to access it where it is hard to verify the intent of performing a transaction, referring to the usage of hacked devices or hacking the transaction protocols used to transmit messages across the network. Zheng et al. (2017) state that transactional privacy cannot be guaranteed as the transaction's values and balances are visible for each public key and can be linked to reveal users' information. ENISA (2016) also warns that private key management needs more focus, especially that unlike traditional banking systems; where the number of credentials using trials is limited, blockchain do not have server imposed query limits and attempts to break into a user's account cannot be tracked or noticed until after the fact.

Interoperability: Lang (2017) believes that friction in global market lengthens and complicates financing and trading processes. As blockchain will be sharing validated records of transactions, it will enhance trade partners trust and efficiency, while reducing the process's cost and time. Angela Walch, a researcher at the Centre for Blockchain Technology at University College of London, sees that making use of blockchain technology is not a plug-and-play concept (Wharton 2018). According to Walch, "Blockchain technology is, at core, group recordkeeping. To reap its full benefits, one needs all the relevant members of the group to join the system. This requires collaboration with and across businesses, which is a potentially big hurdle, and may be the hurdle that most limits adoption" (Wharton 2018). ENISA (2016) sees that the different emerging distributed ledgers will have to interact among each other to share data requiring translation of exchanged formats and protocols. Also, reconciling transactions between different ledgers is challenged by the used consensus protocols compatibility.

2.5 The Need for an Adoption Model

Beck and Müller-Bloch (2017) see that a few of the expected benefits of using blockchain technology in banking and finance include transaction speed improvements, better security, transparency, and reduction in transaction costs, with revolutionary predictions to redefine systems and change the current economy's fundamental structure, comparing blockchain with the invention of the Internet and its impact on all industries. Tapscott and Tapscott (2017a) on the other hand see that blockchain will affect the nature of companies in terms of how they will be funded and managed, the ways they will create value and how they will perform their basic organisational functions and not only on the business services they provide.

Ito et al. (2017) see that the adoption of the blockchain technology will require a challenging fundamental restructuring of major parts of the economic system, which will need preparing through research and experimenting. They also declare that those who will adopt blockchain technology will be the ones to thrive in the new emerging economy.

Wang et al. (2016) proposed a blockchain maturity model (BCMM), an adaptation to the popular and general capability maturity model (CMM), as they believe that for a business to adopt a new technology it should be able to measure its level of maturity. However, the BCMM model provides a maturity assessment model not a technology adoption model. Using their proposed BCMM, they concluded that blockchain has not achieved its optimum maturity level yet, and recommended feasibility studies before adoption decisions. However, they tried to measure the blockchain's technology maturity in general, focusing on the technology rather than a specific industry. Furthermore, their results could be challenged due to the fast pace of technology growth; while the Internet took 30 years to achieve its full potentials, new network-based technologies evolvement is expected to be faster.

Beck and Müller-Bloch (2017) also acknowledge that even though banks and financial institutions are serious in their actions to embrace the blockchain technology, yet it is still unclear how they will act to adopt the new disruptive technology. Therefore, this research will aim to investigate and propose an adoption model for the banking industry in an attempt to highlight the successful adoption factors and overcoming the adoption challenges to provide the industry with an adoption model that will facilitate smooth and successful adoption of the new disruptive technology.

2.6 Theorical Framework on Adoption Models

Taherdoost (2018) emphasises the importance for decision makers to understand a new technology's acceptance or rejection reasons to better anticipate the user's adoption of it and be prepared accordingly. This research examines the blockchain adoption in the banking sector from the side of the institutional providers, the banks, as the blockchain users. Work is carried under the assumption that such a highly regimented sector's blockchain adoption will be shaped by the new regulations and best practice recommendations of the legislators, practitioners and expert researchers of the field worldwide rather than being driven by the banks' customers' requirements.

Technology adoption models have been studied extensively through the last couple of decades providing several models such as, but not limited to, the Technology Acceptance Model (TAM), the Extension of Technology Acceptance Model (ETAM), and Rogers DOI model (Taherdoost 2018).

Roger (2003:177), as cited by Sahin (2006:14), identifies adoption as "the decision of full use of an innovation as the best course of action available", while rejection is "the decision not to adopt an innovation". This definition, in general, agrees with Taherdoost's proposed terms of acceptance and refusal and this research's categorisation of the adoption factors. This research sees that the adoption of a new technology refers to the acceptance and usage of it and not rejecting its new provided solutions and services.

According to Gangwar et al. (2014) and Taherdoost (2018) TAM is one of the most accepted and used models for technology adoption. They explain that TAM attributes the user's motivations for adoption to three factors: perceived usefulness (PU), perceived ease of use (PEOU), and attitude toward using (A), and sometimes includes a fourth factor; external variables, as shown in figure 1. Due to these factors, TAM is adept at explaining adoption variance caused by users' behavioural intentions (BI), especially for work related technology adoption (Gangwar et al. 2014). However, Bagozzi (2007); one of the original co-founders of the TAM, elaborates that TAM is not without shortcomings, namely, its simplicity would not be fitting for all evolving technology types, situations, and different decision makers. He also sees that TAM lacks a sound defining theory for PU and PEOU determinants, examines decision making from an individual perspective neglecting the group and its environment affecting factors, and attributes decision making to emotional factors without considering regulations, were they internal or external. While Taherdoost (2018) believes that by ignoring the social influence, TAM application is limited to the workplace, and by failing to address the motivations it cannot be extended to the customers context. While these shortcomings may doubt the fit of the TAM, yet it is more in line with this research's objective as it is examining the banking industry from the side of the banks as work and regulated providers and not the banks' customers as accepting or rejecting receivers.

The ETAM tried to improve the TAM model by adding new factors in two separate studies, one resulted with the TAM2 (Taherdoost 2018; Gangwar 2014). TAM2 added social influence and cognitive factors as antecedent to PU and BI of TAM improving the predictivity of PU. While TAM3 added antecedent to PEOU in 2 groups: adjustments and anchors making PEOU the most dominant predicting factor. However, these new improvements still address adoption from an individual perspective rather than from an institutional one.

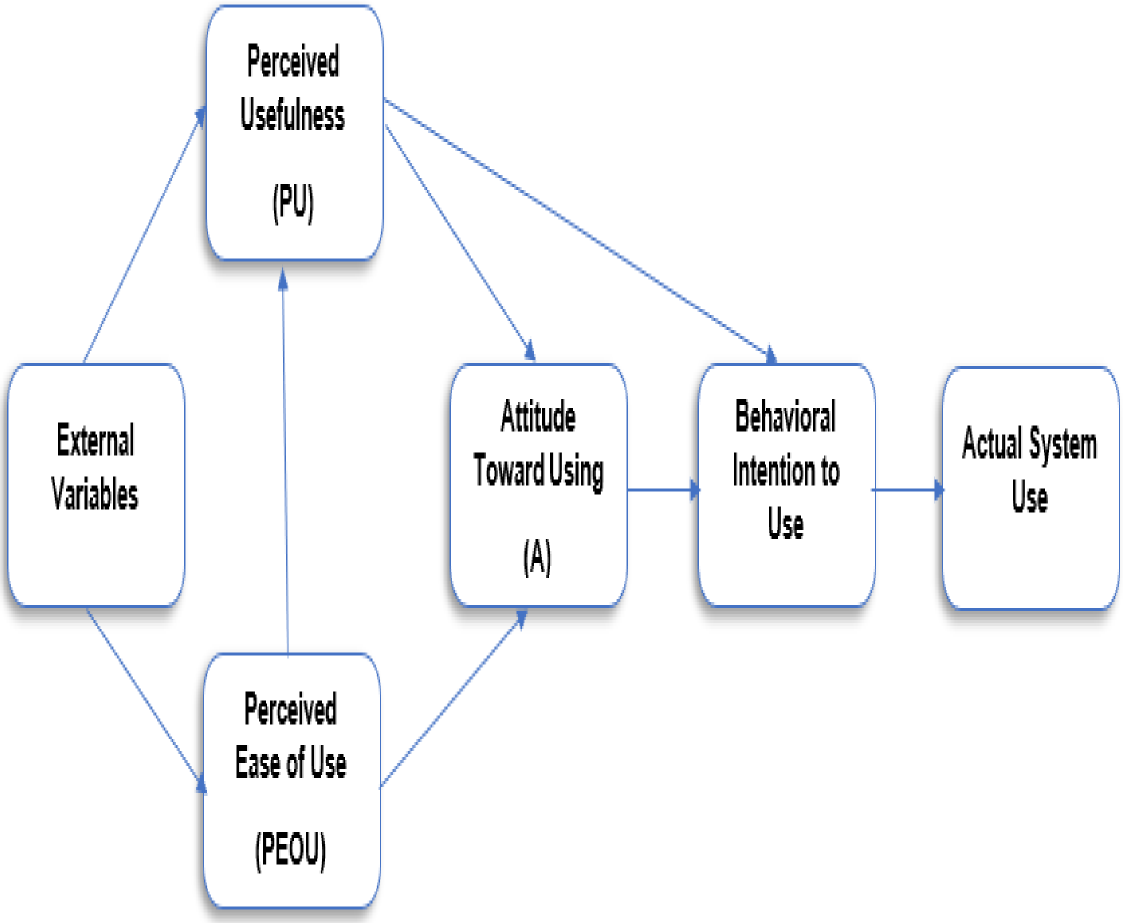

Figure 1 Technology Acceptance Model Source (adapted from Davis et al. 1989)

According to Sahin (2006) and Taherdoost (2018), and as per Rogers' (2003) definition of diffusion, The DOI model has 4 main elements: time, communication channels, innovation and social system. These components allow DOI to be used for measuring a new idea's spread on a global level across time. Taherdoost (2018) summarises that DOI also integrates 3 components: adopter's characteristics, characteristics of innovation, and innovation decision process. Each component consists of 5 steps. As its not within this research's scope, further details can be obtained from Rogers (2003) and Sahin (2006). The DOI is more appropriate for measuring the adoption status according to its defined ecosystem's characteristics with little prediction and explanation powers compared to the other adoption models.

This paper argues that DOI is a more of an after-the-fact evaluation tool rather than an adoption facilitating framework. Hence in alignment of the focus for the paper to propose a model that will facilitate successful adoption of the technology in the banking industry, in addition to the fitness of the TAM for IT adoption, the TAM model is seen as a more appropriate candidate for initial point of exploration in context with the objectives of this research

3. Methodology

The research used qualitative secondary data in the form of published regulations, white papers and official articles from global banking legislators and practitioners, as input for text mining. Secondary data on existing adoption models and the blockchain technology and usage were also collected through the literature review of books, journals and official webpages. To explore the adoption model from the data gathered and analysed using text mining, a subjective stance was adopted, being as the model building was guided by the legislators' regulations and practitioners' recommendations from the analysed data. This approach was in line with the interpretivism epistemological position (Saunders et al. 2015).

According to Woodside et al. (2017), 85% of the world's data is estimated to be stored in various unstructured textual forms. This indicates the huge amount of insights waiting to be mined. This research used text mining; a form of content analysis, which is an objective analysis approach that quantifies qualitative data bringing forward new insights, according to Saunders et al. (2015). The adoption factors that this research worked to subjectively identify during the literature review were used as the analysis' predetermined categories, ensuring the objectivity of the analysis (Saunders et al. 2015). Also, the analysis allowed for the emergence of new categories that have not been predetermined, adopting an exploratory approach similar to that of the thematic analysis. The text mining used frequency analysis to quantify the collected textual data, which adopted a mutually exclusive stance to ensure that each term was categorised once for better objective results. The text mining tools of choice used for this research were the online Voyant tools and NVivo.

Table 2 summarises the collected documents that this research used for analysis. The collected documents have varied in size and were published between 2015 and 2018, making sure to cover the latest available publications. The document types and author category summaries demonstrate the reliability and validity of the collected data. While the author's region summary ensures that the objective of exploring a global adoption model in the banking industry is met.

Table 2. Summary of Analysed Documents' Type, Author Category, and Author's Region

Document Type	Number of Documents
White papers	8
Series and journal articles	7
Working papers	3
Reports	3
Consultative document	2
Research papers	2

Document Author Category	Number of Documents
Central Banks	7
Regulatory bodies	7
Consulting organisations	3
Research organisation	5
Non-profit Organisation	2
Fintech	1

Document Author's Region	Number of Documents
EU	4
US	5
Global	11
Countries (UK, Germany, Spain, New Zealand, South Africa)	5

3.1 Data collection and method of analysis

After establishing the blockchain adoption supporting factors, barriers, and circumstantial factors through the literature review, text mining analysis was carried out with the aim to determine the importance of the identified adoption factors. Text mining is a useful method in exploring large volumes of unstructured textual data to extract insights. For the purposes of this research, text mining was used to determine the availability and significance of the identified adoption factors in the mined texts, look for new factors that were not highlighted in the literature, and determine which of the adoption identified factors categories is the most dominant.

This research followed the text mining process demonstrated in figure 2 in order to achieve the final desired results. The text mining process went through three main steps: data preparation, data cleaning, and frequency analysis and categorisation. Exact work and steps are described in detail next.

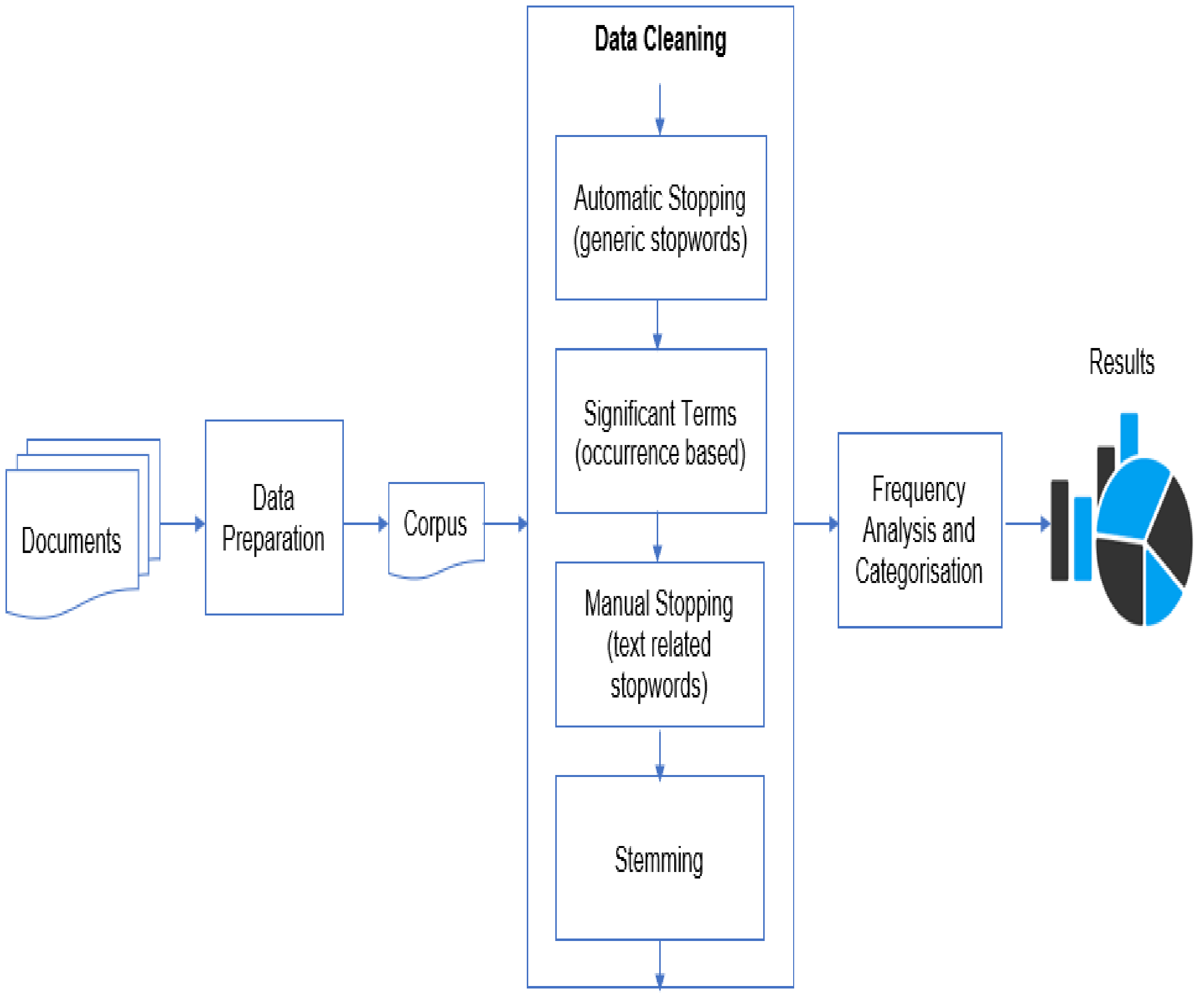

Figure 2 The Research Text Mining Process

First step in the analysis was the data preparation to prepare the corpus, which consists of all the documents that will be mined. Table 3 demonstrates the set of documents composing the corpus. As this research is trying to determine the adoption model of the blockchain technology in the banking sector, the corpus documents were selected from series, reports, articles, working papers, whitepapers, research and consulting documents. Also, the authors of these papers where considered when selecting the documents. The corpus documents' authors are mainly the most active authors writing and publishing in the new area of blockchain in the banking sector varying from central banks, regulatory bodies, non-profit organisations, research organisations, consulting organisations and even a FinTech. The selection of the documents and the authors is attempting to capture the views, guidelines and recommended best practices from the bodies and organisations that have the most effect on the strictly regulated banking industry. The author's region of the selected document also demonstrates the attempt to cover the most globally active and effective documents. Analysed documents were published between 2015 and 2018. After preparing the corpus, it was uploaded to the Voyant online tool for analysis.

Table 3 Corpus Composing Documents

Title	Author / Publisher	Author Category	Document Type	Author's Region	Year	Source
1. Blockchain & Infrastructure (Identity, Data Security)	Massachusetts Institute of Technology	Research Organisation	Series	US	2016	Shrier 2015
2. Blockchain and Financial Market Innovation	Federal Reserve Bank of Chicago	Central bank	Whitepaper	US	2017	Lewis et al. 2017
3. Blockchain Beyond the Hype A Practical Framework for Business Leaders	World Economic Forum (WEF)	Non-profit organisation	Whitepaper	Global	2018	Mulligan al. 2018
4. Blockchain for Trade Finance: Payment Instrument Tokenization	Cognizant	Consulting organisation	Journal article	Global	2018	Varghese et al. 2018
5. Blockchain in financial services: Regulatory landscape and future challenges for its commercial application	BBVA Research	Research organisation	Working paper	Spain	2016	CERMEÑO 2016
6. Decrypting the role of distributed ledger technology in payments processes	Reserve Bank of New Zealand	Central bank	Bank bulletin series	New Zealand	2018	Wadsworth 2018
7. Distributed ledger technologies in payments and securities settlement: potential and risks	Deutsche Bundesbank	Central bank	Monthly report	Germany	2017	Deutsche Bundesbank 2017
8. Distributed Ledger Technology	European Central Bank (ECB)	Regulatory body	Series	EU	2016	ECB 2016
9. Distributed Ledger Technology & Cybersecurity	European Union Agency for Network and Information Security (ENISA)	Regulatory body	Whitepaper	EU	2016	ENISA 2016

10. Distributed ledger technology in payments, clearing, and settlement	Divisions of Research & Statistics and Monetary Affairs Federal Reserve Board	Central bank	Series	US	2016	Mills et al. 2016
11. Fintech and Financial Services: Initial Considerations	International Monetary Fund (IMF)	Regulatory body	Series	Global	2017	He et al. 2017
12. FinTech: a More Competitive and Innovative European Financial Sector	European Commission	Regulatory body	Consultative document	EU	2017	European Commission 2017
13. Four Blockchain Use Cases for Banks	FinTech Network	Consulting organisation	Whitepaper	Global	n.d.	FinTech Network n.d.
14. Governance in the Blockchain Economy: A Framework and Research Agenda	The Association for Information Systems (AIS)	Research organisation	Research paper	Global	2015	Beck et al. 2018
15. Implications of FinTech developments for banks and bank supervisors	Bank for International Settlements (BIS)	Regulatory body	Consultative document	Global	2017	BIS 2017
16. Innovation, Technology, and the Payments System	The Federal Reserve Board	Central Bank	Speech whitepaper	US	2017	Powell 2017
17. MyCryptoBank Whitepaper	MyCryptoBank (MCB)	A Fintech	Whitepaper	Global	2018	MCB 2018
18. Navigating Essential Anti-Money Laundering and Combating the Financing of Terrorism Requirements in Trade Finance: A Guide for Respondent Banks	International Financial Corporation (IFC)	Regulatory body	Informative brochure / working paper	Global	2018	ICF 2018

19. Project KhoKha	South African Reserve Bank (SARB)	Central Bank	Whitepaper	South Africa	n.d.	SARB n.d.
20. Realizing the Potential of Blockchain	WEF	Non-profit organisation	Whitepaper	Global	2017	Tapscott and Tapscott 2017b
21. Research Report on Financial Technologies (Fintech)	International Organization of Securities Commissions (IOSCO)	Research organisation	Research paper	Global	2017	IOSCO 2017
22. Some Simple Economics of the Blockchain	National Bureau of Economic Research	Research organisation	Series	US	2018	Catalini and Gans. 2016
23. The Distributed Ledger Technology Applied to Securities Markets	European Securities and Markets Authority	Regulatory body	Report	EU	2017	ESMA 2017
24. The Economics of Distributed Ledger Technology for Securities Settlement	Bank of England	Central Bank	Series - Staff working paper No. 670	UK	2017	Benos ET AL. 2017
25. The Future of Financial Infrastructure	WEF + Deloitte	Non-profit organisation + Consulting Organisation	Industry project report	Global	2016	WEF and Deloitte 2016

Second step was to initiate the data cleaning sequence of subprocesses to clean the input data and prepare it for the next step starting with "Stopping", which refers to the excluding of all the stopwords that are most likely to have high occurrences in the corpus, yet that will not add any insights to the targeted mining results. The stopwords would skew the results if they are not omitted. The stopping was done in two separate sub-steps: first, the Voyant tool automatically identified and excluded the most common words, like articles and conjunctions, then again manually for text related stopwords. Most terms related to blockchain were considered stopwords as listed in table 4.

Table 4 Blockchain Corpus Stopwords

dlt	ledger	blockchain	distributed	network
dl	example	pdf	e.g	ledgers
post	khokha	june	adoption	european
said	chapter	mycryptobank	block	node

After automatic stopping, significant terms to mine were decided, terms with 115 occurrences and above were considered significant, while terms with lower count were considered to have little significance and therefore neglected.

The final sub-step of data cleaning was to apply stemming. Terms that occur together were paired and treated as a single compound term and their occurrences were counted as one and not accumulated. Meaning that when two terms with the occurrence count of 10 each were stemmed; the new compound term occurrences were counted as 10 instead of 20.

Table 5 summarises the word count after the data preparation and cleaning steps that was then text mined.

Table 5 Summary of Corpus word counts

Summary of the total word count	**Word count**
The total number of words in the corpus	341,107
The total number of words with significant word count (with occurrences >= 115, and after the initial automatic stopping)	80,664
The total number of words after manual stopping	73,139
The total number of words after Stemming	**59,578**

The third and final step of the analysis process was the frequency analysis and categorisation. Using frequency analysis, it is assumed that the more important a term is, the more frequently it will be used. The terms were evaluated based on their meaning and then categorised into the identified adoption factors.

4. Findings and Analysis

After categorising the adoption factors, each category was examined separately. Figure 3 shows the adoption supporting factors with the term occurrences after the categorisation of the terms. “Improving KYC process” factor topped the list with 46.80% of the total supporting factors. “Improving KYC process”, “Improved transaction speed”, and “Smart contracts” factors made up over 85% of the adoption supporting factors. While less than the remaining 15% was made of “Regulatory compliance”, “Enhanced data exploration”, and “Increased transparency” factors. This indicates that the most prominent adoption supporting factor is “Improving the KYC process”, while the “Increased transparency” factor might be neglected as it is insignificant. As the top three factors are the most significant ones, this indicates a higher effect of the level of provided services and processes compared to the compliance and audit gain when it comes to the adoption of blockchain in banking.

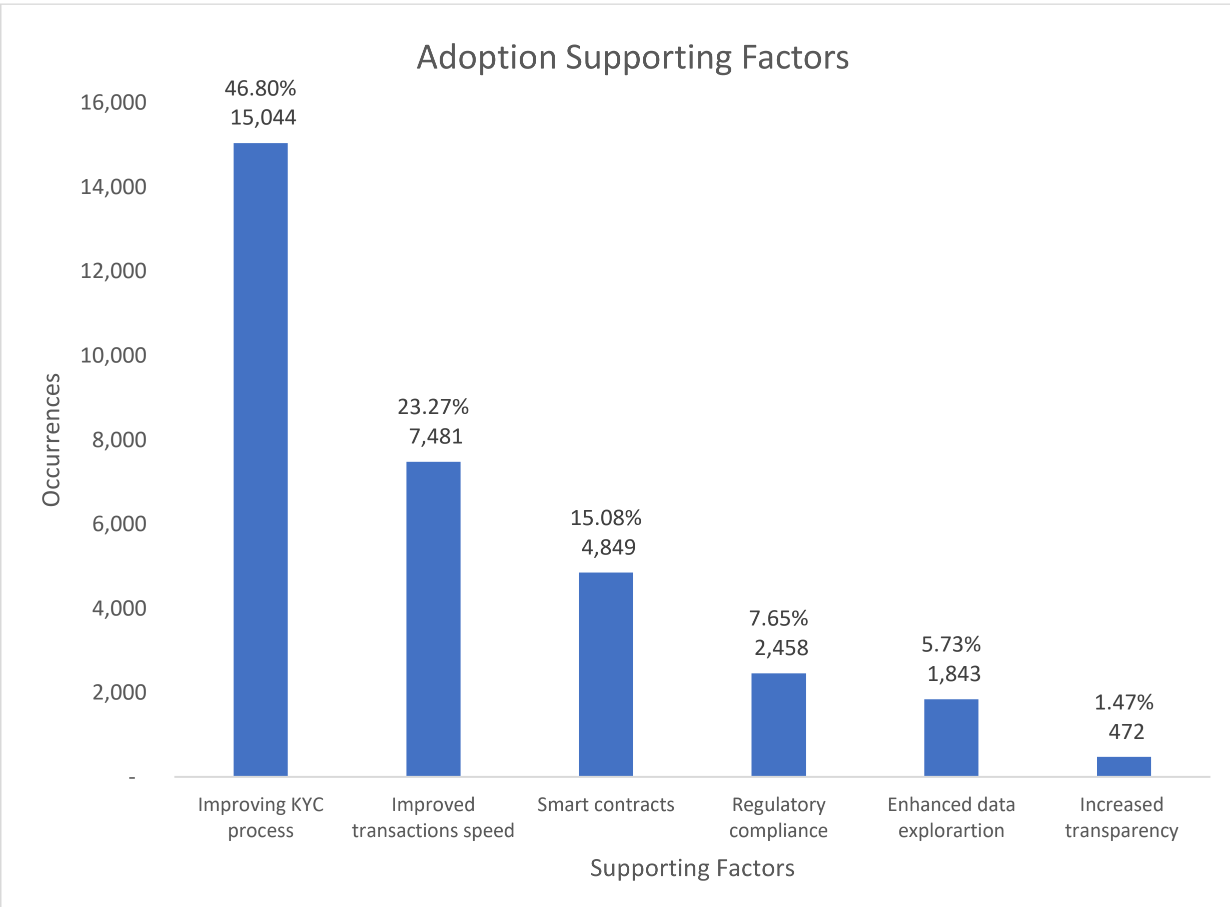

Figure 3 Adoption Supporting Factors

Figure 4 shows the adoption barriers with the term occurrences after the categorisation of the terms. “Governance” was the main barrier with 32.43% of the total barriers, while “Energy consumption” came last with only 5.80%. the other middle adoption barriers ratios where almost even between 16-24%. This indicates that while “Energy consumption” have low significance as a barrier and might even be neglected compared with the effect of the rest of the barriers, the other identified barriers are actually more significant and highlight the regulatory needs of governance and legislations and regulations related to blockchain and cryptocurrency, closely followed by the infrastructure and accessibility issues related with scalability.

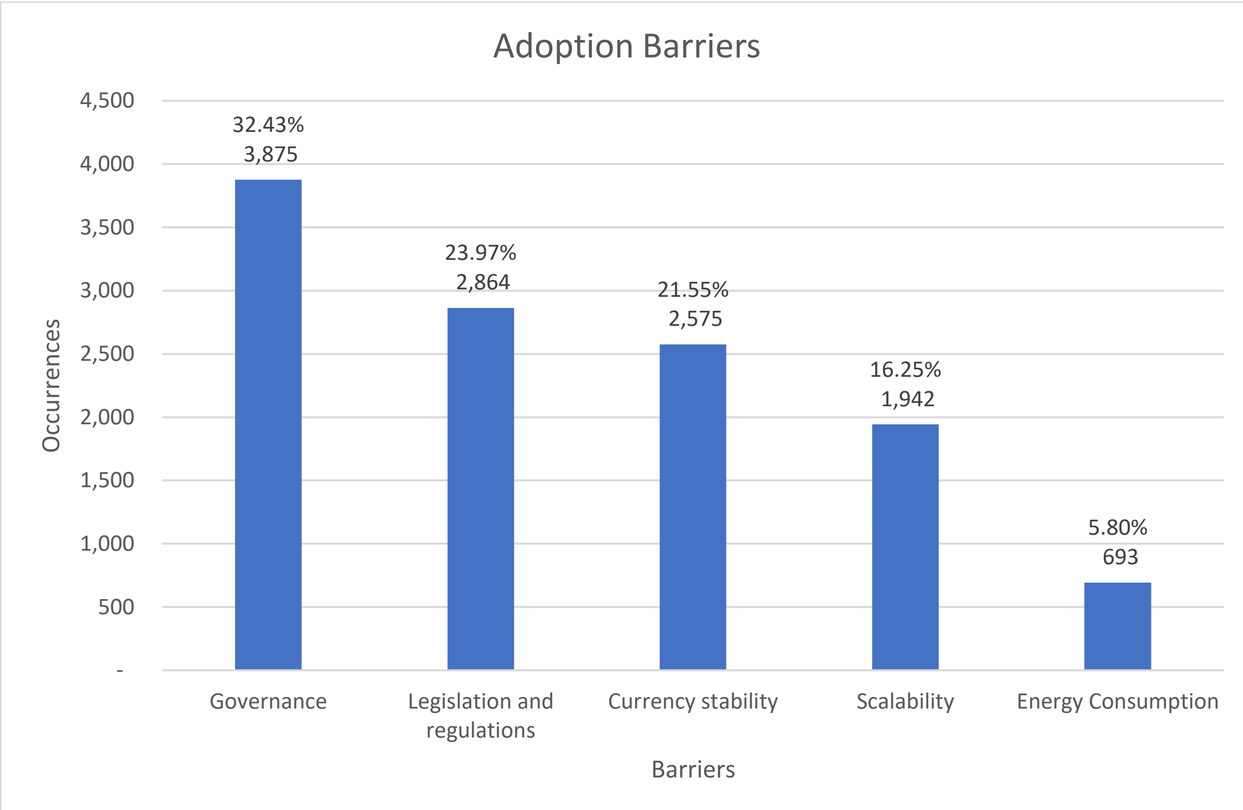

Figure 4 Adoption Barriers

Figure 5 shows the adoption circumstantial factors with the term occurrences after the categorisation of the terms. The three circumstantial factors result varied drastically. “Security” dominated the circumstantial factors with 71.20% of them, followed by “Cost” with 22.06%, while “Interoperability” came last with 6.73%. None of these factors can be considered insignificant, yet security demands higher attention.

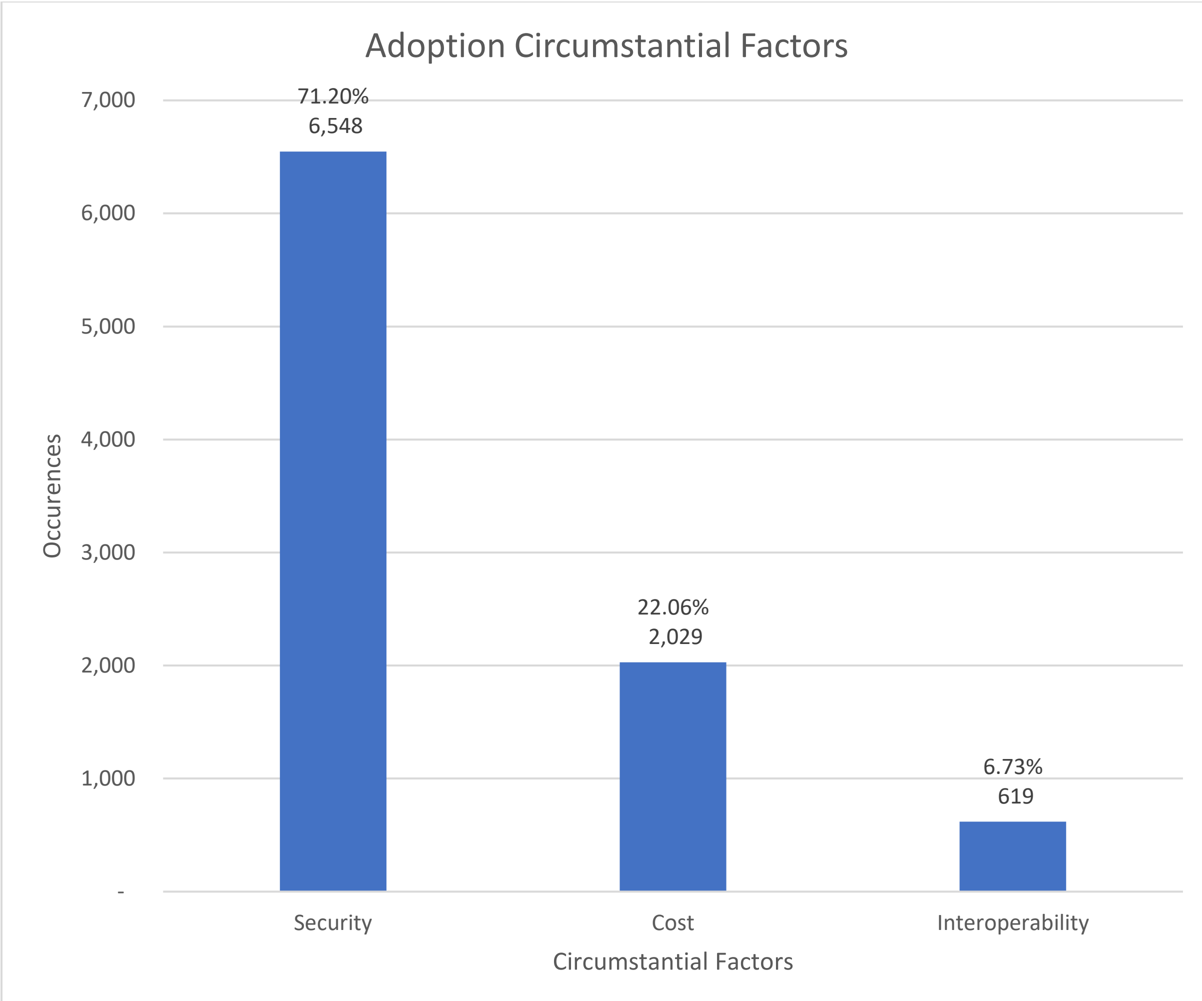

Figure 5 Adoption Circumstantial Factors

The three adoption factors categories were then accumulated and examined together to see the most dominant category. As shown in figure 6, the adoption supporting factors are dominating with 60.32% of the total factors, followed by the adoption barriers with 22.42% and then the circumstantial factors with 17.26%. as the circumstantial factors can be either support or hinder the adoption based on the taken actions by the adopting organisation, combining this category with either the supporting factors or barriers will only confirm the supporting factors dominance over the barriers (77.58% vs 22.42% if the circumstantial factors become supporting factors, or 60.32% vs 39.68% if the circumstantial factors become Barriers).

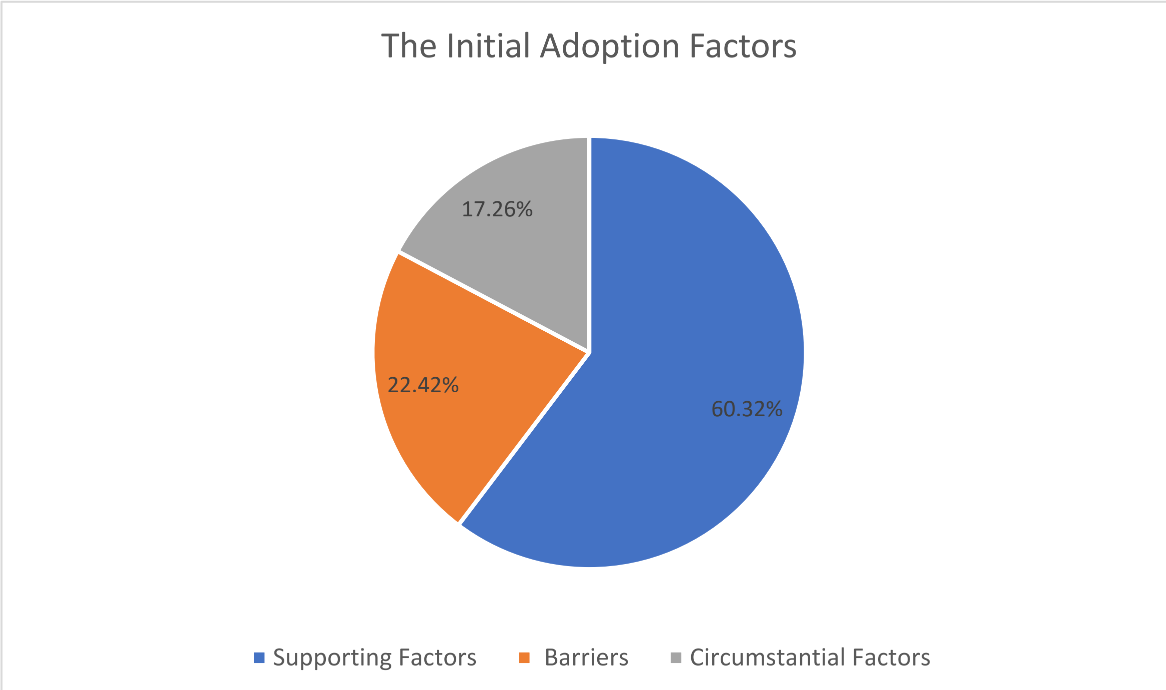

Figure 6 The Initial Adoption Factors

During the term categorising step of the analysis, a new supporting factor was discovered as it became clear that some terms could not be categorised under any of the already identified factors and rather required a new factor of their own. This new factor is "Competitive advantage", with 10.55% of the total factors as per figure 7. Although the literature has referred to the provided competitive advantage and the new competitors such as the FinTechs, yet it was not identified as an adoption factor. The insight brought forward from the text mining analysis highlighted this factor. As per the literature, the competitive advantage and new competition will shake the incumbent banks and will demand more actions, hence this new factor will be considered as an adoption supporting factor. Comparing the new identified factors with the already established factors categories, the "Competitive advantage" made 10.55% compared to 53.96% supporting factors, 20.06% barriers and 15.44% circumstantial factors.

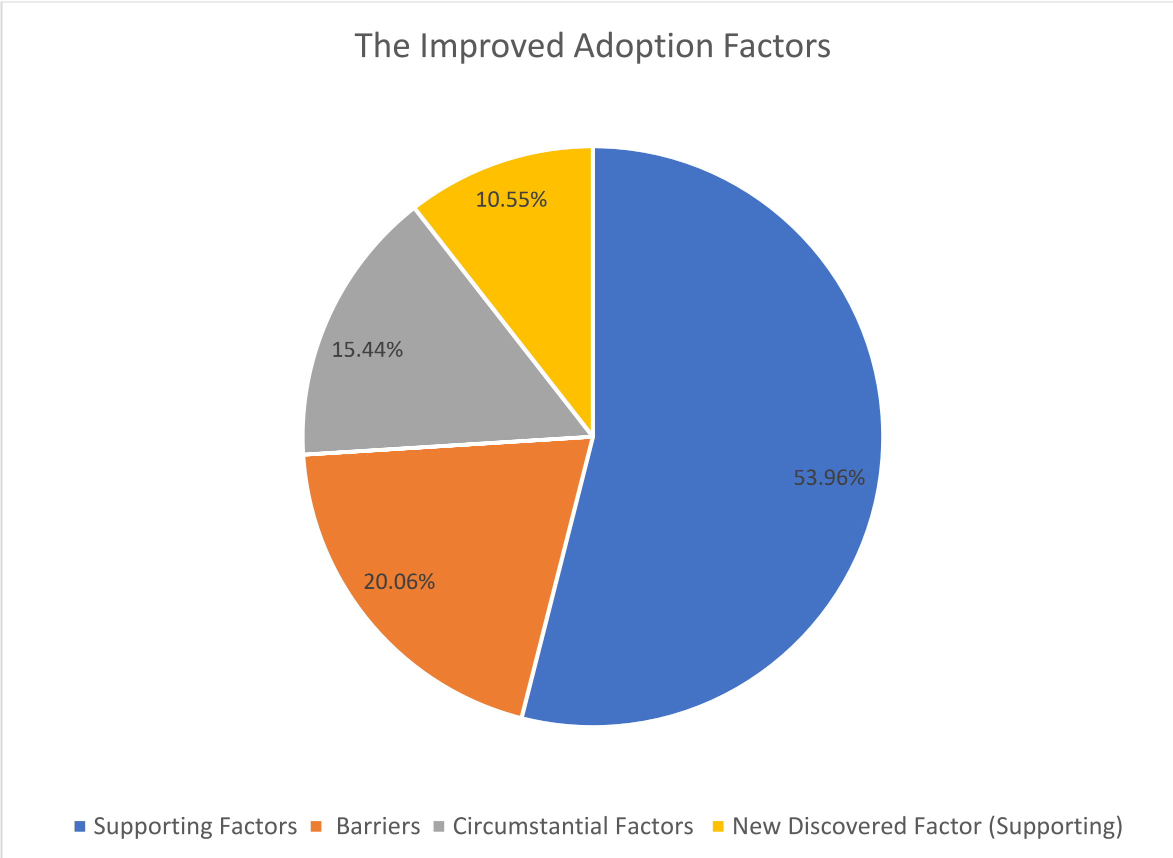

Figure 7 The Improved Adoption Factors

As the new identified factor is a supporting factor, the final adoption factors percentages per category, as shown in figure 8, keeps the supporting factors dominant with 64.51%, followed by the barriers with 20.06% and then the circumstantial factors at 15.44%. This shows improved ratios than the initial ratios before the new factor was included. This also supports the initial discovery of the dominance of the supporting factors.

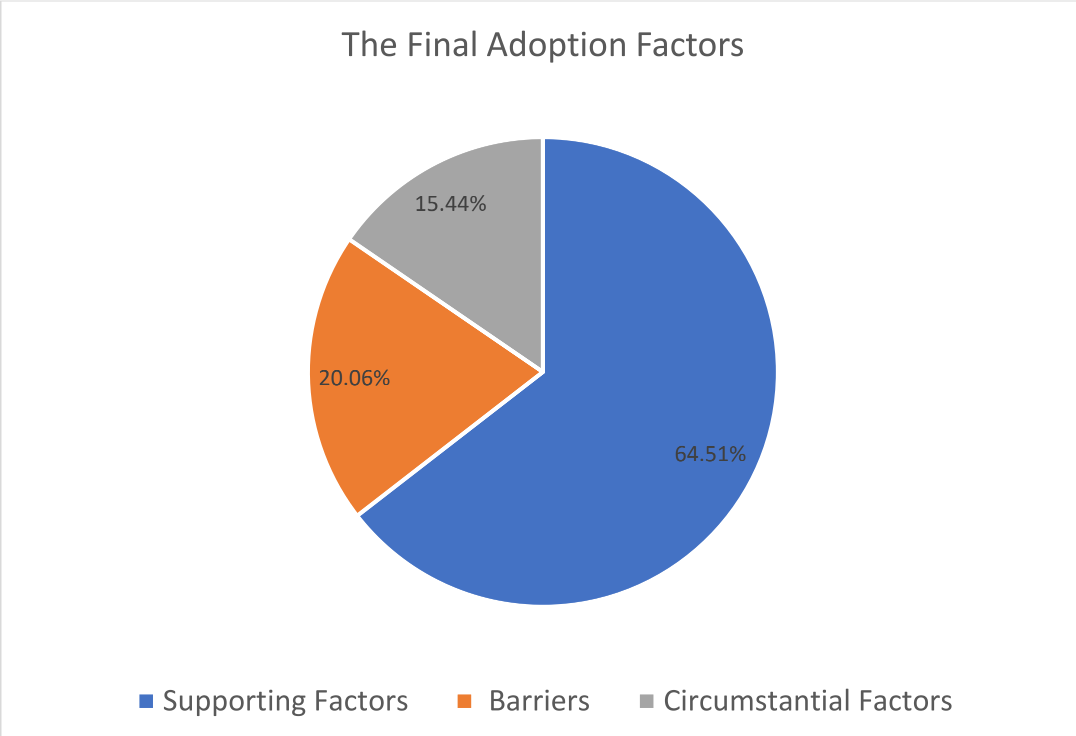

Figure 8 The Improved Adoption Factors

Also, factors were examined after being ordered by importance to better determine the adoption model. As per the previous findings, the supporting factors still dominate, leading with the "Improved KYC process" and "Improved transactions speed" factors with over 37% of the 15 identified factors. The circumstantial factors of "Security" followed with 10.99%, closely followed by the new supporting factor of "Competitive advantage". As "Security comes in third place, this emphasises the attention required by this factor especially as it can work as a supporting or hindering factor depending on how it will be employed. For the new discovered factor of "Competitive advantage", coming fourth highlights the importance of it and why it warranted being identified as a new factor by itself. The barriers do not show up until the sixth factor. And the last three factors, that happens to be one of each category, have very low values between 0.79% and 1.16%, making them insignificant compared to the other adopted factors. This insignificance warrant ignoring these factors or re-evaluating each one as it might be merged with another more significant factor. However, as these factors were identified vigorously through the literature, this research sees to keep them and include them in the adoption model as their significance might change over time.

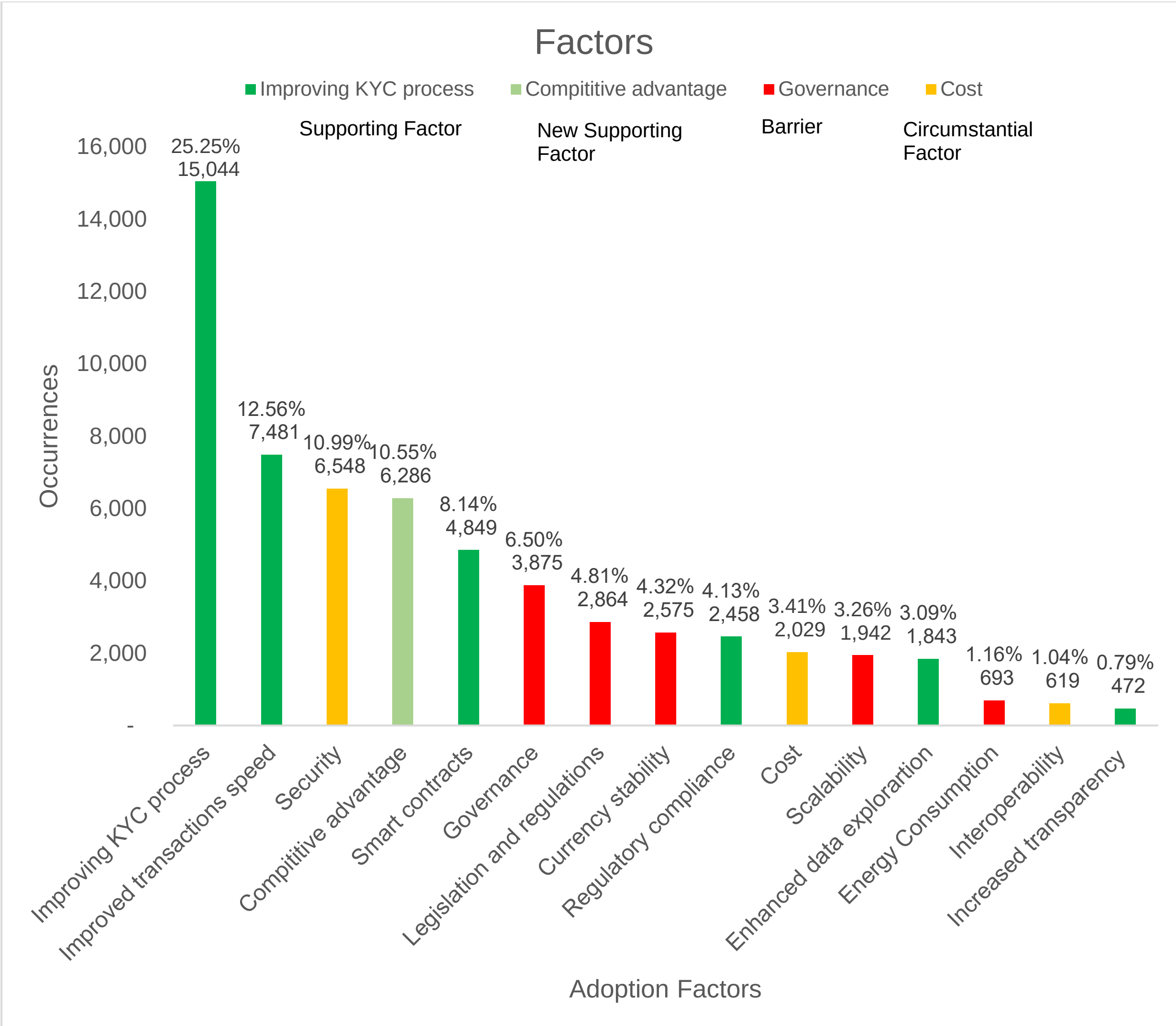

Figure 9 Factors Odered by Importance

The analysis was also done using the NVivo text mining tool. And while the word occurrence results for both tools where very close for each category in terms of percentages, there were huge differences in the counts themselves with NVivo yielding higher counts. The count difference was due to difference in the counting technique between the two tools. While NVivo automatically did the word count for each provided factor terms across the corpus separately so that words might be counted in more than one factor at the same time, Voyant term categorisation was manually done and a term was categorised under a single factor. Also, NVivo was unable to highlight the new factor that was identified during the frequency analysis and categorisation done by the Voyant tool. And while the thematic analysis provided by NVivo might have been able to detect the new factor, that was not possible using only the frequency analysis feature of the tool and would require significantly more time. According to Welsh (2014), the Voyant is a powerful and user-friendly text analysis tool especially for frequency context analysis of prespecified words in relation to the whole text. For that, and the new insights and added value of the provided final findings, the NVivo results were dropped in favour of the Voyant tool results.

4.3 The Adoption Model Construction

To address the final objective of this research, the blockchain adoption model for the banking industry needed to be identified. The TAM model was used as an initial point of exploration. The identified adoption factors; supporting, barriers, and circumstantial factors; where examined against the TAM model to identify fit. While some factors were able to fit in the TAM model, others could not, highlighting the need for modification. The lack of fit for some factors with the TAM model is due to the nature of this research, as it is exploring the adoption model on the institutional level in work context rather than the individual employee or the end user's level.

The TAM model was modified in two regards: the model's attributes and the effect of relationships of the model as demonstrated in figure 10.

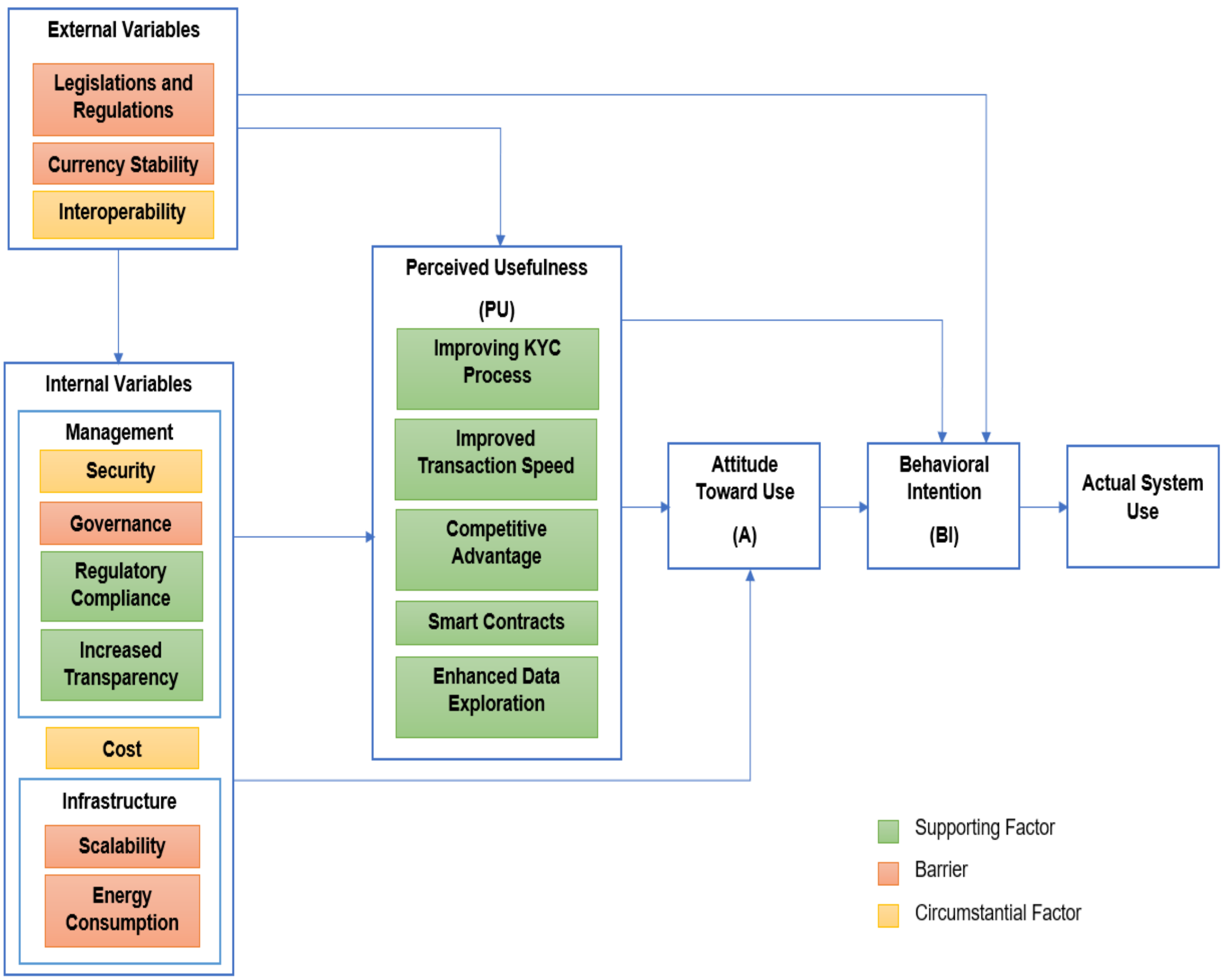

Figure 10 New Blockchain Adoption Model for the Banking Industry

The model's attributes were modified as following:

1. The PEOU was omitted as it is related to individuals rather than institutions. Also, PEOU assumes that the new adopted technology is a system, while blockchain is not a system but more of an infrastructure that is expected to revamp the way systems work with the possibility of introducing new products. In this context PEOU is rendered obsolete and therefore was discarded from the model.

2. PU was evaluated on the institutional level and was found to include the following identified adoption factors: improving the KYC process, improved transactions speed, competitive advantage, smart contracts, enhanced data exploration. They are all supporting factors with the ranks 1, 2, 4, 5, and 12 retrospectively as per figure 10. This indicates that PU variable consists of the topmost supporting factors and this will ensure successful adoption of the technology.

3. While the original TAM included individual's effecting external variable, the new modified model identified the external variables affecting the banking institutions, highlighting the involved role of the legislators in the adoption process. The external variables included the adoption factors: legislations and regulations, currency stability, and interoperability, which according to figure 10 ranked 7, 8, and 14. This shows that external variables consists of two barriers and one circumstantial factor. Although the analysis shows that the significance of these factors is in the lower range. This indicates that these factors should be addressed by banks seeking to adopt the technology. And while legislations and regulations might be a barrier at the time of conducting this research, it might change to a supporting factor once enough regulations regarding the new technology are issued. Same goes for the currency stability, in case of regulating the cryptocurrency market or issuing a regulated central bank cryptocurrency. So, for successful adoption, banks should be prepared to handle these factors with the required agility.

4. A new attribute, Internal variables, was added to the model to reflect the institutional role of the adopter. This new attribute was broken further down to 2 sub-attributes: management and infrastructure, in addition to the cost factor. The management sub-attribute includes the factors: security, governance, regulatory compliance, and increased transparency. With the ranks of 3, 6, 9, and 15 as per figure 10. This sub-attribute refers to the managerial actions taken by the bank focusing on the major areas of security, governance, compliance and audit. This sub-attribute includes the topmost circumstantial factor, the topmost barrier, and two supporting factors that are relatively low ranking. This indicates the sensitivity of this sub-attribute as it is dealing with the internal mindset of the institution. Since the security factor is identified as a circumstantial one, it warrants extra attention for successful adoption to ensure that its supporting effect is maximised. The infrastructure sub-attribute includes the factors of scalability and energy consumption. These factors are related to the institution's adopted infrastructure and hardware. And although these factors are barriers, their ranks of 11 and 13 signal low effect. This does not eliminate the need to address these factors to ensure a successful adoption. Finally, the cost circumstantial factor, ranking 10, is included within the internal variables attribute as it will affect the institution. Being circumstantial gives the cost factor the flexibility to be employed positively to ensure successful adoption.

As for the model's effect relationships, the following modifications where made:

1. A new effect relation was identified and established between the external variables attribute and the BI as issuance of new regulation favouring the new technology will directly affect the BI of the institution.

2. An effect relation between the external variables attribute and the internal variables attributes was established, and the internal behaviour of the banking institutions will have to comply with the external legislations and regulations were they national or international.

3. A relation between the internal variables attribute and PU was established as the PU of the new technology will be affected by the institution's technical strategy

4. A relation between the internal variables attribute and A was established as A will be affected by the internal technical literacy of the employee and their acceptance of change.

5. Conclusion

The blockchain technology adoption process for the banking industry will require more involved and active roles of the legislators and regulators. As the adoption factors from all three identified categories involve the regulations in one form or another, the lack of regulations should not be dismissed and should get the appropriate attention it requires. Revisions of the current legislations and regulations to include the new technology are due. Quick actions are expected to improve the adoption of the new technology in the banking sector. A new adoption model was proposed based on the analysis and resulted in the modification of the traditional TAM model to be more appropriate for the specific banking industry adoption. The new Blockchain Adoption Model for the Banking Industry worked to address the TAM's shortcomings making it more fitting for institutional adoption. The new model is more of a suggested adoption framework that proposes an adoption process, yet the adopting bank still has to do its due diligence to ensure the successful adoption based on the identified adoption factors and their importance.

6. Limitations

The new proposed model was developed for the blockchain adoption in banking industry specifically and might not be applicable for other technologies in the banking industry, or for the blockchain adoption in other less regulated industries. The new proposed model does not include a time element making it a suggested adoption framework for the adoption process rather than a measuring model. The model would not be able to identify the adoption status of the industry for a specific bank. For adoption status measuring, the DOI model is more appropriate. The proposed model does not include the maturity level of the blockchain technology. As the technology is relatively new and in its early stages and might change very frequently in the near future, the technology's maturity level can be measured using the BCMM model. The identified adoption factors and their significance might change over time as the technology matures. Factors might lose or improve significance, new factors might be introduced, and factors might be merged or split to new ones. Frequent refinements of the proposed model are recommended.

7. Recommendations

Frequent re-evaluation of the proposed model is recommended to ensure its validity and fitness. Iterations of the analysis to include new publications are recommended to improve the factors importance identification and explore the emergence of new factors. Case studies on banks attempting to adopt the new technology using the proposed model is recommended, which might be followed up with comparative studies between adopters using the new model versus adopters not using it. Also, quantitative research is recommended to be carried on proving the validity of the new proposed model. Adoption factors measuring criteria should be established and quantitative research should be prepared to evaluate the proposed model on banks with various stages of adoption across the globe. Quantitative research can also be used to measure the banks acceptance of the new proposed adoption model. As the technology gets adopted, deeper examination to incorporate the customers and end users in the model will be more appropriate. Further research to include time in the adoption model, reviewed in relation to the DOI model, is recommended to enable measuring the adoption status. Due to the relative novelty of the blockchain technology, further in-depth research of the possibility to include a maturity measurement to the new proposed model such as the BCMM maturity model is also recommended. Now the question is how fast should a bank act to adopt the new technology before it becomes incumbent and suffers from being left behind? For this purpose, it is recommended that banks should start incorporating blockchain adoption in their strategies. At the very least, banks should get more aware and educated of the new technology in order to be well prepared for quick actions if and when the need arises.

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