Mindful technology adoption: Exploring the role of technology features in blockchain adoption

BRACHES, MARTIN

Martin Braches: Exploring the role of technology features in blockchain adoption

Abstract:
Blockchain has become a hyped emerging technology that is predicted to be heavily influential in all our lives, not just triggered by the success of Bitcoin. Yet, until now, it has failed to deliver most of its advertised benefits. To tackle this problem and provide an explanation for the missing wider success, this study focuses on the role of technology features in the adoption of blockchain. Thus, this research integrates the view on technological characteristics, represented by aspects of the mindfulness concept, with the sociological aspects influencing technology adoption decisions based on the widely used unified theory of acceptance and use of technology (UTAUT). The resulting research model is evaluated qualitatively, based on 11 international cases.
This research advances previous research by focusing on the role of technology features for the potential adoption of blockchain technology in a cross-industry context. It expands the literature on technology adoption models by highlighting the role of technical characteristics and combining social, psychological and technological factors into one model. Further, it helps practitioners to understand the causes for the limited success of this technology and advances the general knowledge on the adoption of technology.
The findings indicate that the unique technology features of blockchain technology are one crucial factor for adoption decisions which is often neglected due to the hype state of this technology. However, the overall missing success of blockchain technology is found having also different causes like for example missing regulation and standardization.

Durham University Business School

DBA Thesis

Mindful technology adoption: Exploring the role of technology features in blockchain adoption

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Statement of Originality:

I confirm that this piece of work is the result of my own work. Materials from the work of others has been acknowledged, and quotations and paraphrases suitably indicated.

Statement of Copyright:

Acknowledgements:

This thesis has been completed over a period of five years of part-time study. Its completion would not have been possible without the help, inspiration, and support of a number of people, to whom I would like to express my sincere gratitude.

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“The best way to predict your future is to create it” — **Peter Drucker**

1 Introduction

Today, many innovations in firms are based on new or emerging[1] technologies. However, the simple introduction of new technology as innovation does not automatically lead to the creation of benefits for the implementer. Individual technology adoption behaviour based on the understanding of new technical features is one of the main factors determining the benefits resulting from a new technology. As such, this thesis aims to investigate the role of technological characteristics for the adoption of blockchain technology as one specific emerging technology of which there are great expectations, but which is still going through slow adoption.

1.1 Background

Emerging technologies help companies to improve their business models and become more productive (Schiavi and Behr, 2018, Akoka and Comyn-Wattiau, 2017, Morkunas et al., 2019, Verhoeven et al., 2018). For example, emerging technologies like gamification offer the opportunity for digital games to deliver much greater social and scientific value (Almeida and Simoes, 2019). Other examples are companies like Airbnb and Uber which have benefited significantly from emerging technologies like artificial intelligence (AI) and the Internet of Things (IoT) by embracing such technologies to develop new innovative business models (Lee et al., 2019b). While there is no universally accepted definition of emerging technologies, they are distinguished by the following attributes: radical novelty, fast growth, coherence, prominent impact, uncertainty and ambiguity (Rotolo et al., 2015).

There is an emerging stream of research in “developing a definition of ‘emerging technologies’ and linking this conceptual effort with the development

[1] Emerging technologies can be characterized by their, radical novelty, relatively fast growth, coherence, prominent impact, uncertainty and ambiguity; ROTOLO, D., HICKS, D. & MARTIN, B. R. 2015. What is an emerging technology? *Research policy,* 44**,** 1827-1843.

of a framework for the operationalization of technological emergence" (Rotolo et al., 2015). However, such discussions are beyond the scope of this research, which mainly focuses on the individual adoption of emerging technologies. What is clear from the literature is that companies have benefited from adopting emerging technologies to develop innovative processes within organizational systems. For example, De Paulo et al. (2020) show that organizations have developed innovative green propulsion systems using emerging technologies. Other examples include the use of IoT to implement Industry 4.0 or drone technologies to deliver products (Chiang et al., 2019). In all these instances, emerging technologies have allowed organizations to develop new innovative processes and create tangible value.

Despite overwhelming academic and industrial interest in the benefits of adopting emerging technologies to improve process innovation and therefore, value creation activities in a firm, there is little research on how and why organizations can develop processes that can be underpinned by technology that can be 'trusted'. The reasons for this gap in the research include lack of technology that can address issues of transparency, traceability and security, difficulties in accessing high-quality technology implementation data, a lack of objective metrics to validate the value of technology implementation, commercial sensitivities around the adoption of emerging technologies, and an assumption that all emerging technologies deliver value to organizations.

Blockchain technology is one of the emerging technologies that has the potential to support the development of processes that can have a high level of 'trust' as it aims to eliminate the need for trust between process owners (Nakamoto, 2008). The underlying principle of blockchain technology is that process owners can interact with each other via a technology platform that is immutable and trustworthy rather than the authority of centralized actors who are deemed untrustworthy (Cole et al., 2019). A growing number of studies focus on the implementation and use blockchain technology for developing secure and traceable processes. However, research into the benefits of using blockchains is limited and mixed. Industrial studies have shown that organizations adopting blockchain solutions do not always generate effective value for the adopters (Hackius and Petersen, 2017). Furthermore, there is little and, sometimes, counterintuitive evidence concerning the technological reasons for the selection of blockchain as a basis for developing processes with a high degree of trustworthiness.

This gap between the potential benefits embedded in the blockchain paradigm and the currently limited exploitation of its benefits represents an area of investigation that this thesis aims to explore. To address this gap, this thesis focuses on the role of the technological characteristics in the individual adoption behaviour of blockchain technology.

1.2 Problem Statement

Innovation is crucial for productivity and growth in firms, as recognized by experts and policymakers (Drucker, 1973, Mañez et al., 2013, Davenport, 1993, Milewski et al., 2015, Špacek and Vacík, 2016). Firms adopt innovations to avoid falling behind competitors and to create additional value by improving speed, efficiency, or updating old technologies (Ashurst, 2011, Mitropoulos and Tatum, 2000, Peppard and Ward, 2004, Gerdsri, 2007). Information technology, especially, has become a key driver of innovation, offering new opportunities and competitive advantages. Blockchain is a notable emerging technology and potentially disruptive information technology with significant potential for value creation (Treiblmaier, 2019, Glaser, 2017, Chang et al., 2020).

Since 2015, blockchain has gained widespread attention due to Bitcoin's success, leading to high expectations for its disruptive potential (Treiblmaier, 2018). This has attracted substantial investments and numerous projects across various sectors, promising benefits like transparency, traceability, efficiency, and security (Glaser, 2017, Yli-Huumo et al., 2016, Babich and

Hilary, 2019). Despite these advantages, only a few blockchain projects have been successful, indicating a largely untapped potential. The anticipated benefits for firms using blockchain have not always been realized, prompting scholars to explore reasons for the slow adoption and limited success of blockchain applications (Treiblmaier, 2019, Glaser, 2017, Hackius and Petersen, 2017). Therefore, this study aims to investigate the technological factors contributing to this gap. These technological factors are described by the features of a technology which are discussed in the next section.

1.3 Technology Features

The term "technology features" can have different meanings depending on the context. For instance, in the context of software programs in a product line, a feature describes an increment in program functionality that can be used to distinguish the individual program (Lopez-Herrejon et al., 2005). Meanwhile, in the context of software evaluation, it is used to describe criteria for users to select hardware or software (Kim et al., 2009). In the same context, Valacich et al. (2018) use a more general meaning and refer to technology features as "predefined technology criteria". Another, more general, definition is provided by Hiltz et al. (1981), who use features to describe the "capabilities of computer-based communication systems". DeSanctis and Poole (1994) refer to features as "properties of technology" which can be used to describe and study information systems. All the above definitions are summarized by Griffith (1999), who describes "the building blocks or components of a technology" as features that can be used for the selection, differentiation, description or study of technology. This work adapts this more general definition and uses technology features to describe the properties and attributes of blockchain technology.

Technology features themselves can be categorised in different ways. DeSanctis and Poole (1994) distinguish between "structural features of the given technology and the spirit of this feature set", where the spirit points to the intention of use of certain features, and structural features are seen as the specific capabilities themselves. A separation between core and ancillary features, where core features characterize the technology as a whole and ancillary features point to optional or unused features, is proposed by Jasperson et al. (2005). Another, more fine-grained, categorization is offered by Griffith (1999), who provides the categories of core versus tangential and concrete versus abstract features (see Figure 1). In her model, which is used in this research, core features define the nature of a technology while tangential features describe more its exchangeable parts. Further, concrete features are easy to verify while abstract features are difficult to observe. Overall, a features-based analysis of a technology allows more granular insights compared to the study of a technology as a whole (Kim et al., 2009, Griffith and Northcraft, 1994).

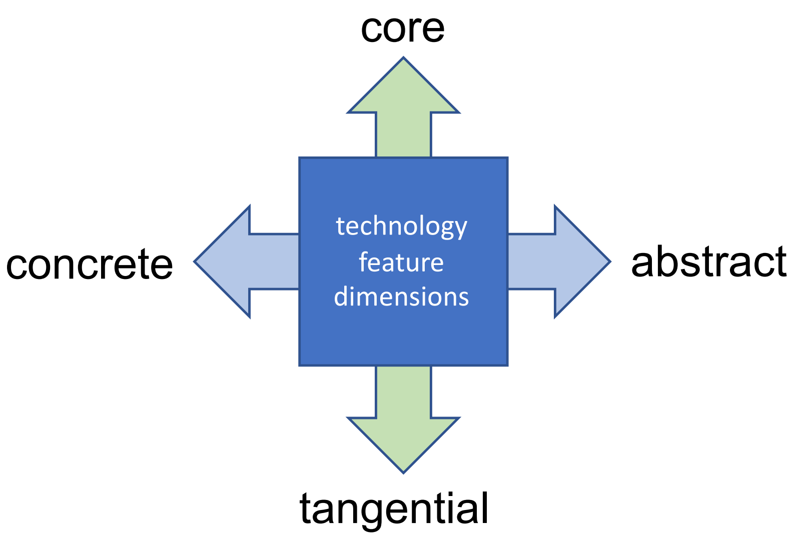


Figure 1 - Technology Feature Dimensions

Although there is a wealth of research on information technologies (IT) and, especially, blockchain technology (see Figure 7), a feature-based approach for assessing blockchain technology, as proposed here, could not be found. In general, researchers seem to prefer a black-box approach for studying IT applications, instead (Jasperson et al., 2005). Few empirical studies examine IT systems at a feature level (Kim et al., 2009, Harrison and Datta, 2007, Hiltz et al., 1981, Kay and Thomas, 1995, Bhattacherjee, 1998, Ginzberg, 1981, Straub et al., 1995). However, until now, there are no studies that use technology features within the context of technology adoption.

While technology features can be used to describe technologies, the unique combination of such features (core features) allows the differentiation of technologies and determines their capabilities and benefits (Griffith, 1999). The features of a technology are designed to support and fulfil an intended use (Verhoeven et al., 2018, Sun, 2012). Though the use of a technology can differ between technology applications and deviate from the original intention, it cannot go significantly beyond what the technology features support (DeSanctis and Poole, 1994). Using the list of blockchain benefits discussed in Chapter 2.3.4, the core technology features for blockchain technology can accordingly be directly derived, as shown in Table 1 below.

Blockchain Benefits	Blockchain Core Features
ensuring that records cannot be manipulated →	record immutability
providing a full record history →	record aggregation
supporting anonymous transactions →	anonymity
allowing transactions between untrustful partners →	record validation via distributed consensus (disintermediation)
supporting distributed operations →	decentralization

Table 1 - Blockchain Core Features

Comparable technologies, such as blockchain and relational databases, can be differentiated by their core features. Both are types of databases, but a look into their core features[2] (see Table 2) shows differences, which qualifies each of them for different applications.

Blockchain Core Features	Relational Database Core Feature
record aggregation	tabular structure of indexed file data
decentralization	centralised operations
record immutability	high transaction throughput
record validation via distributed consent (disintermediation)	efficient data definition and manipulation language
anonymity	support of complex data structures

Table 2 - Core Feature Comparison

As blockchain, unlike many other technologies, is a modular technology, it allows the implementation of applications without using all of its core features. However, if too many core features of a technology are not used in an application, it becomes interchangeable with other technologies, which asks whether the chosen technology is the right choice at all. Further, depending on the respective application, the concrete list of used features can vary, and there are applications where some of the blockchain features are not needed or wanted. For example, in provenance or tracking applications within the SCM context where it is crucial to publish who owns a certain asset or who performed a certain transaction, the anonymity feature of blockchain technology might not be needed or wanted, whereas it is crucial in cryptocurrencies, like Bitcoin.

A review of the main types of blockchain applications discussed above shows that most of them rely only on a small subset of the blockchain core features which differentiate blockchain from other technologies (see Table 3).

[2] This non-exhaustive list of core features for relational databases is derived from www.microfocus.com

	Use Case / Application					
Blockchain core features	BitCoin / crypto currencies (Crosby et al., 2016)	Blockchain provenance tracing (Everledger, 2020),(Kim and Laskowski, 2018)	Blockchain in healthcare (Tanwar et al., 2020),(Dwivedi et al., 2019a)	ODO meter fraud prevention (Coinjournal, 2019)	supply chain enhancement B2B (Treiblmaier, 2018),(Helo and Hao, 2019)	parcel tracking B2C (Yaga et al., 2019),(Chang et al., 2019)
record validation via distributed consensus (disintermediation)	X					
record aggregation	X	X	X	X	X	X
record immutability	X	X	X	X	X	X
decentralized storage	X			X	X	X
anonymity	X		X			

Table 3 - Blockchain Application Feature Usage

This observation leads to the question of why blockchain technology has been chosen or proposed in the first place if these applications possess only a few of the core features of this technology and, therefore, they could potentially be replaced by other, more mature, technologies (Verhoeven et al., 2018). This practical gap is also reflected by a gap in the theory. Following Brown et al. (2010) are numerous studies which have shown that technological characteristics as experienced by users can, potentially, influence their adoption. But until now, there is no research available that has considered the role of technology features as a factor influencing the adoption of blockchain applications.

1.4 Research Aim and Questions

The general purpose of this research is to provide a better understanding and possible explanations for the ongoing slow adoption of blockchain technology.

1.4.1 Research Aim

To fulfil the general purpose, this research aims to explore the factors influencing the individual adoption behaviour regarding blockchain technology. There are several recent studies focusing on technology adoption in various contexts (Queiroz et al., 2020, Rahi et al., 2019, Mitropoulos and Tatum, 2000, Khazaei, 2020). However, despite this wealth of existing research, the role of technological characteristics for technology adoption has not been the focus of research so far. To tackle this blind spot in the currently available models and theories, the concept of mindfulness, which represents the individual awareness of technological characteristics, is combined with the widely accepted unified theory of adoption and use of technology (UTAUT). The combined model allows an assessment of the role of technical characteristics in the adoption of blockchain technology. This research extends the general knowledge by linking the aspect of technological characteristics with an acknowledged and proven technology adoption theory. The results may help us to understand the current limited adoption and success of blockchain applications by providing more transparency and empirical evidence concerning the role of the distinct technological characteristics of the adoption. This research will shed light on the role of technology awareness related to the commercial benefits of blockchain applications. The fulfilment of this research aim is realised by addressing the following research objective.

1.4.2 Research Objective

The objective of this research is to create empirical evidence for the role of technological characteristics in the adoption behaviour of blockchain technology. To achieve this, first, the technological base of blockchain is defined, using the concept of technology features provided by Griffith (1999). Based on her definition, technology features can be seen as the building blocks or components of a technology. These building blocks can generally be separated into core and tangential features. Core features define the nature of a technology, while tangential features describe more the exchangeable parts of a technology. To illustrate this, Table 4 lists the core features found in the

Bitcoin blockchain application and provides a reference to the underlying base technologies.

Blockchain Core Features	Underlying Technology
Record aggregation →	Database
Decentralization →	Peer to peer networking
Record immutability →	Cryptography
Record validation via distributed consent (disintermediation) →	Peer to peer networking
Anonymity →	Cryptography

Table 4 - Blockchain Features in Bitcoin

Since some of the underlying technologies have a long history (for example, databases became dominant in the 1980s), the novelty and uniqueness of blockchain results mainly from the new combination and application of the underlying but also complementary technologies (Halaburda, 2018). The unique combination of technical features is what differentiates blockchain from other technologies and, in this way, determines the basis of its value creation potential. However, different applications of blockchain technology require different or modified features, which leads to diverse blockchain configurations and feature sets. Some of these configurations do affect core features; for example, private blockchain applications do not require anonymity as the participants must be known based on the concept of private blockchains. Other configurations do affect more tangential features such as, for instance, the integration of complementary technologies like the IoT or radio frequency identification (RFID), which are needed for most supply chain-related applications.

Taking this understanding of the blockchain technology and its unique features as a base, the role of these distinct characteristics of blockchain technology as factors regarding the individual adoption behaviour is addressed. As the use of a new technology determines the economic benefit resulting from its introduction, this research will help to predict the benefit for blockchain applications and understand its current slow adoption. The outlined research objective is achieved by answering the research question, which is defined next.

1.4.3 Research Question

While commonly used technology adoption models and theories consider diverse factors influencing adoption behaviour, the role of distinct technological characteristics and their awareness has, until now, not been considered in this context. Therefore, the research question (RQ) aims at addressing this blind spot:

> RQ: How does the awareness of distinct blockchain characteristics influence the behavioural intention to adopt blockchain technology?

This research question is answered by validating the research model outlined in the conceptual framework section (chapter 0). The empirical part of this research is not limited to a specific geographical context, although it is expected that there is a focus on German speaking countries for the data collection. Further, as general blockchain adoption behaviour is in focus, no limitation with regard to industry or blockchain application type is applied. The level of analysis is defined as organizations and projects as discussed in chapter 3.2.5 while it is acknowledged that adoption behaviour is exerted by individuals. This research allows, for the first time, a clear view on the role of technological characteristics in the adoption of blockchain technology and, thus, for the benefits this technology can deliver in real-world cases. The graphical representation shown in Figure 2 below provides a summary of the research aim, objective, gap and question.

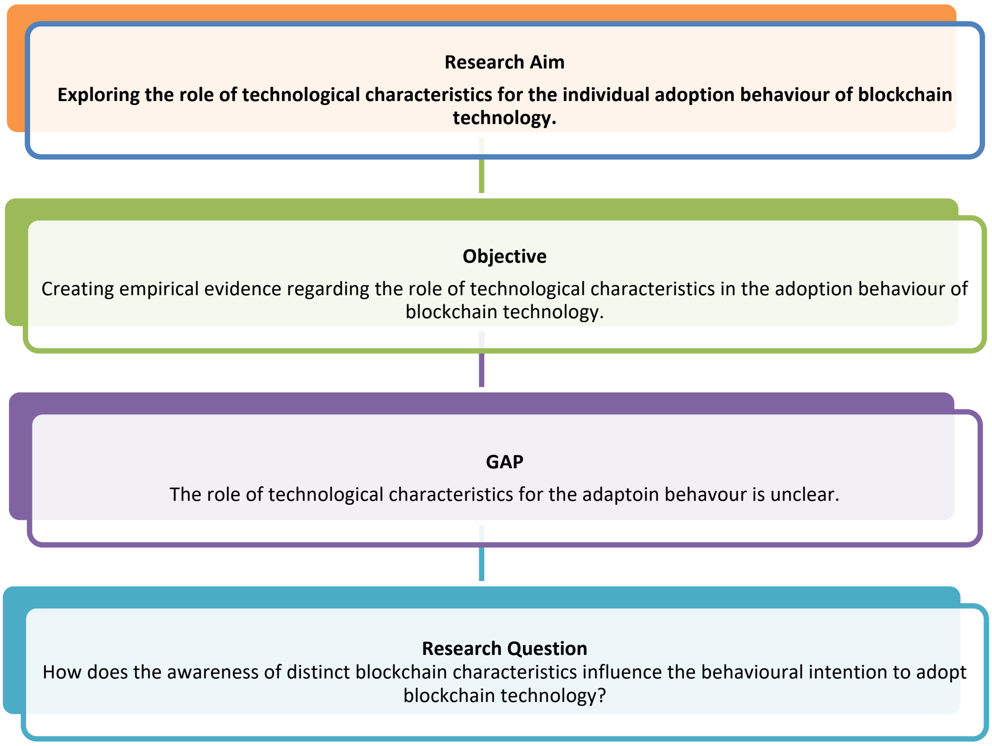


Figure 2 - Research Overview

1.5 Utility of the Study

This research study seeks to compile empirical evidence that will reveal the role of technological awareness in the intention to adopt blockchain technology. By this, technological awareness is established as a factor in determining the economic success of blockchain applications. Based on a methodologically robust approach, the findings and result will have significant social relevance and utility as emerging technologies, such as blockchain, have the potential to disrupt many parts of the current business world and, in this way, indirectly impact our social life. By applying a vigorous research method based on well-accepted theories, this research delivers a clear view on the technological base of blockchain adoption. Further, this study enriches the discussion on technology selection and adoption in academia and practice by directly linking the aspect of technological characteristics to the adoption of new technology applications. It can help managers and decision-makers to manage the risks and maximize the benefits of blockchain projects by revealing further factors that influence the individual technology adoption behaviour. Further, the present study is very much relevant as it extends the general knowledge in the area of technology adoption and encourages further research by providing a connection between the technological and the economical view on emerging technologies.

1.6 Research Methodology Stages Overview

The research methodology of this research generally follows the stages suggested by Thornhill et al. (2015).

Phase one starts with the definition of the research problem, aim and question. This is followed by a systematic literature review in phase two, which covers the main themes of emerging technologies, blockchain and technology adoption. Then, in the third phase, the conceptual framework is developed based on existing theories. Phase four covers the research design, starting with the philosophical world view which is followed by the strategy of inquiry. Based on the research design, the data collection is performed in phase five, followed by the data analysis in phase six. This research is concluded in phase seven with an interpretation of the results, discussion, recommendations, conclusion and implications. An overview of the research stages is presented in Figure 3, which is followed by details on the structure of this thesis in the next section.

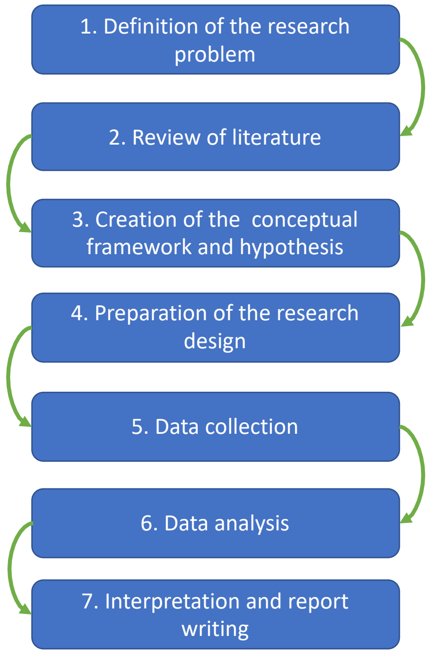


Figure 3 - Research Stages

1.7 Structure of the Thesis

This thesis comprises seven chapters which are organized systematically to present the approach in which the research question is proposed and answered.

Chapter one – Introduction – provides an introduction into the focal issue and the general background to the study. Further, a statement of the problem is presented and the research goal and question, as well as the use of the study, the research methodology stages, and the structure are defined.

Chapter two – Literature Review and Conceptual Framework – offers a systematic and critical review of the existing literature following a defined relevance tree. The review starts with the relevant literature on emerging technologies in general, which is followed by a detailed review on blockchain technology as one concrete form of an emerging technology, taking into consideration its main technical and commercial aspects. This is followed by the relevant literature on technology adoption leading to the creation of the conceptual framework, research model and propositions.

Chapter three – Research Design and Methodology – explains the development of the formal research design and strategy. Further, the research philosophy, the overall methodological approach and the data collection for this thesis are discussed. Starting with a philosophical worldview, this chapter gives details about the chosen qualitative research method.

Chapter four – Data Analysis – presents details concerning the analysis method and the coding approach.

Chapter five – Findings – presents details concerning the findings including their classification and grouping.

Chapter six – Discussion and Implications – discusses the findings, answers the research question and examines the theoretical, practical, policy and general implications of this work.

Chapter seven – Conclusion and Recommendations – provides a summary of the findings, the theoretical contributions to knowledge, the methodological contribution and practical conclusions of this research, identifies the limitations of the study, and points out avenues for further research.

The next chapter provides the literature review, starting with an outline of the general concept and search terms.

2 Literature Review and Conceptual Framework

This literature review is generally based on a structured database search using online search engines and the internet as key sources. The main focus is, thereby, on articles from peer-reviewed journals. To consider recent developments, especially in blockchain research, other sources (grey literature) are considered. Insights gained from non-scientific sources are treated with special care, such as cross-checking with the current academic knowledge coming from more trusted peer-reviewed sources. To increase the reliability, further to the recommendations of Webster and Watson (2002), Okoli and Schabram (2010), approaches such as not limiting the search by journal or database, applying forward and backward searches and using a concept centric presentation are applied. Although there are possibly relevant documents in other languages, this literature review focuses on documents in English as this is exclusively used in most of the high-quality peer-reviewed journals and accounts.

2.1 Search Terms and Relevance

The primary research interest of this work, as outlined in chapter 1, is to explore the role of technological characteristics for the adoption behaviour of blockchain technology. Therefore, the following search terms were applied: blockchain, application, emerging technology, technology adoption, and information technology. The application of different combinations of these search terms returned a large number and wide spectrum of documents. Based on their relevance, which was derived from the title and abstract, a subset was chosen for a detailed analysis. In addition to the direct results from the databases, references and citations found within the analysed documents were used as sources of relevant information. While retrieving documents using “blockchain”, it was found that after ignoring capital letters, there were three different notations used (block-chain, block chain and blockchain) by different authors. Yet, as most scientific articles use the original notation “blockchain” introduced by Nakamoto (2008), this is also used within this project.

In order to structure and visualize the search results, a relevance tree based on Thornhill et al. (2015) was created (see Figure 4).

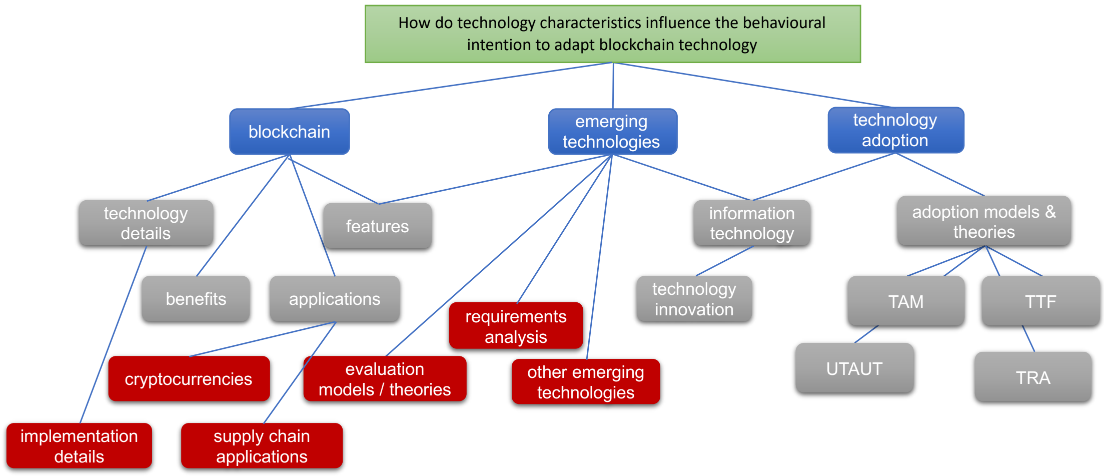


Figure 4 - Relevance Tree

In this relevance tree, the blue marked boxes indicate the primary focus areas of this research. These primary search results are complemented by results from secondary focus areas (marked in grey) which help to complete the understanding of the broader context. Further, it must be noted that based on the wealth of research available, especially on blockchain and emerging technologies, this literature review cannot cover all the connected areas in depth. Therefore, topics marked red in Figure 4, like blockchain implementation details or other emerging technologies, are intentionally omitted.

Following the relevance tree top-down, this literature review starts with providing the wider context of emerging technologies. This is followed by a review of the relevant literature on blockchain technology as the concrete form of emerging technology, which is the focus of this research, covering its technical and commercial aspects as well as applications. Then, the focus of interest is widened to include technology adoption theories and models, which allows the creation of the conceptual framework for this thesis. Finally, this chapter closes with a short summary of the gaps found in the literature.

2.2 Emerging Technologies

There is a vast amount of literature available highlighting the role of emerging technologies for today's highly competitive, fast-changing and global business environment presenting key solutions for process, service or product innovations in firms (Gerdsri, 2007, Bashir et al., 2016, Schiavi and Behr, 2018). Companies like Apple, Airbnb, Alibaba, Amazon, Google, Tesla, Uber or UPS have applied innovative business models based on the use of emerging technologies (Lee et al., 2019b). However, despite the broad interest and their important role in the creation of competitive advantage, it is still difficult to find a clear definition on what emerging technologies are. This results from a lack of rich scientific discussion in this area.

What is clear from the literature is that the definition of what an emerging technology is depends on the context regarding the application, domain and place (Halaweh, 2013). For example, RFID could be seen as an emerging technology in less developed countries while it is today treated as mature technology in most developed countries. This also points to the difference between new and emerging technologies as a technology can still be emerging in one context although it is not new anymore (i.e., it already exists in another context). Next to the context, there is the subjective perspective of the analyst towards a certain technology, which can lead to different opinions or views on whether it is seen as an emerging technology, a natural extension of an existing technology or old technology (Rotolo et al., 2015).

Despite this ambiguity, Rotolo et al. (2015) provide a definition that offers us five attributes upon which to characterize emerging technologies; these are visualized in Figure 5 below. Their definition covers the characteristics named for emerging technologies by Halaweh (2013), and goes beyond them. As it is the most comprehensive and accepted definition for emerging technologies currently available, it is used for this research.

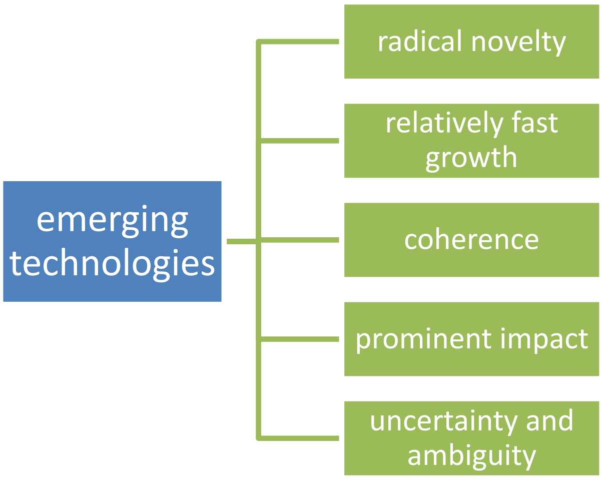


Figure 5 – Attributes of Emerging Technologies

These attributes describe blockchain technology without exception. All the attributes of an emerging technology can be easily identified within Bitcoin as the model application for blockchain technology. Bitcoin is a radical novelty as no truly working cryptocurrency existed before. Furthermore, it has seen fast growth while being coherent, as proved by the wealth of other crypto currencies. Bitcoin is also causing a prominent impact (disruption) not only in the banking sector but also among governments and online payment services, while there is still a lot of uncertainty and ambiguity around it, which not least motivates this research project. Taking this clear categorization of blockchain as an emerging technology as a base, the next section explores the details of this technology.

2.3 Blockchain

The blockchain concept was introduced in 2008 by Satoshi Nakamoto[3] as a public transaction ledger for the Bitcoin crypto currency, and it has functioned flawlessly since (Wikipedia, 2019). The Bitcoin blockchain is today the most developed distributed ledger technology among others like Hyperledger Fabric, R3 Corda or Ethereum (Valenta and Sandner, 2017).

[3] A group or person whose true identity remains unknown till today

The public hype began after major financial institutions started publishing their interest in this technology in 2015. Since then, blockchain has been compared to the introduction of the IP protocol, the internet or the invention of the combustion engine with its potential to transform the world (Kosba et al., 2016). At the peak of the hype, established companies chose to include the term blockchain in their names, as seen, for example, by the change from Long Island Iced Tea Corp. to Long Blockchain Corp., triggering average share prices to rise more than threefold (Pal, 2018). At the time of writing, blockchain has been removed from Gartner Inc. 2019 Hype Cycle[4] for emerging technologies and has found its place in its own Hype Cycle for blockchain technology (see Figure 6).

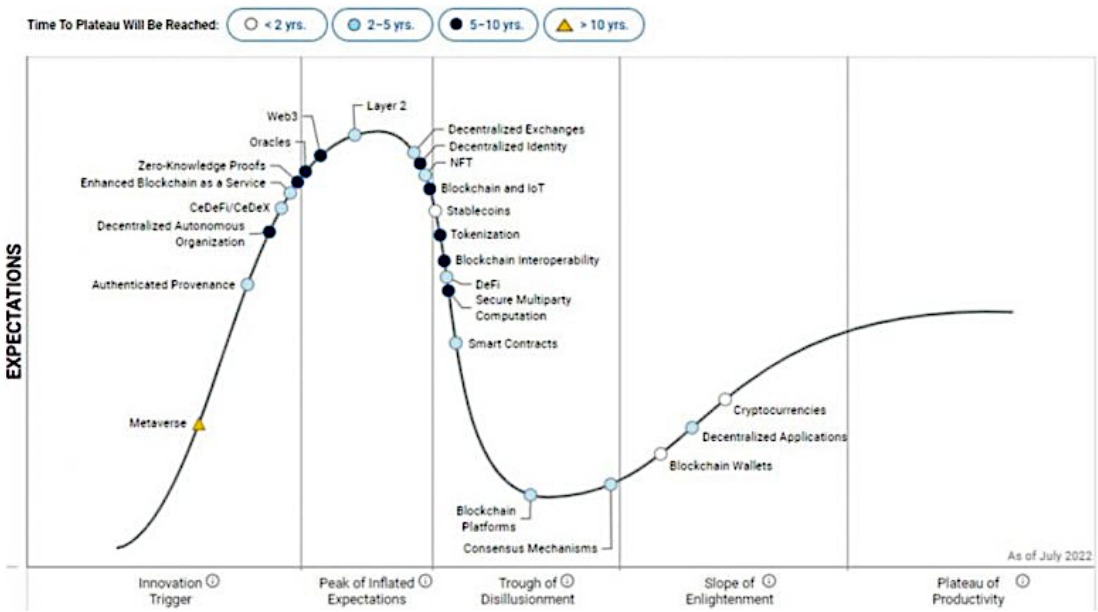


Figure 6 - Blockchain Hype Cycle 2022

[4] Gartner Inc. Hype Cycles provide a graphic representation of the maturity and adoption of technologies and applications GARTNER.COM. 2020. *Gartner Hype Cycle* [Online]. Available: https://www.gartner.com/en/research/methodologies/gartner-hype-cycle [Accessed 09.03.2020 2020].

The existence of a separate hype cycle for blockchain can be seen as an indicator of the importance and potential seen by economic analysts like Gardner in this technology. Further, the hype cycle itself shows the wide variety of potential blockchain applications, and that most of them are expected to become realized in 5 to 10 years, which is in line with other analysts who expect to see the real breakthrough of blockchain technology not earlier than around the year 2030 (Gartner.com, 2020, Iansiti and Lakhani, 2017).

Next to the economic also the academic interest in blockchain technology has grown consistently as, for example, in 2016, when Yli-Huumo et al. (2016) performed their analysis on the then-current state of research on blockchain. They considered only 41 original papers which they extracted from scientific databases to be relevant. In recent years, the number of research papers and other relevant documents has grown almost exponentially as shown in Figure 7 below, which displays the number of search results from the Durham University online library for the search term “blockchain” filtered by journal articles and the respective year.

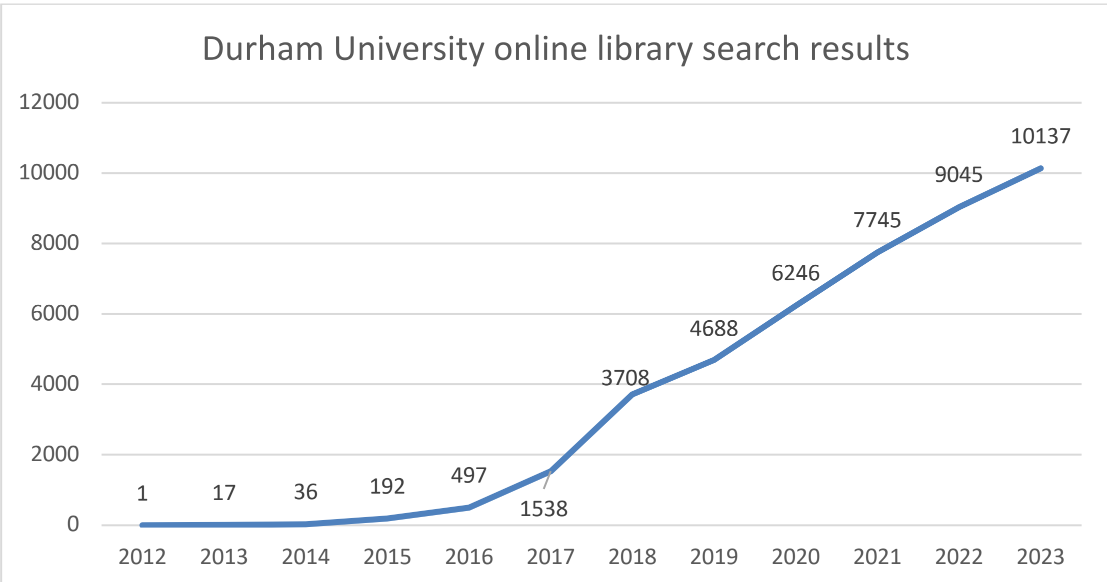


Figure 7 – Blockchain Articles

While in the beginning, there was a strong focus in the research and literature on technical challenges, limitations, security and the Bitcoin cryptocurrency, this has shifted and today there is more attention given to the potential use cases and blockchain applications. Further, researchers have left the questions concerning what blockchain can do behind and moved on to questions about what blockchain can do better than other technologies. For example, Glaser (2017) already states "blockchain is an innovative technology in search of use cases". This shift in research is also reflected by the high number of proposed and implemented applications in diverse industries like banking, insurance, travel, legal, food, healthcare, supply chain, operations management and others (Verhoeven et al., 2018, Karamchandani et al., 2017). However many of these applications seem to be driven by technology providers, consultants and journalists who create high expectations by promising significant business potential or by the bandwagon effect of exaggerated expectations (Newswire, 2018, Verhoeven et al., 2018, Hackius and Petersen, 2017).

From a more technical perspective, blockchain is not a single technology but a new combination of existing and proven technologies enriched with some innovative ideas, as visualized in Figure 8 below (Babich and Hilary, 2018). Blockchain combines peer-to-peer (P2P) networking, exemplified by the music sharing applications like Napster and public key cryptography, which is used for most encrypted communication on the internet (like the Secure Socket Layer - SSL in any web browser). This modularity is what makes blockchain special and leads to a variety of options for its adoption. The main distinctive characteristics of blockchain are its consensus-based distributed trust model, its cryptography-based anonymity and the immutability of the data which offers permanent data storage and allows for the verification of all previous records by all participants of a blockchain.

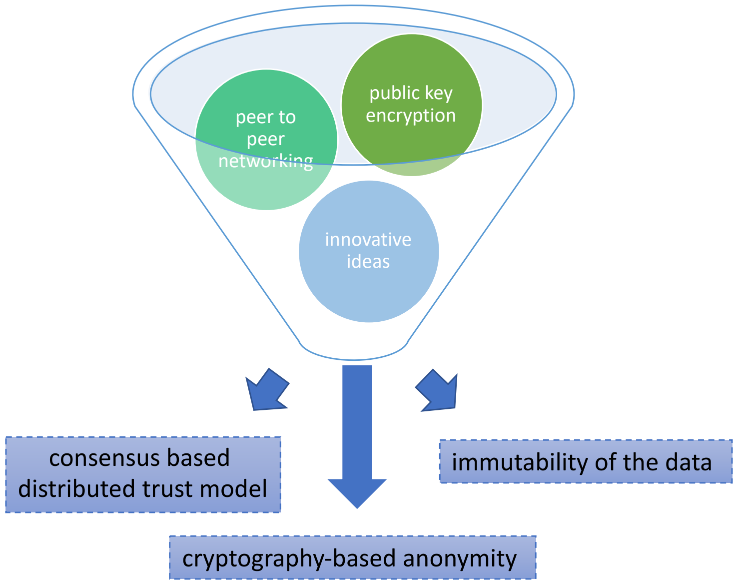


Figure 8 - Blockchain Foundations

Today there still exist organizational and technical challenges, for example, missing standardization and low transaction throughput, which hinder the implementation of blockchain technology (Swan, 2015). In addition to this, proof of many of its potential benefits, in particular published uses cases, remains open, as does the business case behind current blockchain implementations. For example, Babich and Hilary (2018) state that "the overwhelming majority of current blockchain projects fail". This is also reflected by the findings of Deloitte (2017), who state that only 8% of the GitHub[5] projects related to blockchain are active and that the average life span for a blockchain project there is approximately 1½ years. This short project life span and the high rate of abandoned projects reflect the premature nature and point to an obvious problem with regard to the adoption of blockchain technology.

[5] GitHub is a company that provides version control software for developers as an online service

In this context it is important to understand that there are generally two main types of blockchains. The first type is the “permission-less” blockchain, where everyone can participate: for example, Bitcoin or Ethereum. The second type are the so-called “permissioned” blockchains, where the participants are controlled by a central authority: for example, Hyper Ledger Fabric or R3 Corda. However, there are also other classifications, such as public (permission-less), federated (permissioned) and private (permissioned, company internal or enterprise) blockchains (BlockchainHub, 2019). Each type of blockchain and its distinct implementation come with different unique attributes and features serving different purposes and, thus, offering different benefits.

2.3.1 Technology

From a high-level technical perspective, a blockchain can be seen as a kind of distributed, transactional database. One of the key benefits of its distributed architecture is its robustness to the failure of single nodes, especially when there is imperfect information about whether a component has failed; this is called Byzantine fault tolerance (Babich and Hilary, 2018). Further, as a distributed ledger, it stores all the transactions ever made by the participating parties, who are usually represented by anonymous pseudonyms (Subramanian, 2018). All the nodes participating in the blockchain network hold a full copy of the ledger and can verify the validity of the blockchain itself and the validity of each transaction at any time via the verification of a hash value (Nakamoto, 2008). New transactions are broadcast to the blockchain network and verified by each node in the network against the blockchain protocol using cryptographic methods. Invalid transactions are rejected and valid transactions are added by each node to its local list of temporary unconfirmed transactions (Yaga et al., 2019). Parallel to validating transactions, each node works on the distributed consensus which is, in the case of Bitcoin, a cryptographic puzzle that can only be solved by a certain amount of computing effort. When a node is able to solve this puzzle successfully, it adds a new block to the blockchain and distributes it to the network. The new block is then validated by each node and if it gets accepted, it will be added to the blockchain and the nodes start working on the next block (Nakamoto, 2008). One of the basic pillars of blockchain technology, which has been the focus of researchers since its emergence, is security (Yaga et al., 2019).

2.3.2 Security

As with any other cryptographic solution, the security of current blockchain implementations depends at least on the quality of the algorithms, the key length and the quality of the random factors used. If any of these elements are weak then the resulting encryption is weak and can be hacked. Even if these elements are chosen wisely, every encryption can theoretically be cracked, for example by guessing passwords and hash inputs. The likelihood of success for such an attempt depends on the computing power and time provided. In particular, the appearance of quantum computers can put blockchain security at risk unless the designers and operators are prepared for it (Fedorov et al., 2018). Next to this, every application introduces some systematic risks like double-spending or 51% attack, which especially is the case with cryptocurrencies like Bitcoin (Bastiaan, 2015, Nakamoto, 2008, Eyal et al., 2016, Bradbury, 2013). However, it is far more likely that the private keys of users get stolen via classic ways of computer hacking, which might weaken trust in this technology. Further, blockchains are often connected to backend applications that do not necessarily have the same security level as the blockchain protocol itself (Babich and Hilary, 2018). Negative examples for blockchain security are the hack of Mt. Gox, a previously leading Bitcoin exchange company, in 2014, and the decentralized autonomous organization hack mid-2016, or the recent successful 51% attacks on crypto currencies (Orcutt, 2020). Other than security, blockchain technology faces yet more challenges.

2.3.3 Challenges

Some challenges for blockchain technology are based on technical limitations like latency which results from the distributed nature of blockchain applications. Further the size of the blockchain itself can become a problem as blockchain is a kind of write only database which potentially grows for ever. Other limitation arise from bandwidth which is a geographical and commercial limitation for the transfer of larger amounts of data. Also, the transactions times or throughput are seen as a limitation for many current blockchain implementations. For example, the Bitcoin blockchain processes around 4.6 transactions per second and Ethereum 14 to 15 transactions per second. These are comparatively low transaction throughput rates compared to normal transactional databases (Li, 2020). For comparison, the Visa credit card network is capable of performing up to 45.000 transactions per second, and normal SQL[6] databases can provide throughput rates at up to hundreds of million transactions per second (Hertig, 2020, Hood, 2020).

Further, there are conceptual issues like wasted resources, for example in the form of computing power in proof of work (PoW) based consensus mechanisms, usability due to a lack of standardization in protocols or hard forks, which are new chain structures caused by radical changes in the blockchain protocols which may be needed to fix security issues (Swan, 2015, Vranken, 2017, Babich and Hilary, 2019). In particular, the currently missing standardization is hampering many use cases and further leading to a general uncertainty among potential users (Babich and Hilary, 2018). However, there are also attempts like the Blockchain in Transport Alliance (BiTA), which was founded in 2017 is concerned with standardization issues, having the support of firms like UPS, Daimler, BNSF, Delta, FedEx and others.

Another area of concern is the usage of blockchain technology with regard to compliance with the recent EU General Data Protection Regulation and applicable laws: for example, “the right to be forgotten” is difficult to combine with the feature of immutability (Jackson, 2018). Furthermore the general trust

[6] SQL is the structured querey languag, which is used for a majority of databases today

in digital cryptography, which is especially relevant as blockchain technology primarily relies on cryptography, is another common cause for concern (Fedorov et al., 2018). However, apart from the challenges, the unique technical setup of blockchain technology also offers several benefits.

2.3.4 Benefits

One of the most often highlighted key benefits of blockchain is that its records cannot be changed. Blocks in a blockchain are usually only added and can hardly ever be erased or altered as each added block includes a cryptographic reference to the previous block which results in a temporal order of blocks (Yaga et al., 2019). This immutability of records directly leads to the second key benefit of blockchain technology, which is providing a full history of all the records. As blocks are being continuously added, so all of the stored information in a blockchain is always available. However, theoretically, an alteration of a block is possible, but altering a block would require the majority of the computing power, the voting power or whatever else is used as a consensus mechanism, and a re-validation of all the blocks that follow the altered block (Babich and Hilary, 2018, Nakamoto, 2008). Though block alteration is impractical in public blockchains, in private blockchains, and in consideration of quantum computers, the situation may be different (Fedorov et al., 2018, Babich and Hilary, 2018). A potential drawback of this record immutability is that wrong or unwanted information published in a blockchain is very hard to erase or correct.

Another often highlighted benefit of blockchain technology is that it allows for anonymous transactions based on the usage of cryptographic pseudonyms. However, this benefit is limited by the above-discussed general concerns regarding cryptography and by the respective application, as, for example, in provenance applications, this feature may be unwanted. Next to this, the ability to make transactions between untrustful parties while cutting out the middleman is another key benefit of blockchain technology; this is often cited in the literature. This feature, which is called “disintermediation”, is expected to help in realizing cost reductions while increasing the speed of transactions, especially in SCM applications. It is one of the most discussed, and also most misinterpreted, benefits of blockchain technology. The disintermediation feature is expected to support the creation of “trusted” processes that can be operated in a non-trust environment, and so eliminate the need for trust between process owners (Halaburda, 2018, Yli-Huumo et al., 2016). Finally, the distributed nature of blockchain is often named as one of its key benefits as it ensures high resilience against outages of single nodes, as well as it proves the validity of single transactions and the whole blockchain, in combination with the distributed consensus protocols (Glaser, 2017, Babich and Hilary, 2019). A downside of this distributed nature is, for example, the dependency on networks that introduce throughput and performance limitations compared to centralised systems.

In summary, the key benefits of blockchain technology are:

- ensuring that records cannot be changed
- providing a full record history
- supporting anonymous transactions
- allowing transactions between untrustful parties
- supporting distributed operations

However, all the potential benefits must be carefully reviewed and considered in the context of distinct applications as they cannot be generalised, and they mostly depend on the particular blockchain implementation and the chosen feature set (Ølnes et al., 2017). It must also be kept in mind that most of the proposed benefits of blockchain technology originate directly from the underlying technologies, such as encryption, peer-to-peer networking and complementary technologies like smart contracts, which have been used as distinct technology long before the emergence of blockchain (Halaburda, 2018). In the end, only a few of the blockchain benefits are really unique and cannot be provided by other technologies, such as relational databases. One of these unique benefits is the disintermediation. The technical base for the disintermediation feature is the distributed consensus mechanism in blockchain technology.

2.3.5 Distributed Consensus

The distributed consensus certifies the integrity of the blockchain itself by ensuring that only valid blocks are added to the chain based on the implemented protocol rules (Dos Santos, 2018). The consensus rules also aim to guarantee that there is only one chain followed and used (prevent forking). Further, they have to ensure that the whole system is not being controlled by any single party. Therefore, common consensus protocols require a majority of computing effort, tokens or votes (Yaga et al., 2019).

The actual consensus model can be different for each blockchain implementation depending on the specific consensus protocol used. The three most common consensus protocols are “proof of work”, which is used for Bitcoin and relies on the majority of the computing effort in the network, “proof of stake”, where the number of certain tokens determines the level of influence on the consensus, and “proof of authority”, where the consensus is agreed among a defined number of authorized participants (Tönnissen and Teuteberg, 2019, Vranken, 2017). Next to these protocols, there are, today, numerous other consensus protocols available, serving different purposes (Yaga et al., 2019).

The role of the distributed consensus is sometimes misinterpreted as, in most use cases other than Bitcoin, it cannot be used to certify the content of a transaction. For most real-life applications, the garbage in, garbage out principle (GIGO), which also applies to blockchain and other emerging technologies (like AI), constitutes a problem (Babich and Hilary, 2018). Algorithms and protocols cannot check the actual content or payload of a transaction, especially if it is in any way related to physical goods. This is one of the biggest misperceptions about blockchain technology as, for example, it is assumed in many proposed supply chain use cases. The physical existence, status or location of a good cannot be verified by the distributed consensus, but still must be entered by a trusted party or device, which leaves room for fraud, as with any other technology (Chod et al., 2018).

Many of the proposed applications of blockchain have problems in connecting the virtual blockchain world to the real world, which inputs the data into the blockchain (Yaga et al., 2019). This can be explained by the parcel tracker case, for example. To verify whether a parcel has reached a certain stage of its journey and in what condition it is, a person or device must have physical access to the parcel in that location, and the information provided by this person or electronic device must be trusted. Blockchain technology contains no feature to support this, and the distributed consensus only helps if transactions can be verified by a protocol (coded rules). As soon as the physical world comes into play, the interfaces between the physical and digital world can turn out to be a weak link and endanger the cryptographic trust base of blockchain technology (Glaser, 2017). This problem is known as the “oracles” problem in the blockchain literature.

2.3.6 Oracles

Whenever a blockchain solution needs to access information outside the blockchain network, agents are needed to deliver this information or build a connection to outside systems. In recent literature, these agents have been called oracles (Babich and Hilary, 2018). The fact that they are needed constitutes a problem as one of the main ideas and unique benefits of blockchain is the disintermediation feature, which is contradicted by the need for oracles as they have to be trusted intermediates who, for example, report a parcel’s status in a blockchain. Further, they have to be as secure and reliable as the blockchain itself in order not to pose a single point of failure for the system or application.

Many projects attempt to solve the oracles problem and create reliable mechanisms to integrate external data in a trustworthy manner, like Oraclize, Astraea, b.verify or Chainlink, all of which are new and are yet to prove their value (Babich and Hilary, 2018, Adler et al., 2018, Yaga et al., 2019, Chod et al., 2018). These approaches usually tackle the connection to other electronic information or services while, regarding the integration with the physical world, much hope is invested in trusted and tamper-proof IoT devices (Serrano-Callea et al., 2018).

2.3.7 IoT

The term IoT was originally introduced in 1999 by the British entrepreneur Kevin Ashton (Keertikumar et al., 2015). IoT is another hyped technology. It basically stands for the idea of connecting all kinds of equipment and devices, from smart sensors used in industrial production to an average refrigerator in a private home, to the internet. In this way, beneficial information may be obtained and provided. According to Kshetri (2017), the application of blockchain in combination with IoT will improve security compared with current IoT systems. However, as the integration of IoT and blockchain will connect the virtual and the physical world, questions on how IoT devices and blockchain technology can be integrated into a coherent framework have yet to be answered (Babich and Hilary, 2019). Further, it can be argued whether blockchain technology is really needed to improve the security of IoT or whether encryption is the technology that would provide the real benefit here.

Not at least driven by the hype around blockchain, many technology enterprises are currently working on a combination of IoT and blockchain technology. For example, IBM and Samsung have announced experimenting with IoT and the Ethereum blockchain on a platform for autonomous decentralized peer-to-peer telemetry (Beck et al., 2016). A real-world example for the IoT-blockchain integration is provided by the company Slock.it, which successfully connects IoT devices to a blockchain and so enables automated payments and other interactions (Slock.it, 2019). Also, car makers like Volkswagen, BMW and others are considering using blockchain technology: for example, for self-reporting odometers (IoT devices) to prevent odometer fraud (Volkswagen, 2019, Coinjournal, 2019). Again, it is worth questioning whether blockchain or encryption is needed to accomplish the desired results or if a central database could be used instead. In addition to the corporations, researchers like Banerjee et al. (2018) or Reyna et al. (2018) have analysed the potential of blockchain technology being used for the secure sharing of IoT datasets, thus securing IoT systems. However, the practical outcomes of their research have yet to be shown.

IoT itself also comes with some challenges as, for example, IoT devices have to be updated and maintained, which introduces costs that consumers are not used to shouldering. For example, today, almost no one has a maintenance contract for a fridge. Following Brody and Pureswaran (2014) "the cost of supporting and serving billions of smart devices will be substantial – even something as simple as maintaining centralized servers that distribute regular software updates". As well as IoT, smart contracts present a complementary technology that is often proposed in blockchain applications.

2.3.8 Smart Contracts

The concept of smart contracts was introduced by Szabo (1997) and describes a combination of "computer protocols with user interfaces to execute the terms of a contract" (Nofer et al., 2017). Smart contracts are often cited in direct conjunction with blockchain but have long been in existence: for example, as automated recurring bank payments or stock exchange limit orders (Halaburda, 2018). Smart contracts do not necessarily require blockchain as blockchain does not require smart contracts. Both exist independently but have the potential of being meaningfully combined, as, for instance, in proposed smart property use cases, where smart contracts can control the ownership of physical property such as houses, cars or smartphones, as long as the oracles problem is considered and overcome (Yli-Huumo et al., 2016).

Many researchers, like Beck et al. (2016), Fairfield (2014) or Kosba et al. (2016), have provided proof of concept applications combining blockchain technology with smart contracts to tackle trust and privacy issues. However, until now, these concepts have not left the prototype stage. Though there may be different reasons for the missing real-world implementation, this can point to a lack of benefit of implementation, which supports the basic idea of this research.

Despite the highlighted benefits of smart contracts, there has also been some criticism as programming errors prevail based on the blockchain immutability feature, and the social context, like personal relationships or individual circumstances, cannot be considered by smart contracts, which could lead to unethical decisions or behaviour of a smart contract system (Cole et al., 2019). However, the potential problems do not seem to influence the number of proposed and implemented blockchain applications using this combination of technologies, which is still rising.

2.3.9 Applications

There is a wealth of proposed or implemented blockchain technology-based applications offering solutions for almost any industry or sector like the travel and automotive industries or the public and healthcare sectors (Forbes, 2018, Coinjournal, Beck et al., 2016, Önder and Treiblmaier, 2018, Tanwar et al., 2020, Angraal et al., 2017, Dwivedi et al., 2019a, Jayaraman et al., 2019, Yaeger et al., 2019, Fridgen et al., 2018b). Other than industry or sector-specific applications, there are numerous applications that are centred around the unique features of blockchain technology: for example, the applications proposed by Chen (2018), Wright and De Filippi (2015), which focus on the disintermediation feature or the public sector application proposed by Fridgen et al. (2018a), which focuses on the immutability feature of blockchain technology. However, for most proposed applications found in the literature, real implementation proving the theoretical benefits in praxis has yet to happen.

The list of unsuccessful blockchain projects is long, including previously hyped solutions like BITCRYPT (latest GitHub update in December 2014), Ascribe (latest GitHub update in September 2018) or Block Notary, where the website is still active at the time of writing but was most recently updated in 2017 (Blocknotary, 2017). The most successful blockchain implementations can be found in the field of cryptocurrencies. Today, there are several regularly traded crypto currencies available which either extend or complement Bitcoin and, thereby, leverage most of the unique benefits of blockchain technology. Examples of this are Litecoin (LTC), Ethereum (ETH), Zcash (ZEC), Dash, Ripple (XRP), Monero (XMR), and Bitcoin Cash (BCH), NEO (NEO).

Despite the high number of proposed and implemented blockchain applications, this literature review shows that most of them have either never left the conceptual state or have been abandoned after a relatively short life cycle. This points towards a significant gap between the high potential for value creation and the actual value creation in blockchain applications, which supports the primary intention of this research project.

One of the main benefits of blockchain technology is its potential to support the development of processes that can have a high level of trust, thus aiming to eliminate the need for trust between process owners. Based on this, blockchain technology seems to offer solutions for a multitude of challenges in today's complex supply chain networks, where speed, transparency and flexibility are crucial (Ganeriwalla et al., 2018). These beneficial expectations lead to a wealth of proposed SCM applications that often combine blockchain technology with smart contracts, IoT or RFID. For example, Beck et al. (2016) have investigated how the decentralization of transactional systems can be realized via blockchain technology. Their prototype implementation is based on the Ethereum blockchain and smart contracts. Also, Kim and Laskowski (2018), who focused on traceability, have created a set of smart contracts to build a provenance-tracing use case based on the Ethereum blockchain. Other examples are provided by Chang et al. (2019) and Helo and Hao (2019), who propose blockchain- and smart contract-based processes for real-time tracking of logistic status information. However, as in most proposed solutions in other areas, including the above-mentioned examples for SCM applications, they have not gone beyond the conceptual or prototype stage and their practical, as well as their economic, validity has still yet to be proven. Furthermore, the reviewed literature shows that the majority of proposed SCM applications are still in the stage of basic theoretical models or prototypes.

Apart from the projected solutions and prototypes, a number of already implemented blockchain applications in the SCM area can be found. For example, a blockchain success story often referred to is provided by the company BlockVerify, which was founded in 2014 to offer blockchain-based anti-counterfeit solutions which increased transparency in supply chain processes (Blockverify, 2019). Unfortunately, at the time of writing, it has gone out of business (latest Tweet in January 2019). Other often-cited applications are the two Walmart food tracking prototypes, which are using IBM's Hyperledger Fabric blockchain technology for tracking pork meat in China and mangoes in the Americas. During the course of the prototype operations, it was found that these applications had to be business, and not technology, driven, while collaboration needed to be at the centre of interest of all the participants (Kamath, 2018). The fact that since 2019, no more information on these projects has been published could be taken as an indicator that they have been stopped as well.

As the increased level of disintermediation enabled by blockchain technology is predicted to have a big impact on the travel industry, this has led to another widely recognised blockchain application initiated by the TUI Group, the world's largest travel company (Önder and Treiblmaier, 2018). TUI uses blockchain technology and smart contracts to maintain a hotel and room inventory in their Bed Swap application, which was set into production in June 2017 (Forbes, 2018). Yet, since the end of 2018, no more entries have been found on the Bed Swap application which, again, could be an indicator of its limited success.

A sustained successful blockchain application is maintained by Everledger. Initially, Everledger provided a permanent ledger of diamond certification, including the complete transaction history of individual diamonds, to guarantee ethical sourcing from conflict-free countries (Kamath, 2018, Hackius and Petersen, 2017). Today, they have extended their blockchain platform business to all kinds of high-value goods, from wines and spirits to art and e-recycling (Everledger, 2020). In this way, Everledger has taken on the role of a trusted intermediate certifying all kinds of transactions, which contradicts the basic blockchain claim of disintermediation and asks why blockchain instead of any other encrypted database technology is used.

The wealth of theoretical work on blockchain applications reflects the current academic interest, and also its perceived business relevance. However, the diversity of topics on the research agenda also point to a lack of direction confirming the need for a model to measure the practical relevance and impact of the proposed applications. Currently, only a few researchers, like Verhoeven et al. (2018). have investigated the general mindfulness of adapting blockchain applications. Their research highlights the need to apply the right technology to solve a problem, which supports the basic idea of this work by pointing towards a benefit-driven view when proposing or selecting blockchain as a solution.

Table 5 below summarises the discussion on blockchain applications.

#	Author(s)	Topic	Status
1	(Adler et al., 2018)	ASTRAEA: A Decentralized Blockchain Oracle	concept
2	(Angraal et al., 2017)	Blockchain Technology Applications in Health Care	concept
3	(Banerjee et al., 2018)	Blockchain-based compromised firmware detection and self-healing	concept
4	(Beck et al., 2016)	Trust-free blockchain-based transaction	prototype

5	(Blocknotary, 2017)	Blocknotary	suspended 2017
6	(Blockverify, 2019)	Blockverify	suspended 2019
7	(Chang et al., 2019)	Supply chain re-engineering using blockchain technology: A case of smart contract-based tracking process	concept
8	(Chod et al., 2018)	B verify, an open-source blockchain protocol that leverages Bitcoin to provide supply chain transparency	prototype
9	(Dwivedi et al., 2019a)	A Decentralized Privacy-Preserving Healthcare Blockchain for IoT	concept
10	(Everledger, 2020)	High-value goods certification	active
11	(Forbes, 2018)	TUI Bed Swap application	suspended 2018
12	(Slock.it, 2019)	Connection of IoT devices to a blockchain for enabling automated payments	suspended 2020
13	(Tanwar et al., 2020)	Blockchain-based electronic healthcare record system for healthcare 4.0 applications	concept
14	(Verhoeven et al., 2018)	Cooperation IBM, Walmart	suspended
15	(Verhoeven et al., 2018)	Kouvola Innovation	suspended 2018
16	(Bext360, 2022)	Bext360	active
17	(BanQu, 2022)	BanQu	active
18	(300Cubits, 2022)	300Cubits	active
18	(Volkswagen, 2019)	Self-reporting odometers (IoT devices)	concept
20	(Wright and De Filippi, 2015)	Lex Cryptography	concept
21	(Kamath, 2018)	Tracking pork meat in China and mangoes in the Americas	suspended

Table 5 - Blockchain Applications

As can be seen from the application examples discussed above, many blockchain applications focus on supply chain provenance problems or disintermediation. While the provenance solutions rely mainly on the record immutability feature of blockchain technology, it is crucial to acknowledge that these applications are limited by the above-described oracles and the garbage in, garbage out problem. The disintermediation-related applications often point to the distributed consensus as the disintermediating feature of blockchain technology (Schmidt and Wagner, 2019). However, as explained in Chapter 2.3.5 this can only work if the blockchain protocol is able to verify the individual transactions, which is difficult other than for cryptocurrency applications. This fact could be seen as one reason for the finding of Tönnissen and Teuteberg (2019), who discovered in their research that disintermediation seldom takes place in SCM applications and, instead, re-intermediation occurs as a result of the proposed blockchain applications.

As the adoption of new technologies determines their usage and economic success, there is significant interest among scholars and practitioners in understanding the factors influencing technology acceptance and use. Over the last decades, this has been leading to the proposal and use of several theoretical models focusing on technology acceptance and use, the most influential of which are reviewed in the next section (Dwivedi et al., 2019b).

2.4 Technology Acceptance Models

While in the literature the terms “acceptance” and “adoption” are often used interchangeably, this research distinguishes between these two and regards acceptance of a technology as a stage prior to its adoption (Brown et al., 2010). Acceptance is defined as the changes in an individual’s attitudes and perceptions that lead to the intention to try new technologies or innovations (Kaldi et al., 2008). Adoption, on the other hand, is defined as the phase of exploration of a new technology (Bouwman et al., 2005). While technological innovations always play a vital role in the field of business, they cannot deliver any benefits until they are accepted and used (Kamble et al., 2019). Previous studies have shown that technology adoption is a complex process that is not based on the technology alone but also involves social dimensions like attitudes, personality, social influences, trust, and others (Venkatesh et al., 2012, Ajzen, 1985, Thompson et al., 1991).

Technology adoption can be studied on a individual as well as on an organizational level. On the organizational level, which is in the focus of this research one of the often-used frameworks to research technology adoption processes is the technology organisation environment (TOE). The TOE uses three elements (technological context, organizational context, environmental context) of a firm to explain adoption decisions (Tornatzky et al., 1990). Its main criticism is that it may be too broad and general. Based on this it is seen as difficult to be applied in a specific context.

On the individual level, in recent years several acknowledged theories have been proposed. These theories and models are successfully used to assess the individual behaviour but also the factors influencing the adoption of new or emerging technologies like blockchain. Some of the most influential theories and models are derived from the area of social science and psychology. One example of this is the technology acceptance model (TAM) created by Davis et al. (1989). The TAM, as visualized in Figure 9, is one of the most widely cited models in the field of technology acceptance; it explains the behavioural intentions and actual system uses using the three factors of perceived usefulness, perceived ease of use, and attitude toward use. However, this model has shortcomings, such as not considering social influences, which limits its usability (Taherdoost, 2018). These shortcomings have led to several extensions of TAM, like TAM2 from Venkatesh and Davis (2000) and TAM3 (Venkatesh and Bala, 2008).

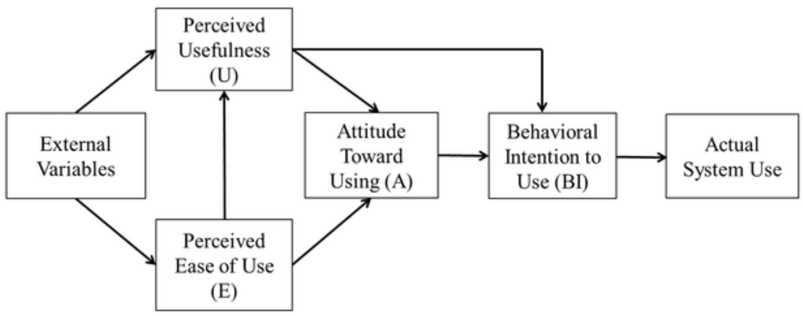


Figure 9 – TAM; source: Davis et al. (1989)

Another similarly important theory is the task-technology fit (TTF) theory (Goodhue and Thompson, 1995). The TTF refers to the match between a task's characteristics and its technology characteristics. Goodhue and Thompson (1995) define task-technology fit as "the degree to which a technology assists an individual in performing his or her portfolio of tasks" and assumes that a good fit between task and technology increases the likelihood of utilization, and the performance since the technology meets the task needs and wants of users more closely (see Figure 10). One of the main difficulties with this model is that the aspect of "FIT" can have different meanings, which complicates its interpretation (Howard and Rose, 2018).

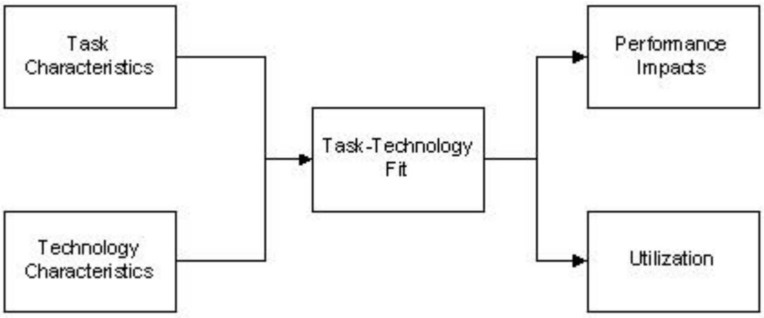


Figure 10 – TTF; source: Goodhue and Thompson (1995)

The theory of reasoned action (TRA), created for sociological and psychological research by (Fishbein and Ajzen, 1975), has become one of the most often-cited and popular theories in technology adoption (Lai, 2017). This theory considers the intention to perform a certain behaviour preceding the actual behaviour, while the behavioural intention is linked to attitudes based on a set of beliefs. As well as this, TRA considers subjective norms linked to normative beliefs and the motivation to comply as a second factor affecting behavioural intentions (

Figure 11). The main criticism of TRA is that it does not consider the role of habits and cognitive deliberation, in addition to a general scepticism towards attitude theories as indicators of behavioural intention (Howard and Rose, 2018).

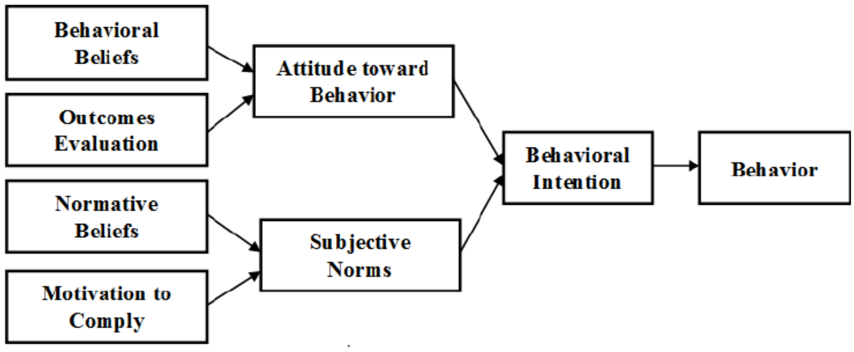


Figure 11 – TRA; source: Fishbein and Ajzen (1975)

To overcome the weaknesses of individual theories, Venkatesh et al. (2003) developed the UTAUT.

2.4.1 Unified Theory of Acceptance and Use of Technology

The UTAUT is a synthesis of eight different theories and models. It combines elements from the TAM (Davis et al., 1989), the TRA (Fishbein and Ajzen, 1975), the motivational model (MM) (Davis et al., 1992), the theory of planned behaviour (TPB) (Ajzen, 1985), the combined TAM and TPB (C-TAM-TPB) (Taylor and Todd, 1995), the model of PC utilization (MPCU) (Thompson et al., 1991), the innovation diffusion theory (IDT) (Rogers, 2010), and the social cognitive theory (SCT) (Compeau and Higgins, 1995). The UTAUT (shown in Figure 12) is an influential theory in several research areas and it has not only shown its relevance in diverse studies but also inspired scholars to propose some modifications (Farooq et al., 2017, Heidari et al., 2018, Dwivedi et al., 2019b).

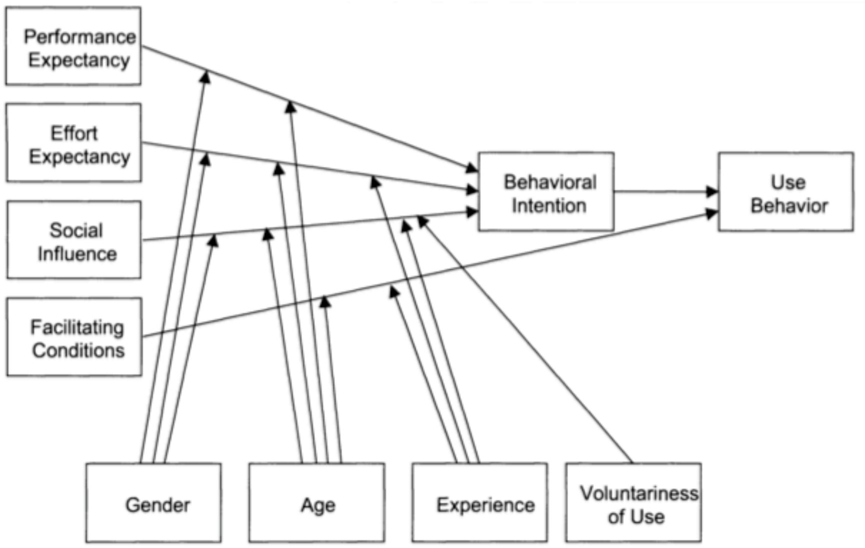


Figure 12 – UTAUT; source: Venkatesh et al. (2003)

In the original version, the authors modelled the 14 initial constructs from eight acceptance theories into four exogenous factors to explain behavioural intention and use of technology (Venkatesh et al., 2003). These factors are effort expectancy, performance expectancy, social influence and facilitating conditions. Then, the UTAUT also introduces the four moderator variables of gender, age, experience and voluntariness of use. The UTAUT as a combination of multiple theories and models has proven to be superior to single theories in explaining technology adoption behaviour and has, therefore, been chosen for this research (Queiroz and Fosso Wamba, 2019). To summarise this, Table 6 provides an overview of the reviewed technology adoption and acceptance literature which is split into the two categories blockchain acceptance and general technology acceptance.

Theoretical Model	Population	Author(s)
Blockchain acceptance		
TOE	146 employees from 71 North American organisations	(Dehghani et al., 2022)

UTAUT	184 from the LinkedIn platform randomly selected Brazilian OSCM professionals	(Queiroz et al., 2021)
TOE, Mindfulness	case study, agroindustry Indonesia	(Rijanto, 2021)
UTAUT, TTF, ISS	449 managers of supply chain, production, operations, procurement/logistics, and quality in Australia	(Alazab et al., 2020)
UTAUT	267 members of thematic social media (LinkedIn, Facebook) groups "blockchain" and "Italy"	(Caldarelli et al., 2020)
UTAUT	384 members of SMEs in Malaysia	(Khazaei, 2020)
Theory framework	Framework development	(Janssen et al., 2020)
UTAUT	344 (India) + 394(US) supply chain professionals with at least three years of experience in the area of blockchain	(Queiroz and Fosso Wamba, 2019)
TAM, TPB, TRI	181 supply chain practitioners in India	(Kamble et al., 2019)
UTAUT	concept	(Salem, 2019)
UTAUT	127 students and faculty of a midsize university and IT professionals in several organizations	(Lee et al., 2019a)
UTAUT	concept	(Francisco and Swanson, 2018)
Mindfulness	5 case studies	(Verhoeven et al., 2018)
Technology acceptance		
UTAUT	436 mobile payment users in Oman	(Al-Saedi et al., 2020)
UTAUT	395 customers of commercial banks in Pakistan	(Rahi et al., 2019)

Experiment	82 junior-level business class students	(Valacich et al., 2018)
Review	review of technology acceptance / adoption models and theories	(Taherdoost, 2018)
UTAUT	meta-analysis based on 162 prior studies on IS/ IT acceptance and use	(Dwivedi et al., 2017)
UTAUT2	481 executive business students in Malaysia	(Farooq et al., 2017)
UTAUT	321 users of a new IT in US	(Maruping et al., 2017)
UTAUT, TRA, SCT	160 local government employees in Indonesia and Philippines	(Batara et al., 2017)
Review	review of technology acceptance / adoption models and theories	(Samaradiwakara and Gunawardena, 2014)
UTAUT, ITM, TTF	194 mobile phones users in Portugal	(Oliveira et al., 2014)
UTAUT2	1512 mobile internet users in Hong Kong	(Venkatesh et al., 2012)
UTAUT	349 short message service users in Finland	(Brown et al., 2010)
TAM	70 internal auditors in US	(Kim et al., 2009)
TAM	349 short message service users in Finland	(Dennis et al., 2008)
UTAUT	multiple studies with new technology users	(Venkatesh et al., 2003)

Table 6 - Technology Acceptance Literature

While the UTAUT alone can explain up to 70% of the variance in behavioural intention (compared to previous models which could only explain about 40%) it does not regard the potential influence of technical characteristics (Venkatesh et al., 2003). Therefore, this research combines the UTAUT with the concept of technology feature mindfulness, which represents the different aspects of an individual's technological awareness and, so, allows consideration of the role of technology features within the context of technology adoption.

2.5 Mindfulness

Mindfulness is an important and emerging topic reflected by the continuing strong interest from researchers and practitioners which started around the 1970’s and still continues. The positive effects of mindfulness on personal health as well as other areas like improving personal relationships found in the early research have triggered a wealth of research covering different levels of analysis and various domains including management, health and information systems, where it has successfully been applied to both individuals and organizations (Brown and Ryan, 2003, Dernbecher and Beck, 2017). According to Brown et al. (2007) the psychological and medical research on mindfulness has seen an almost exponential increase around 1990 which is still continuing based on the number of publications in this area. Today the research on mindfulness is differentiated into two main streams. Based on their origin, most researchers distinguish between the eastern mindfulness and the western mindfulness.

2.5.1 Eastern Mindfulness

The concept of mindfulness as used in the eastern mindfulness research stream was originally associated with esoteric beliefs and religion before the term was taken up by scientific researchers and translated into measurable terms. Rooted in Buddhist psychology and tradition the conceptualization the eastern mindfulness has evolved into a own research stream (Brown et al., 2007). Definitions of mindfulness in this context are for example provided by Brown and Ryan (2003) who have defined mindfulness as “a receptive attention to and awareness of present events and experience” or Dane (2011) who defines mindfulness as a state of consciousness that can be described as “being attentive to and aware of what is taking place in the present”. In this context, being mindful has been posited to help humans to become alive in the present moment as well as aware of their internal states. In line with this Buddhist based view on mindfulness other researchers suggest that mindfulness can help people to become mentally and physically healthier (Brown and Ryan, 2003). While there is a wealth of mindfulness definitions available, following the Buddhist tradition, most of them share three common elements (first: mindfulness can be learned or achieved by most people at one point or another; second: mindful individuals are attentive and focus on the present moment, the “here and now”; third, mindfulness involves paying attention to environmental as well as internal stimuli and phenomena) (Dane, 2011, Hyland et al., 2015). Next to the eastern mindfulness which is often times connected to meditation as means to achieve this state of mind there is also a second stream of empirics-based mindfulness research existing. This stream is called western mindfulness and is used as basis for this research.

2.5.2 Western Mindfulness

Complementary to the traditional definitions of Eastern mindfulness, Langer (1989a) conceptualized the psychological construct of mindfulness and with this created the foundation for the research stream which today is regarded as the western mindfulness. Mindfulness definitions following this research stream are characterised by active, mindful conceptualizing and have found their way into psychological-, clinical- but also managerial- and organizational-literature and research. Opposite to the eastern mindfulness which is often seen as means to develop self-knowledge and wisdom the western mindfulness research was triggered by mindless behaviour observed in events like an air plane crash caused by wrong tick marks of the pilots in the pre-take-off control checks or brain cancer diagnosed as senility just because the of the age of the patients. These and other largely observed mindless behaviour patterns triggered the interest of researchers in the mid 1970’s and lead to the discovery of the basic characteristics of mindfulness (Langer and Moldoveanu, 2000). In the beginning this research focussed on the discovery of what is causing mindless behaviour (Langer and Piper, 1987). Mindlessness here describes the human error in complex situations and can for example be observed in form of prejudice, stereotyping, usage of fixed categories or ignoring new information. Research found that, the causes for mindless behaviour patterns are various and reaching from repetition, practice, premature cognitive commitment and belief in limited resources to the influence of context. As these patterns influence each day of our lives, researchers started soon after their discovery to focus on the search for mitigations of mindless by promoting the opposite (mindful) behaviour.

In her book with the title “Mindfulness” Langer (1989a) provides several examples and research results from a psychological and medical view on mindlessness. Next to this she also describes how the research on “the costs of rigid mindsets and single-minded perspectives” gradually lead to looking at the positive side and by this the huge potential benefits of mindfulness for health, creativity and aging. The concept of mindfulness was especially convincing as Langer (1989a) found in her experiments that relatively small changes had dramatic effects and led to measurable decreases in problematic health symptoms. Until today, the potential benefits of mindfulness for employers and employees like increased creativity, productivity, innovation, leadership as well as satisfaction attract researchers as well as practitioners and ensure that this concept is still in focus (Oyler et al., 2022).

In the western mindfulness, which is primarily concerned with intra-personal cognitive processes, mindful individuals are considered as being conscious of the content as well the context of information. Langer (1989b) defines mindfulness in this regard as “a state of alertness and lively awareness“ which is represented by three specific behavioural patterns:

- The first one is the creation of new categories (alertness to distinction) for structuring problems instead of relying only on existing mental categories like for example old vs. young or success and failure. Mindful persons in this regard would not just try to make the best choice but to create new options.
- The second behaviour pattern is welcoming new information (openness to novelty) or active information processing as for example seen by people not following senseless or even harmful rules without rethinking.
- The third one is the application of different viewpoints (awareness of multiple perspectives) which goes beyond the application of new

information as for example seen by the invention of the post-it notes as a result of a failed glue invention.

Over time these three initial behavioural patterns have been extended by a fourth one which is described by a greater sensitivity to one's environment (sensitivity to different contexts) and a fifth which is the orientation in the present (Langer and Moldoveanu, 2000, Langer, 2000). While the interest of research into these psychological states was not new, as for example awareness of multiple perspectives has been studied under the title of dialectical thinking by cognitive-developmental psychologists, their combination into the term mindfulness is what makes the distinction to other psychological constructs (Sternberg, 2000). Furthermore, it is important to recognise that these behavioural patterns cannot be seen in isolation as they are often interconnected and pointing to each other (Langer, 2000). Also it must be noted that despite the fact that the cognitive state of mindfulness as defined by Langer (1989a) shows some fundamental differences from the Buddhist tradition of mindfulness-meditation some post-meditative states have been found supporting mindfulness (Brown and Ryan, 2003, Brown et al., 2007, Langer, 1989a, Dane, 2011).

While the definitions of the term mindfulness are selectively interpreted, depending on the researchers and their area of interest as found by Brown et al. (2007), the mindfulness definition provided by (Langer, 1989a, Langer, 1989b, Langer and Moldoveanu, 2000) has enabled the use of the mindfulness concept different contexts. One example for the application of the work of Langer (1989a) in a different context is the research of Weick et al. (1999) who transferred mindfulness into organizational mindfulness within the context of high reliable organizations (HRO). According to their definition mindful HRO's are preoccupied with failure, reluctant to simplify interpretations, sensitive to operations, committed to resilience and underspecify structures. In the recent years their definition of organizational mindfulness has further evolved to become the foundation of subsequent research in as for example (Swanson and Ramiller, 2004) apply organizational mindfulness to investigate aspects of information technology innovation. Other examples using organizational mindfulness are the research of Wolf et al. (2012) who apply organizational mindfulness to investigate the consequences of the bandwagon effect on IT innovation and Nwankpa and Roumani (2014) who investigate the role of organizational mindfulness on ERP (enterprise resource planning) system usage.

Still today the concept of mindfulness is actively used as recent research on the role of mindfulness on the intergroup bias or project management shows (Oyler et al., 2022, Daniel et al., 2022). Besides these recent examples from the area of organizational research the concept of mindfulness has also moved into the area of information system (IT) adoption. For example Roberts et al. (2007) investigated the role of mindfulness in IT adoption, usage, reliability and post adoption behaviour by modelling mindfulness as second order construct consisting of four first order factors (alertness to distinction, openness to novelty, orientation in the present, awareness of multiple perspectives). To summarise the development of the concept of mindfulness Table 7 below provides an overview on the different reviewed definitions of mindfulness in a chronological order before the next section discusses mindfulness in the context of technology adoption.

Mindfulness Definition / Concept	**Context**	**Eastern / Western**	**Author(s)**
“mindfulness involves active information processing”	Psychology	W	(Langer, 1989a)
“mindfulness is a state of conscious awareness in which the individual is implicitly aware of the context and content of information.”	Psychology	W	(Langer, 1992)
Preoccupation with Failure, Reluctance to Simplify Interpretations, Sensitivity to Operations, Commitment to Resilience, Under-specification of Structures	Organizational	W	(Weick et al., 1999)

"being mindful is the simple act of drawing novel distinctions"	Psychology	W	(Langer, 2000)
mindfulness implies "(1) a greater sensitivity to one's environment, (2) more openness to new information, (3) the creation of new categories for structuring perception, and (4) enhanced awareness of multiple perspectives in problem solving"	Psychology	W	(Langer and Moldoveanu, 2000)
"mindfulness/mindlessness probably is more similar to cognitive styles than it is to cognitive abilities or personality traits"	Psychology	W	(Sternberg, 2000)
"mindfulness is a receptive attention to and awareness of present moment events and experience"	Psychology	E	(Brown and Ryan, 2003)
"organizational mindfulness concerns the adaptive management of expectations in the context of the Unexpected"	IT Innovation	W	(Swanson and Ramiller, 2004)
"mindfulness involves the ability to detect important aspects of the context and take timely, appropriate actions"	IT Reliability	W	(Butler and Gray, 2006)
"mindfulness is a flexible cognitive state that results from drawing novel distinctions about the situation and the environment"	Psychology	W	(Carson and Langer, 2006)
mindfulness comprises "alertness to distinction, openness to novelty, orientation in the present, and awareness of multiple perspectives"	IT Usage	W	(Roberts et al., 2007)
"mindfulness is a flexible state of mind that is characterized by openness to novelty, sensitivity to context and engagement with the present moment"	Psychology	W	(Langer, 2009)
"mindfulness is a state of consciousness in which attention is focused on present-moment phenomena occurring both externally and internally"	Psychology	E	(Dane, 2011)
"organizational mindfulness implies a preoccupation with failure, a reluctance to simplify interpretations, a commitment to	Technology	W	(Teo et al., 2011)

resilience, sensitivity to operations, and reliance on expertise over formal authority”	Implementation		
“mindfulness is a psychological state of consciousness in which a person focuses on and is aware of the issues surrounding a technology adoption decision and occurring both internally and externally”	Technology Adoption	W	(Sun, 2011)
organizational mindfulness includes” preoccupation with failure, reluctance to simplify, sensitivity to operations, commitment to resilience and deference to expertise”	IT Innovation Assimilation	W	(Wolf et al., 2012)
“mindfulness is defined as an active state of mind characterized by novel distinction-drawing that results in being (1) situated in the present; (2) sensitive to context and perspective; and (3) guided (but not governed) by rules and routines”	Psychology	W	(Langer, 2014)
“organizational mindfulness refers to the degree to which an organization captures detail about emerging threats and creates the capability to promptly act on these details”	IT System Usage	W	(Nwankpa and Roumani, 2014)
“mindfulness of technology adoption (MTA) as a psychological state of consciousness in which a person focuses on and is aware of the issues surrounding a technology adoption decision”	Technology Adoption	W	(Sun et al., 2016)
Zen-informed mindfulness is to “recognize the fact of living in the midst of life as it is lived”	Technology Usage	E	(Akama et al., 2017)
“IT mindfulness as a dynamic IT-specific trait, evident when working with IT, whereby the user focuses on the present, pays attention to detail, exhibits a willingness to consider other uses, and expresses genuine interest in investigating IT features and failures”	Technology Adoption	W	(Thatcher et al., 2018)
mindfulness of adoption comprises “engagement with the technology, technological novelty seeking , awareness of local context, cognizance of alternative	Blockchain Implementation	W	(Verhoeven et al., 2018)

technologies, anticipation of technology alteration”			
“mindfulness in organizations is based on five interrelated processes: preoccupation with failure, non-simplified interpretations, sensitivity to operations, commitment to resilience, and deference to expertise”	Organizational Mindfulness	W	(Vu et al., 2018)
“mindfulness is a state of alertness and lively awareness”	Mobile Payment	W	(Chokkannan, 2020)
“mindfulness of adoption”	Blockchain Adoption	W	(Rijanto, 2021)
mindfulness “includes awareness of internal and external experience”	Organizational Mindfulness	W	(Choi et al., 2022)
“mindfulness is both mindful conceptualizing and mindful attention”	Project Management	E	(Daniel et al., 2022)
“the practice of maintaining a non-judgmental state of heightened or complete awareness of one's thoughts, emotions, or experiences on a moment-to-moment basis”	Dictionary	E	(Merriam-Webster, 2022)
mindfulness allows individuals to notice their thoughts and emotions with a non-judgmental orientation, which allows them to refrain from being defensive toward others	Organizational Mindfulness	W	(Oyler et al., 2022)

Table 7 - Mindfulness Definitions

2.5.3 Mindfulness and Technology Adoption

By applying mindfulness, the field of technology adoption researchers seek to understand its role in avoiding economic expense within technology adoption processes. The interest in mindfulness and especially in combination with information technology is reflected by the interest of public magazines like “TIME” or “the Economist” but also by business schools adding mindfulness into their curriculum (Thatcher et al., 2018). Triggered by phenomena such as technological hype or the bandwagon effect, organizations have tended act mindlessly and to adapt technologies without objectively considering if a technology is appropriate for the particular use or not (Verhoeven et al., 2018). Mindlessness in organizations, especially when adopting IT technology is a largely observed phenomenon. Examples for this can be seen by organizations jumping into highly advertised cloud operations models, considering the use of quantum computers without real use cases or embarking into diverse blockchain projects as outlined above. Mindlessness and the neglection of technology implementation costs while overestimating the benefits are likely to lead to sunk cost in terms of abandoned projects, frustrated users and organizational confusion.

The psychological construct of mindfulness can be used to address this mindlessness in IT adoption by considering factors that describe whether the decision to adopt a technology is objectively reasonable and therefore, well thought out (Sun et al., 2016). For this purposed, the initial definitions of mindfulness as provided by (Langer, 1989a) have recently been adapted by different subsequent researchers like Sun et al. (2016) to reflect a “mindfulness of technology adoption” state, or by Thatcher et al. (2018) to conceptualise an “IT mindfulness” trait. The review of 64 studies using the concept of mindfulness by Dernbecher and Beck (2017) shows that the concept of mindfulness can be successfully used as prerequisite, as accelerator or as implication within theories and models, which demonstrates its wide applicability. In the context of technology adoption for example, the research of Sun (2011), Sun et al. (2016) has confirmed that mindfulness can be a critical factor in technology adoption as it helps to ensure choosing a technology that will be a good fit to address the problem at hand. Recently, the mindfulness concept has also been used in the context of blockchain when, for example, Verhoeven et al. (2018) investigated the mindfulness of blockchain adoption by assessing five blockchain use cases from the logistics and supply chain management (LSCM) field. Another example in this field is provided by Rijanto (2021) who applied mindfulness for his research on patterns of business financing in the area of blockchain adoption in the agricultural industry sector. Table 8 below summarises the reviewed research on mindfulness in the IT and technology adoption context.

Research Context	Unit of Analysis	Mindfulness Definition / Concept	Author(s)
Blockchain adoption	Organizational	Mindfulness of adoption	(Rijanto, 2021)
Acceptance of social media policy change	Organizational	Adaptive acceptance	(Lannacci et al., 2021)
Mobile payment adoption	Individual	IT mindfulness based on (Thatcher et al., 2018)	(Chokkannan, 2020)
Blockchain adoption use cases in LSCM	Organizational	Mindfulness of technology adaption	(Verhoeven et al., 2018)
IT system post-adoption	Individual	IT mindfulness	(Thatcher et al., 2018)
Mindfulness in technology adoption	Individual	Mindfulness of Technology Adoption	(Sun et al., 2016)
Influence of organizational trust and organizational Mindfulness on ERP systems usage	Individual	Organizational mindfulness	(Nwankpa and Roumani, 2014)
IT innovation assimilation	Individual	Organizational mindfulness	(Wolf et al., 2012)
Mindfulness in technology adoption	Individual	Mindfulness of Technology Adoption	(Sun, 2011)
Stakeholder oriented mindfulness in a case of RFID implementation	Organizational	Stakeholder oriented mindfulness	(Teo et al., 2011)

Using information technology mindfully	Individual	Mindfulness based on (Langer, 1989a)	(Roberts et al., 2007)
Organizations mindful IT innovation	Organizational	Mindfulness in IT Innovation based on (Weick et al., 1999)	(Swanson and Ramiller, 2004)

Table 8 – Mindfulness in Technology Adoption

As mindfulness provides a valid operational definition it allows to measure the degree of reasonability for technology adoption decisions from an individual but also organizational perspective. Further, as it was successfully used in research similar this, it is seen as perfect fit for complementing the UTAUT technology adoption model and support the objectives of this research. Although, different variations of the mindfulness concept have been successfully used to represent the awareness of the technology in general, they do not necessarily reflect the role of technology characteristics as required for this research. Researchers like Langer (2014), Sun et al. (2016), Thatcher et al. (2018) commonly consider mindfulness as a second-order construct, consisting of four first-order dimensions. As these existing definitions cannot fully reflect the particular interest into the role of technology characteristics in organizational blockchain adoption for this research, the concept of technology feature mindfulness is defined next.

2.5.4 Technology Feature Mindfulness

In line with Langer (1989a), Langer (2014), this research project defines the concept of technology feature mindfulness as a conscious psychological state which comprises the four dimensions technology understanding (1), technology uniqueness (2), openness to alternative use (3) and technology environment awareness (4) as shown in Figure 13 below.

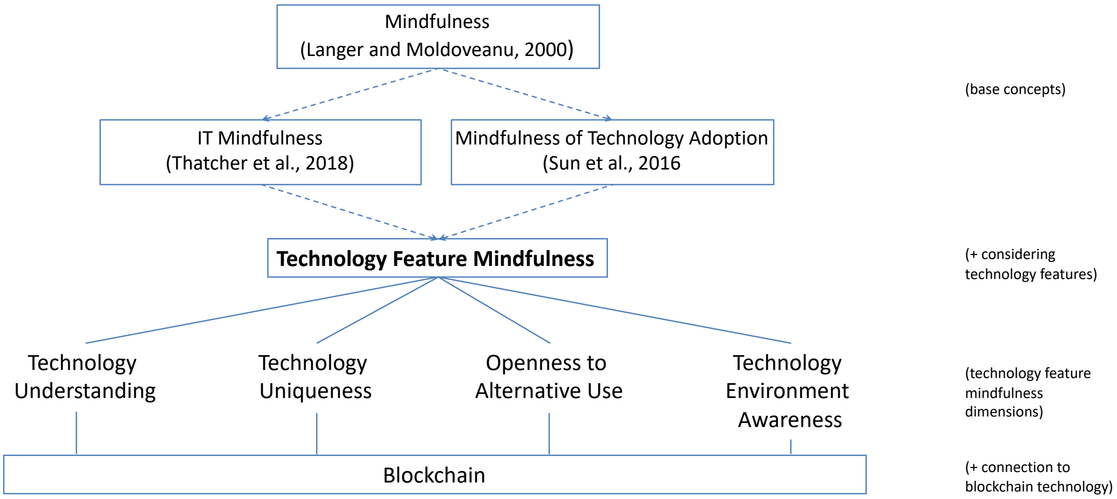


Figure 13 - Technology Feature Mindfulness

1. The dimension of technology understanding is defined as an organization's awareness and attention towards blockchain technology. It includes the active gathering of information about the technology and reflects an organizations willingness to understand the functionality, features and benefits of the technology (Sun et al., 2016).
2. The dimension of technology uniqueness is defined as an organization's awareness of the unique characteristics or features of the technology such as record immutability, record aggregation, anonymity, record validation via distributed consensus (disintermediation) and decentralization in the case of blockchain. It also allows technologies to be distinguished, as in, for example, relational databases, non-SQL databases and blockchain, where the actual differences a cannot be seen without going into the technical details.
3. The dimension of openness to alternative use is defined as an organization's awareness of alternative applications of the technology, and their potential advantages and drawbacks. So, for example other use cases for blockchain technology than crypto currencies.
4. The dimension of technology environment awareness is defined as an organization's awareness of the implications introduced by the technology environment. It implies that organizations are conscious of

the way the technology (in this case blockchain technology) might support their work, as well as the inconveniences the adoption of the technology might impose.

The above defined first-order dimensions of technology mindfulness are based on the mindfulness dimensions provided by previous scholars, especially (Langer and Moldoveanu (2000),Sun et al. (2016) and Thatcher et al. (2018)) which have been adapted in order to reflect the particular interest of this thesis. Table 9 below provides an overview on the dimensions which were used by preceding scholars used to characterise mindfulness.

Mindfulness Dimensions			
Mindfulness (Langer and Moldoveanu, 2000)	**Mindfulness of Technology Adoption (Sun et al., 2016)**	**IT Mindfulness (Thatcher et al., 2018)**	**Technology Feature Mindfulness (this study)**
active information seeking and processing	engagement with the technology	openness to novelty	technology understanding
constant creation of new categories	technological novelty-seeking	alertness to distinction	technology uniqueness
awareness of multiple perspectives	cognizance of alternative technologies	awareness of multiple perspectives	openness to alternative use
awareness of local specifics	awareness of local contexts	orientation in the present	technology environment awareness

Table 9 - Mindfulness Dimensions

As technology mindfulness is a second-order construct, it is necessary to measure the different sub-constructs to capture an organization’s behaviour with regard to mindfulness (Sun et al., 2016). Prior research has shown that mindfulness can be regarded as a trait or state variable and that both paths can lead to valuable insights (Butler and Gray, 2006, Dane, 2011, Sun et al., 2016). For this study, mindfulness is regarded as a psychological state as it focuses on how the different dimensions of technology mindfulness influence a specific behaviour at a given moment in time. The specific adaptions of the above defined technology mindfulness dimensions and their explicit links towards blockchain technology are provided in Section 2.8. To summarise the theoretical roots Figure 14 below provides an overview on the underlying mindfulness literature.

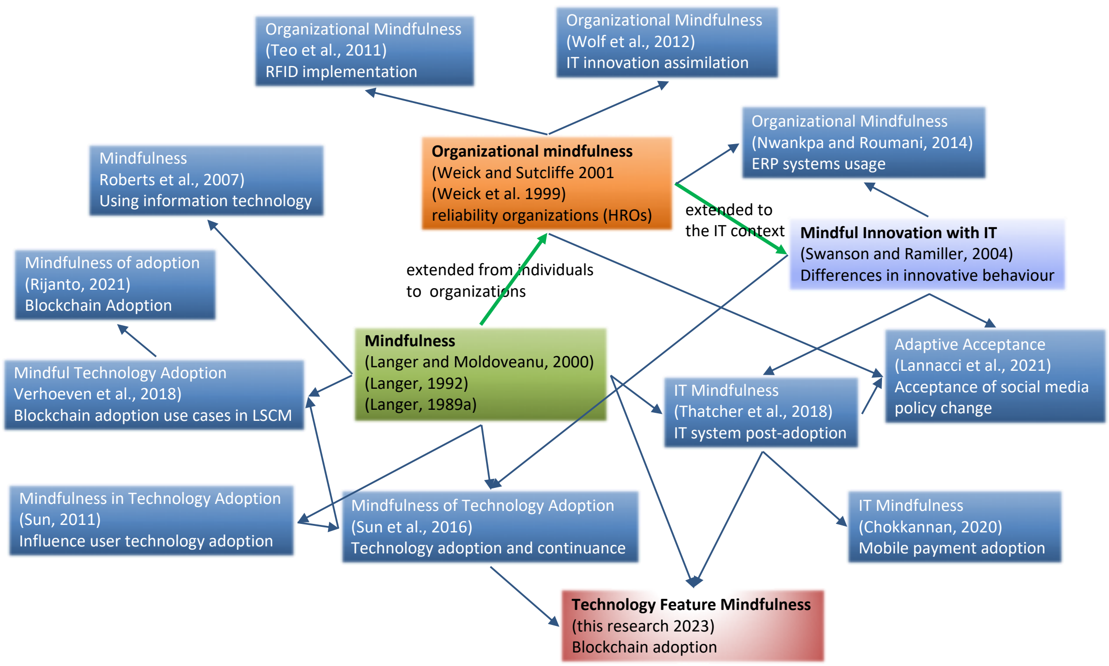


Figure 14 - Mindfulness Literature Map

The next section provides a summary of this literature review and the main gaps found.

2.6 Literature Review Summary

Starting with emerging technologies, this literature review demonstrates that blockchain possesses all the characteristics of an emerging technology. However, whether a technology is seen as emerging or simply new depends on the organizational context. Based on this definition, the literature on blockchain reveals its high complexity, unique benefits, and limitations. Notably, the review of blockchain applications highlights the limited success of these applications, suggesting issues in the organizational adoption of this emerging technology.

Despite extensive research in this field, the role of technological characteristics in the organizational adoption of blockchain applications remains largely unexplored. This gap leaves the technological foundation of blockchain benefits underexamined, as most research has focused on blockchain as a whole rather than its application in organizational contexts. Additionally, the detailed review shows that most blockchain applications utilize only a small subset of blockchain's core features, limiting the potential benefits these applications can deliver. This supports the view that there is a significant gap in understanding how blockchain technology can be fully leveraged within organizations.

The subsequent review of technology adoption literature reveals that, despite numerous robust theories and models, there is no existing model that considers the role of technology features or characteristics as factors influencing adoption. While research has explored organizational intentions to adopt new technologies like blockchain in various contexts, such as by country or industry, there is a lack of focus on how technical capabilities influence adoption behaviour and use within organizations. A recent review of blockchain adoption studies by AlShamsi et al. (2022) confirms this gap, noting that the most commonly cited external factors influencing blockchain adoption are trust, perceived cost, social influence, and facilitating conditions. However, no research has yet examined the role of technological capabilities in this context.

Moreover, the potential benefits of blockchain, such as enhanced transparency, improved traceability, and increased efficiency, need to be clearly demonstrated within the organizational context to justify the investment. Organizations must assess whether these benefits align with their strategic objectives and operational requirements. This necessitates a deeper exploration of how blockchain's technological capabilities can be harnessed to address specific organizational challenges and opportunities.

The lack of a comprehensive model that incorporates the technological features of blockchain into the adoption framework highlights a significant research gap. Addressing this gap requires a multidisciplinary approach, combining insights from information systems, organizational behaviour, and technology management. By developing a model that considers both the technological and organizational dimensions of blockchain adoption, this research aims to provide more practical guidance for organizations looking to implement this technology.

Thus, informed by this theoretically and practically relevant problem, the next section provides the conceptual framework for this research, focusing on the organizational context and the role of technological capabilities in blockchain adoption. This framework aims to bridge the gap between the potential benefits of blockchain technology and its actual utilization within organizations, offering a more nuanced understanding of the factors that drive successful adoption.

2.7 Conceptual Framework and Research Propositions

The conceptual framework[7] of this thesis aims to establish the theoretical base for exploring the role of technology features in the adoption of blockchain technology. According to the extant literature, firms introduce new information technology applications (e.g. blockchain applications) either to create new processes or to improve existing ones, while the overall objective behind these activities is the creation of additional value (Schiavi and Behr, 2018, Verhoeven et al., 2018). New IT applications support these objectives based on their technical capabilities: e.g. being more secure, faster or more reliable (Carrillo and Gaimon, 2002). The actual benefit for a firm resulting from the introduction of a new information technology application emerges from the actual technology adoption by the users, who leverage the technical capabilities of the new technology application. The ongoing slow adoption of blockchain suggests

[7] The conceptual framework describes the general direction and constraints of this research and represents the empirical relationships between every aspect of inquiry.

that this technology has, until now, been poorly understood and emphasises the need for a better understanding of the factors influencing its adoption (Salem, 2019). Although recent research has started to attend the area of blockchain adoption, current studies do not address the need to explore the potential influence of technological characteristics as factors that influence the intention to adopt that technology (Alazab et al., 2020, Queiroz et al., 2020, Salem, 2019, Wong et al., 2020). As technology adoption behaviour is based on assumptions and understanding of the technology, it is important to recognise technical understanding as a crucial input influencing user behaviour when analysing blockchain adoption. For this purpose, the UTAUT model has been combined with the concept of technology feature mindfulness (TFM).

2.7.1 Framework Integration

The UTAUT has proved, in several studies, its statistical robustness by being able to explain the behavioural intentions and use behaviour for technology adoption based on generic input constructs such as “performance expectations”, “social influence” and “facilitating conditions”. The combination of these with previously defined technology mindfulness dimensions adds factors that describe whether the decision to adopt a technology is based on technical background knowledge and, therefore, is objectively reasonable and thought out. Integrating technology feature mindfulness with the Unified Theory of Acceptance and Use of Technology (UTAUT) model offers a comprehensive framework to better understand blockchain adoption. Combining both models might allow gaining deeper insights into how organizations perceive and adopt blockchain technology.

Overall, being mindful enhances an organization's understanding of blockchain technology, leading to a more accurate perception of its technical characteristics and usefulness. When organizations approach blockchain with mindfulness, they critically evaluate its specific technical benefits and potential applications. This critical evaluation ensures a better alignment between blockchain's capabilities such as immutability, decentralization, and enhanced security and the organization's needs. Mindfulness also influences how organizations perceive the complexity of blockchain technology. By being fully present and attentive, organizations can better learn and understand the intricate details of blockchain systems. This focused attention reduces the perceived effort required to implement blockchain, making its technical complexity seem less daunting and more accessible. Mindful organizations are more likely to engage in continuous learning and problem-solving, which helps mitigate initial difficulties and improve the overall ease of use of blockchain. Furthermore, mindfulness in organizations also helps maintain a balanced perspective on social influences. Mindful organizations are less likely to be affected hype behaviour or peer pressure surrounding blockchain and more likely to make decisions based on a comprehensive understanding of its actual technical value. By fostering a reflective mindset, mindfulness encourages organizations to critically assess social influences and make informed decisions rather than conforming to trends without proper evaluation. The above discussed aspects highlight the importance and benefits of a mindful approach to evaluating the performance, social influence, and facilitating conditions related with blockchain technology. The next section summarises the theoretical background of this research.

2.7.2 Theoretical Background

The theoretical background of this study draws on the literature regarding technology acceptance models, blockchain and information systems. In recent years, many theories and models have been created to study the factors that influence user behaviour towards a certain technology like blockchain, as well as the main influences that determine the decision to accept and use it (Lai, 2017, Taherdoost, 2018). Examples of this are the TAM, TPB and the UTAUT. In particular, the UTAUT as a multi-model theory which aims to combine the benefits of different theories has increasingly drawn the attention of researchers and found wide application in various studies covering different areas of research, such as e-commerce, mobile banking and blockchain (Attuquayefio and Addo, 2014, Dwivedi et al., 2020, Queiroz et al., 2020). As the model outperforms the eight individual base theories, UTAUT has recently been used intensively in the context of blockchain, mainly aiming to explain the reason for its ongoing slow adoption, which is similar to this research. For example, Queiroz and Fosso Wamba (2019) have combined UTAUT components with the network theory to investigate blockchain adoption challenges in the supply chain field and Salem (2019) has extended the UTAUT by introducing trust and perceived risk as additional exogenous factors to assess blockchain adoption. Further, Alazab et al. (2020) have integrated components of the TTF model, the ISS model, as well as UTAUT-based blockchain efficiency and IT innovation to investigate blockchain adoption in supply chains. Also, Khazaei (2020) has extended the UTAUT by adding the external constructs of perceived security, perceived trust and technology awareness to explain the adoption of blockchain among Malaysian SME's. While factors like trust and risk have gained some attention in the context of blockchain adoption, the role of its technical characteristics has still been left almost unattended. Based on this theoretical background the next section outlines the proposed research model.

2.8 Research Model

This research combines dimensions of the concept of technology feature mindfulness with components of the UTAUT to propose the conceptual model as shown in Figure 15. This model establishes the theoretical guidelines which allow an assessment of the role of technological characteristics for the acceptance of blockchain technology. From the original UTAUT, the moderator variable "experience" is excluded based on the novelty of blockchain and the chosen cross-sectional research design. The same holds true for "voluntariness of use", which is also not included as the use of blockchain is, per se, considered voluntary (Alazab et al., 2020, Salem, 2019). Also, the two other moderator variables (gender and age) from the original UTAUT (see Figure 12) are excluded as they have been found to cause only minimal variation in the adoption and use of technology (Queiroz and Fosso Wamba, 2019, Dwivedi et al., 2017). In addition, the "effort expectancy" construct is excluded from this research model as, for example, Batara et al. (2017) found in their recent study on e-government adoption in Indonesia that "effort expectancy" does not support the prediction of behavioural intention. This is further supported by Oliveira et al. (2014), who analysed the adoption of mobile banking systems and who also found the UTAUT construct “effort expectancy” was not statistically significant in explaining behavioural intentions. The research aim of understanding factors related to the lack of success of blockchain implies that this technology is not widely used. Therefore, the construct of “usage behaviour” is also excluded from the research model (Batara et al., 2017, Oliveira et al., 2014, Queiroz and Fosso Wamba, 2019). The relationship between “facilitating conditions” and “usage behaviour” in the original UTAUT is redirected to “behavioural intention” based on supporting theoretical and empirical findings which strongly suggest this connection (Ajzen, 1991, Taylor and Todd, 1995, Eckhardt et al., 2009, Dwivedi et al., 2019b). Overall, modifying the UTAUT model is a commonly used approach as, for example, Venkatesh et al. (2012), Dwivedi et al. (2019b), Alalwan et al. (2017) found that most studies use only a subset of the original UTAUT model, and they also, typically, exclude the moderator variables.

To allow an analysis of the role of technology characteristics for blockchain adoption, the modified UTAUT model is complemented by the dimensions of technology feature mindfulness, which comprise “technology understanding”, “technology uniqueness”, “openness to alternative use” and “technology environment awareness”. Although these dimensions are based on considerations from the concept of mindfulness, they are used separately here and are directly connected to the UTAUT dimensions, as shown in Figure 15 below.

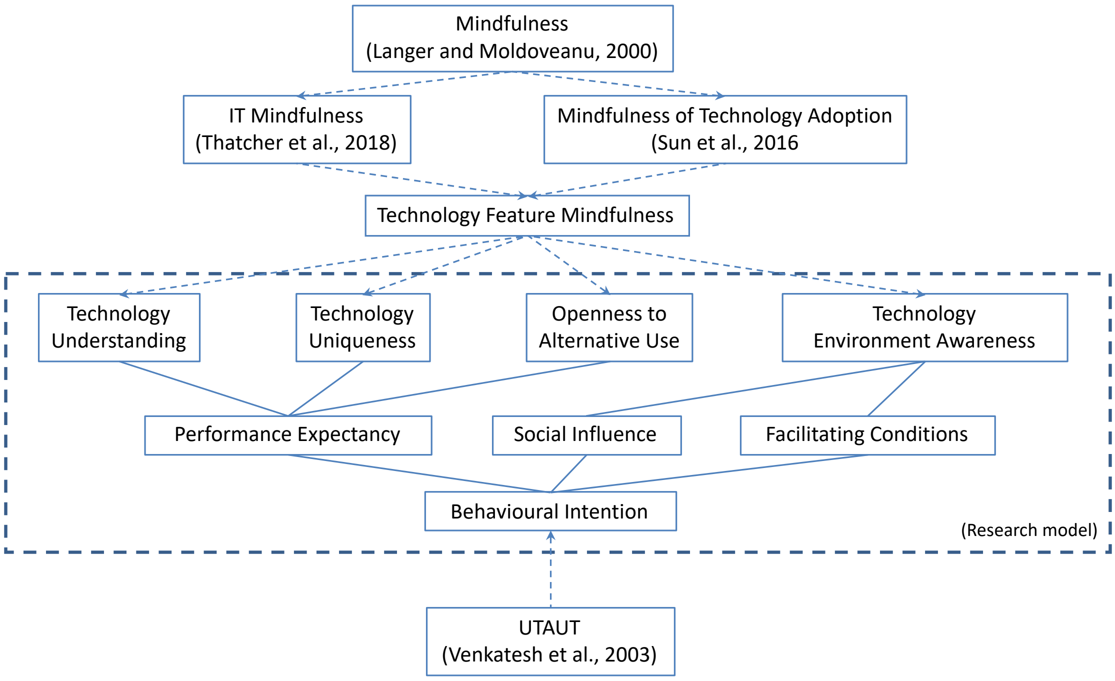


Figure 15- Proposed Research Model

Based on this proposed research model, the next sections outline details of different exogenous factors and how they are expected to be connected to the other elements of the research model, starting with the UTAUT factor of "behavioural intention".

2.8.1 Behavioural Intention

Behavioural intention, in general, describes the willingness to use a new technology. Warshaw and Davis (1985) have defined behavioural intention as "the degree to which a person has formulated conscious plans to perform or not perform some specified future behaviour". For this research, behavioural intention refers to an organization's will to use blockchain technology. The motivation to use a new technology is triggered by the internal evaluation of the behaviour (Venkatesh et al., 2008). Thus, behavioural intention is likely to influence the use of technologies (Venkatesh et al., 2003, Queiroz and Fosso Wamba, 2019). However, the aspect of "use of technology" is beyond the scope of this thesis as prior to analysing the use of blockchain technology, a better understanding of the current lack of success and limited adoption is needed, which is the focus of this research. The first factor influencing the behavioural intention in the model is performance expectancy which is defined next.

2.8.2 Performance Expectancy

Performance expectancy is defined as “the degree to which an individual believes that using the system will help him or her to attain gains in job performance” (Venkatesh et al., 2003). For this research context, performance expectancy refers to the degree to which organizations who adopt blockchain technology believe this it will improve their productivity and performance. Blockchain applications have generated high expectations in terms of improvements, ranging from efficiency and security to product quality and other key process improvements (Kshetri, 2018, Treiblmaier, 2018). Prior research using UTAUT has reported that the intention to use and adopt a technology depends significantly on performance expectancy (Alazab et al., 2020, Queiroz et al., 2020, Chokkannan, 2020). Therefore, performance expectancy is directly connected the behavioural Intention to adopt blockchain. Based on previous research it is also expected performance expectancy that positively affect the behavioural Intention to adopt blockchain. Next the UTAUT construct of social influence is defined.

2.8.3 Social Influence

Social influence describes the extent to which individuals perceive that important others believe they should use a new system (Venkatesh et al., 2003). Prior research shows that users consult peers, family and friends about new technologies and their experience with those which can influence their behavioural intention with regard to technology adoption (Salem, 2019, Queiroz and Fosso Wamba, 2019). For this research social influence refers to perceived importance of other opinions for the intension to adapt blockchain technology from an organizational perspective. Recent studies have shown the importance of social influence for technology adoption like the research of Batara et al. (2017) who show its key role for the adoption of e-government services or the work of Zhang et al. (2018) in the area of the adoption of Internet-based banking. These positive effects of social influence on behavioural intension are expected to be confirmed by this research. Therefore, social influence is directly connected to behavioural intension and is expected to positively affect the behavioural intention to adopt blockchain. The third factor from the original UTAUT influencing behavioural intention are the facilitating conditions.

2.8.4 Facilitating Conditions

Facilitating conditions indicate “the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system” Venkatesh et al. (2003). In the context of this research, facilitating conditions reflect the awareness of available resources to support and promote the use of blockchain. Previous research has found that facilitating conditions (e.g. computers, internet speed, integration with other systems) influence the adoption and use of a technology (Venkatesh et al., 2003, Venkatesh et al., 2012, Sabi et al., 2016, Oliveira et al., 2014, Queiroz and Fosso Wamba, 2019). Thus, a satisfying level of technical and organizational support for using blockchain technology is expected to have a direct positive influence on use behaviour. As in the original UTAUT, facilitating conditions is directly connected to the behavioural intention and is expected having a positive effect on behavioural intention to adopt blockchain.

Taking the modified UTAUT as a basis, the next sections outline the relationships to the elements from the TFM model, starting with a definition of “technology understanding”.

2.8.5 Technology Understanding

Technology understanding is defined for this research as comprising an organization’s awareness and attention towards blockchain technology. It includes the active gathering of information about blockchain technology and reflects an organization’s willingness to understand the functionality, features and benefits of blockchain technology (Sun et al., 2016). Studies have shown that knowledge of the characteristics and benefits of technology (technology awareness), for example, significantly influence the adoption of e payment systems (Abubakar and Ahmad, 2013, Rehman et al., 2012, Mohamad and Kassim, 2019). Technology understanding leads to a comprehensive and realistic view of technology features and functions as well as the creation of trust in the technology, which is based on beliefs in functionality, helpfulness and reliability (Mcknight et al., 2011). Technology understanding is expected to lead to more realistic expectations concerning performance expectancy and, therefore, positively relates to this dimension of the UTAUT for blockchain adoption. Thus, technology understanding is directly connected to performance expectancy and expected having a positive effect on performance expectancy for blockchain adoption. Next the aspect of technology uniqueness is defined.

2.8.6 Technology Uniqueness

Technology uniqueness is defined for this research as the extent to which an organization is engaged in constantly comparing blockchain technology to existing technologies to identify and understand its uniqueness (Verhoeven et al., 2018). It allows organizations to recognize nuanced differences in the new technology compared to alternative technologies, which leads to more realistic expectations regarding its advantages and disadvantages (Langer, 1989a). In this research context, technology uniqueness reflects an organization's awareness of the unique characteristics or features of blockchain technology such as record immutability, record aggregation, anonymity, record validation via distributed consensus (disintermediation) and decentralization. It allows technologies to be distinguished, as in, for example, relational databases, non-SQL databases and blockchain, where the actual differences a cannot be seen without going into the technical details (Sun et al., 2016). It further enables an organization to understand the detailed context in which the technology and its applications may prove useful, which allows for the discovery of eventual inconsistencies between the use of the technology and its potential (Thatcher et al., 2018, Langer, 1989a). The understanding of the uniqueness of a new technology, is expected to positively affect the aspect of performance expectancy from the UTAUT. Therefore, technology uniqueness, is directly connected to the performance expectancy for blockchain adoption. This definition of technology uniqueness is followed by the definition of openness to alternative use.

2.8.7 Openness to Alternative Use

Openness to alternative use is defined as an organization's awareness of alternative views regarding a new technology and its use (Roberts et al., 2007). It allows an organization to identify different concepts about how a technology might be used and to understand the value of each potential use (Thatcher et al., 2018). Thus, recognizing different potential applications of blockchain feature sets enables "using features in new ways, which may not have been intended by the developer" (Sun, 2012). However, in order to be able to do so, the organization must of course be aware of unique features of blockchain technology such as decentralization or record aggregations. In this research context, openness to alternative use describes an organization's awareness of alternative applications of blockchain technology, and their potential advantages and drawbacks. It also includes openness to exploring new features of a technology and curiously experimenting in the interaction with it or with an application (Thatcher et al., 2018). This balanced and flexible view on the potential use of a new technology includes having a "big picture" of the technology and it helps to avoid over- and underestimating its advantages and disadvantages (Sun et al., 2016). Openness to alternative use is expected to support an appropriate adoption of technology to a specific context which leads to a good task-technology fit and, so, positively affects performance expectancy from the UTAUT (Goodhue and Thompson, 1995). Therefore, openness to alternative use is connected to the performance expectancy for blockchain adoption. Finally, the technology feature mindfulness construct of technology environment awareness is defined.

2.8.8 Technology Environment Awareness

The dimension of technology environment awareness describes an organization's recognition and alignment with the specific tasks, as well as the technical and the organisational environment connected to the adoption of blockchain (Sun et al., 2016). It allows organizations to recognise the different environmental conditions, which include aspects such as the available technical support, potential stakeholder reactions and technical compatibilities (Verhoeven et al., 2018). Technology environment awareness implies that organizations are conscious of the way blockchain technology might support their objectives, as well as the inconveniences the adoption of blockchain technology might impose. It is expected to positively affect the factors of social influence and the facilitating conditions of the UTAUT. Therefore, technology environment awareness is connected to social influence and facilitating conditions for blockchain adoption.

The above-proposed research model is evaluated via a qualitative approach using a multiple case study design based on semi structured interviews. Table 10 below outlines some expected findings based on the literature review before the next chapter provides details on the research design.

Construct	Influence on Blockchain adoption
Behavioural Intention	The interviewees will have some clear intention to implement blockchain technology in their companies.
Performance Expectancy	It is expected to find very high and strong expectations towards the performance of blockchain technology based on the hype around it.
Social Influence	High level managers might be only weakly considering their social context when considering blockchain adoption.
Facilitating Conditions	The existence of facilitating conditions for blockchain implementation is expected to be presumed positively.

Technology Understanding	It is expected that the decision takers are actively informing themselves about blockchain technology and that they possess a good level of understanding.
Technology Uniqueness	It is expected that the interviewees don't know the technical details and differences of blockchain technology towards other technologies – so they will give this aspect a low priority and do not consider that other technologies might be better suited for the purpose.
Openness to Alternative Use	It is expected that there is very low awareness towards other use cases and that the willingness to explore those is also limited.
Technology Environment Awareness	The impact of blockchain technology toward the existing solutions in the company is expected to be ignored mostly.

Table 10 – Construct Matrix

3 Research Design and Methodology

By answering the research question “How does the awareness of distinct blockchain characteristics influence the behavioural intention to adopt blockchain technology?”, this research aims to explain the ongoing slow adoption of this technology. To achieve this objective, the above-outlined research model is verified by using primary data which is collected using semi structured interviews with blockchain practitioners. The newly established relationships and positions can help to facilitate the success of blockchain implementations (Glaser, 2017). To meet the scientific requirements with regard to methodological research next, a robust research design is created which starts with the choice of a philosophical worldview (Creswell, 2009b).

3.1 Philosophical Worldview

The choice of a philosophical worldview is inevitably connected to the process of methodological research engagement as this is based on particular philosophical commitments which have implications for the research design. For a researcher, it is particularly important to be explicit about the chosen worldview to be able to argue why certain methods have been chosen and defend against threats to their research validity (Petersen and Gencel, 2013). The worldview is a basic belief system that influences the practice of research and acts as a roadmap for the researcher (Guba and Lincoln, 1994). There are four alternative philosophical world views (also referred to as paradigms or epistemologies and ontologies) discussed by Creswell (2009b) and widely used in literature (see Table 11). To justify the actual choice, these world views are briefly discussed below.

	Philosophical Worldview
1	Positivism
2	Interpretivism
3	Realism
4	Pragmatism

Table 11 - Philosophical Worldviews

The first world view discussed here is the positivism paradigm which is related to a philosophy seeking an objective reality, as used by natural scientists. It is based on a deterministic approach where causes determine effects or outcomes. Knowledge is developed through a lens that is based on careful observation and measurement of objective reality (Creswell and Creswell, 2017). Positivists aim to model the world, and so to predict and control it (Guba and Lincoln, 1994). Within this paradigm, the research which is undertaken aims to be value-free, as far as possible, and to exclude the researcher's subjective impact on the research results. According to Petersen and Gencel (2013), a positivist world view should be replaced by a post-positivist world view, which appreciates the view that evidence is always imperfect and error-prone. Therefore, instead of proving a theory, a post-positivist researcher identifies the failure to reject a proposition. For both streams within the positivist paradigm, the most common research methods are case studies, surveys and experiments. However, a positivistic view cannot be applied for this research as the reasons and factors influencing the behavioural intention of persons deciding on blockchain adoption cannot be observed directly.

In contrast to this the interpretivist world view (also referred to as constructivist word view or constructivism) aims to explain and understand the subjective reality experienced by individuals. In a interpretivist view knowledge itself is a human construction and there is no absolute truth but only a relative and subjective interpretation (Guba and Lincoln, 1994). Interpretivist research often focusses on human interaction and relations in a specific context. It explores how people routinely use language to shape and construct social realities (Creswell and Creswell, 2017). Following Thornhill et al. (2015) it is crucial for interpretivist researchers to enter the world of the research subjects and take an empathic view to understand their world from their point of view. Interpretivist researchers aim to explain the meanings others have about the world and their pattern of meaning (Creswell, 2009b). Based on the aim of this research to understand of the role of technology characteristics within blockchain adoption by using a case study strategy, the interpretivist paradigm is seen as the best fit for the purpose of this research. This in line with Saunders et al. (2009) who state that an interpretivist perspective is highly appropriate in fields of organisational behaviour which fits very well when aiming to understand of the role of technology characteristics within blockchain adoption.

In contrast to the above, researchers applying a realist world view are guided by the belief that research needs to be linked with politics and a political agenda (Creswell, 2009b). Research based on the realism world view "contains an action agenda through intervention for reform that may change the lives of the participants" (Petersen and Gencel, 2013). Realist research advances an agenda for change to improve the lives of the individuals involved by providing a voice and raising awareness. Based on this, the realism worldview is not considered for the purpose of this research.

This also holds true for the pragmatist world view, which focuses on the research problem rather than methods. It allows the use of all available approaches to understanding the problem and is found to be inappropriate for this research. This is especially so, as the focus of the pragmatist researcher is problem-centred, concentrating on actions, situations, and consequences while applying mixed methods. By this definition the pragmatist worldview does not fit to the purpose of this research.

This short review of the different world views shows that the constructivist world view best fits the purpose of this research. As technology adoption decisions in organizations are taken by human individuals it the subjective reality which defines these decisions. Further, the organizations subjective reality itself is based on knowledge and experiences. This perfectly connects to the focus of this research which is concerned with exploring the role of technology features for blockchain adoption as this is one special aspect of knowledge about blockchain technology.

Based on the chosen wold view, next, the general strategy of inquiry is discussed.

3.2 Strategy of Inquiry

The general research strategy for this study follows the research onion model of Thornhill et al. (2015) shown in Figure 16 below.

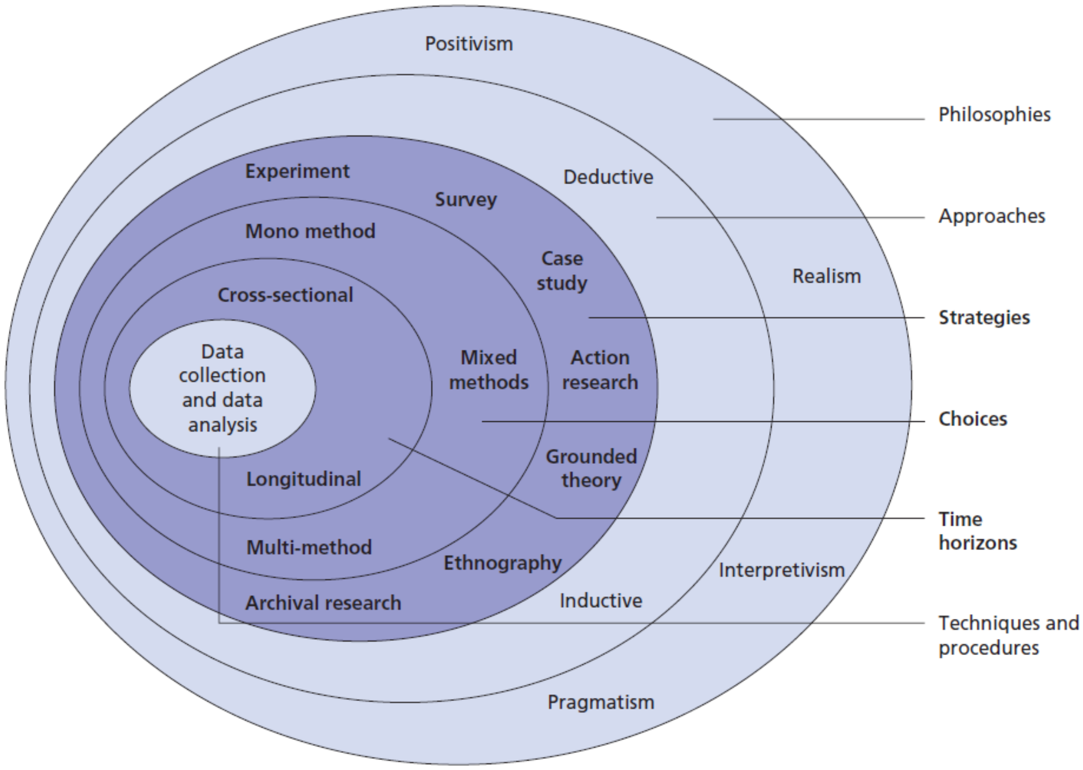


Figure 16 - Research Onion; source: Thornhill et al. (2015)

The next sections explain the particular choices within this research strategy. Following the model top down, the next step, after choosing a world view, is the choice of the research approach.

3.2.1 Deductive Approach

For this research clearly, a deductive approach is applicable as it aims to test a research model which is based on existing and proven theories versus creating new theory which is done with an inductive approach. The chosen deductive approach is seen as the best fit for the purpose of this research as it is following a structured and systematic approach to test the proposed research model. Contrary to this, an inductive approach would follow the stages of observation, pattern recognition and theory development which is not seen as appropriate as blockchain adoption is just one case of technology adoption and not a completely new or unknown phenomenon. Therefore, based on the proposed research model, the factors and drivers influencing the decisions to adopt blockchain technology are analysed. In addition to the objective of bringing new insights through qualitative data collection, this work is also testing the proposed research model and the commonly adopted assumptions on the drivers for technology adoption. Nevertheless, it must be noted that analysing the drivers for blockchain adoption might lead to alternative research outcomes, which is seen as a main limitation of an deductive approach according to Saunders et al. (2009). Therefore, a mix between deductive and inductive approaches was considered, but not followed due to the time and resource limitations of this work.

Based on this, the next section explains the choice of the case study approach as the research method.

3.2.2 Case study approach

In general, there are 5 main approaches in qualitative research. These are biography, ethnography, phenomenology, grounded theory, and case study. For this research a case study approach was chosen as it was found best fitting to the research objective of understanding the role of technology features in blockchain adoption. Different to case studies for example a biography approach usually aims at collecting life history to recall past events and experiences in a personal context. It focuses on empathizing the accomplishments and struggles other people. By this it is found not suitable for this research. The same hold true for ethnography which focussing on a particular organization where specific behaviour and interactions are observed. An ethnography would be an appropriate approach for understanding the details of one particular blockchain adoption decision in one particular organization but not fitting to the aim of this research. Also, phenomenology which is focussing on lived experiences of one particular construct or phenomenon at the time it occurs is not seen as fitting for this research because this research does not focus lived experiences. Likewise, a grounded theory approach was found not fitting to this research as it focusses on social processes, social relationships and group behaviour. Other research strategies, such as a survey strategy using a questionnaire-based research approach, were also considered, but based on the wealth of available quantitative research these were not followed.

Therefore, this study relies on a case study approach as a qualitative approach using case studies allows comparing insights that emerge from the individual cases and so reveal significant variations on the approach, considerations and priorities in adopting blockchain. The cases should represent a population and therefore show variations in the dimensions of interest (Seawright and Gerring, 2008). Often multiple-case studies applied as they are likely to provide more reliable and generalisable results compared to a single-case study. By this they can provide also a stronger base for theory building according to (Rowley, 2002, Kshetri, 2018, Eisenhardt and Graebner, 2007).

Today most studies using UTAUT based models are using quantitative methods of data collection (e.g. survey strategy) and the according quantitative analysis methods like structural equation modelling (SEM) or partial least squares (PLS). This is especially true for the context of blockchain adoption and points to gap in detailed understanding of the individual cases. This study aims to tackle this gap by applying a qualitative approach in combination with the above outlined research model as such combination was already successfully applied in previous research (Gruzd et al., 2012, Mogaji et al., 2021). To improve the generalisability of the results for this research a multi case study approach is chosen. This is as a very promising approach as by now there are no deep insights on the role of technology features for the blockchain adoption process available since most other research in this area focusses on quantitative data. However, it must be kept in mind that according to Yin (2014) case studies are generalisable only to theoretical propositions but not to populations or ecosystems. The next section provides details of the decision to take a mono-method approach.

3.2.3 Mono-method Approach

Following the aim to balance time, effort and resources, this study applies a mono-method approach to fulfil the research objectives outlined in 1.4.2. Although it is acknowledged that a multi-method approach in data collection could lead to the creation of more reliable, valid and robust results, this is not seen as vital for this research as, especially when considering the limitations for this work outlined in Chapter 7.1, the creation of a larger and more complicated research design cannot be justified (Merriam and Tisdell, 2015). Based on the chosen case study approach, the choice of a cross-sectional time horizon is justified next.

3.2.4 Cross Sectional Design

Applying a cross-sectional time horizon involves observations that are made at one point in time, which is suitable for a survey strategy design (Babbie, 2015, Thornhill et al., 2015). Analysing a relatively new topic such as blockchain technology is bound to the cross-sectional research design as there is presently no longitudinal data available. Nevertheless, in future, it could be worthwhile, for example, to analyse how the understanding of blockchain technology has developed or changed over time. Considering these points and the limitations of this work (see Chapter 7.1) leads to the choice of a cross-sectional design.

A summary of the above outlined particular choices of the research design is shown in Figure 17 below.

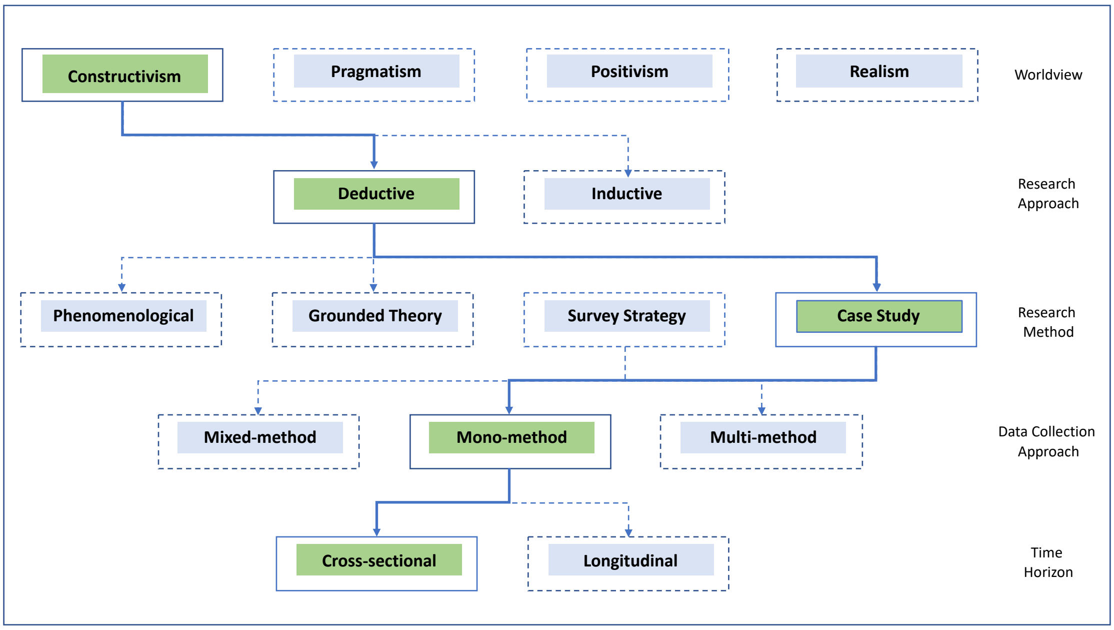


Figure 17 - Research Strategy

Departing from the philosophical and methodical basis outlined above, the next sections explain the operational details of this research starting with the unit of analysis.

3.2.5 Unit of Analysis

The unit of analysis defines the focus of examination and is crucial for collecting relevant data and performing meaningful analysis (Thornhill et al., 2015). This study examines the role of technology characteristics in the behavioural intention to adopt blockchain technology. Although individuals are typically the natural choice for such an analysis, the context of organizational decision-making necessitates a broader focus. Technology decisions in organizations involve multiple stakeholders and layers of approval, making organizations and projects more suitable units of analysis. In organizations, technology adoption decisions are rarely made by a single individual. Instead, they are influenced by a variety of stakeholders, including IT managers, department heads, and senior executives. In larger organizations, a diverse group of stakeholders, each with unique perspectives and priorities, contributes to the decision-making process. These stakeholders can include opinion leaders who drive the decision forward. In smaller organizations, such decisions are often made by the CEO or founder, reflecting a more centralized decision-making process. By acknowledging that technological decisions in organizations and projects ultimately involve human decision-makers, the researcher can justify using organizations/projects as the unit of analysis for this research on the role of distinct technology features in blockchain adoption. This approach allows to capture the complexity and multifaceted nature of organizational decision-making, encompassing both the broader organizational context and individual influences.

The chosen case study strategy combines results from individual interviews with supporting data on the project or organization to create valid and comprehensive cases. This method enables the researcher to consider the wider organizational context and mitigate the effects of individual preferences or biases. The individual interviews provide deep, detailed insights into organizational processes and decision drivers, while the organizational perspective offers a more generalized view of the factors influencing the intention to adopt blockchain technology. Using organizations as the unit of analysis allows to explore how technological characteristics interact with organizational structures, cultures, and strategies. It provides a holistic view of the adoption process, considering factors such as organizational readiness, resource availability, and strategic alignment. This approach also helps identify organizational barriers to adoption, such as resistance to change, lack of technical expertise, and regulatory challenges. Moreover, examining organizations allows us to investigate the impact of blockchain adoption on organizational performance, efficiency, and competitive advantage. It enables assessing how blockchain technology integrates with existing systems and processe, and how it influences organizational outcomes. This broader perspective is essential for understanding the potential benefits and limitations of blockchain adoption in different organizational contexts.

In conclusion, by focusing on organizations and projects as the unit of analysis, this research can provide more comprehensive and generalizable insights into the behavioural intention to adopt blockchain technology. This approach combines the detailed, qualitative insights from individual interviews with the broader, contextual understanding of organizational dynamics. The next section provides details on the role of the researcher in this context.

3.2.6 Role of the Researcher

The general world view of the researcher can influence the analysis and interpretation of the data in a study (Thornhill et al., 2015). Acknowledging that there is no objective truth or reality opens a view for understanding that the personality, identity and knowledge of the researcher may play a significant role. This especially holds true for any kind of interview or moderated discussion, as well as any other form of human data analysis or result interpretation. The self-awareness of the researcher to minimize the subjective influence and peer feedback can be seen as mitigating factors. This is in line with Hammersley (1989), who proposes the researcher’s influence is taken into account, and even utilized for the benefit of the research. Therefore, this research explicitly acknowledges the role of the researcher causing the limitations outlined above. Correctly considering the role of the researcher has also a significant impact on the research quality, which is discussed next.

3.2.7 Research Quality

Ensuring research rigour is of key importance for any research. The relevance of specific threads to research validity depends on the chosen world view and research methods of the researcher (Petersen and Gencel, 2013). Over time, different concepts of research validity and reliability have been developed. The traditional set of criteria for research validity (internal validity, external validity, reliability, objectivity), as proposed by Lincoln (1985), have, for example, been extended by the so-called trustworthiness criteria (credibility, transferability, dependability, confirmability), introduced by Shah and Corley (2006). Each criterion comprises a set of specific actions to support a researcher in meeting the validity objectives.

Table 12 below lists the combined criteria and actions of Lincoln (1985) and Shah and Corley (2006).

Traditional criteria	Trustworthiness criteria	Methods for meeting the trustworthiness criteria
Internal validity	Credibility	• Extended engagement in the field • Triangulation of the data types • Peer debriefing • Member checks
External validity	Transferability	• Detailed description of concepts and categories in the theory • Detailed description of structures and processes related to processes revealed in the data
Reliability	Dependability	• Purposive and theoretical sampling • Informants confidentiality protected • Inquiry audit of data collection, management and data analysis
Objectivity	Confirmability	• Explicit separation of 1st order and 2nd order findings • Meticulous data management and recording • Verbatim transcription of interviews • Careful notes of observations • Clear notes on theoretical and methodological decisions

	• Accurate records of contacts and interviews

Table 12 - Research Quality Criteria

Overall, a good piece of research needs to produce valid (measuring what it is intended to measure) and reliable (ensuring that a given measurement is dependable) results (Babbie, 2015, Taherdoost, 2016). To produce good quality research, these criteria are followed over the course of the primary research. Examples of this are the use of proven measures which are based on previous research for preparing the interview questions and detailed descriptions of the concepts and categories used in the theoretical part. With regard to internal credibility the researcher showed an extended engagement in the field of blockchain adoption over the last 5 years. Further member checks have been performed to ensure that the interviewees are experts in the area and responsible decision takers for their organization in the area of blockchain adoption. To ensure dependability a detailed description of the research methods is provided which includes a clear coding schema as well as all identified codes and patterns. Based on this the results of this research can be rechecked. Also, the confirmability criteria have been regarded for example by the explicit separation of 1st and 2nd order findings, detailed data management and recording, list of records and interview recordings as well as exact transcripts of the interviews. To complete the research design, the next section considers the aspect of research ethics.

3.2.8 Research Ethics

This research is based on a combination of public case data and interview data. Public case data is collected anonymously from various credible online sources, ensuring that the information is accurate and up-to-date. The interview data, which forms a crucial part of this research, is gathered from key stakeholders involved in blockchain adoption within their organizations.

To ensure the ethical integrity of the study, explicit consent for recording is obtained from all interview participants before the interviews begin. This consent process includes informing participants about the purpose of the research, the use of the recorded data, and their right to withdraw from the study at any time. Participants are assured that their identities and any sensitive information will remain confidential, and data will be anonymized to protect their privacy. As the primary focus of this research is on technology adoption, it is not anticipated that the study will encounter significant ethical issues. However, the research design adheres to ethical guidelines to ensure the respectful and responsible treatment of all participants. This includes considerations around data security, informed consent, and the avoidance of any potential harm or discomfort to participants.

Step	Measures
Identification of Public Case Data Sources	Selection of reputable and relevant online sources such as industry reports, academic publications, and case studies from recognized institutions. Systematic collection of data related to blockchain adoption in various organizational contexts, ensuring a wide coverage of different industries and organizational sizes.
Interview Recruitment and Preparation	Identification and recruitment of interview participants who are key decision-makers or stakeholders in blockchain adoption within their organizations. Preparation of interview guides that focus on understanding the organizational context, decision-making processes, and the perceived benefits and challenges of blockchain technology.
Conducting Interviews	Scheduling and conducting interviews, ensuring that participants are comfortable and understand the scope and purpose of the study. Recording interviews with participants' consent, ensuring high-quality audio and video for accurate transcription and analysis.

Data Anonymization and Security	Implementing measures to anonymize data, such as removing company names or other identifiable information from transcripts and case data. Storing data securely in encrypted formats, accessible only to the researcher, to prevent unauthorized access.
Data Analysis	Combining insights from public case data and interview data to create comprehensive case studies. Using qualitative analysis methods to identify common themes, patterns, and insights related to blockchain adoption in organizations.

Table 13 - Research Ethics

By following these steps, the research aims to collect robust and reliable data that can provide meaningful insights into the factors influencing blockchain adoption at the organizational level. Following this comprehensive research design outlined above, the next chapter provides detailed information on the data collection process.

3.3 Data Collection

The objective of this study is to reveal the role of technology characteristics for the behavioural intention to adopt blockchain technology. As organizations and projects are chosen as unit of analysis the data collection consists of two parts. Part one is the publicly available case and organization data obtained from the internet. Part two are the according interviews with the persons who are responsible or involved in blockchain decisions within these organizations. The interview data which represents first hand, original data allows deep and fresh insights into the cases and the real drivers for blockchain adoption. With regard to the selection of cases, primarily these cases for which the researcher could obtain sufficient information were selected. This follows the basic advice of Seawright and Gerring (2008) who recommend that case selection is guided by pragmatic, logistical and financial reasons. However, the selected cases also meet the requirements of Seawright and Gerring (2008) for the selection of extreme cases as the company sizes for the selected cases covers everything from start-ups with just a few employees up to an MNC with several hundred thousand employees. The same is true for the durations of engagement in blockchain technology. There are companies in the population for which the topic of blockchain is relatively new as well as companies who follow this technology from the very beginning (Kshetri, 2018). With regard to the number of cases Eisenhardt and Graebner (2007) state that a number of 7 would be ideal for theory building while for this research 13 cases from 5 different countries have been selected.

As discovered in the literature review, the number of successful blockchain applications especially outside the crypto currency area is very limited. Further, most of the previously hyped cases in the supply chain and other areas have been abandoned. Based on this it was found relatively difficult to discover recent blockchain use case and projects and getting in touch with the persons responsible for blockchain adoption decisions. To solve these issues the researcher first approached the administrators of the Blockchain EU network via email. Blockchain EU is sponsored by EU commission to build up a pan-European public services blockchain. The EU commission provides a wide range of grants and funding for blockchain research, regulations and standardizations via the “Horizon 2020” programme. Via this programme the EU Commission provided some €180 million in grants between 2016 and 2019 and their support programmes are still continuing (EU-Commission, 2023). After several attempts to contact the administrators finally in June 2023 the contract could be established and referrals to some network members who are actively involved in blockchain projects were obtained. Here it must be noted that in today’s high-speed business environment where every manager gets addressed by several email and social network requests every day, direct recommendations are seen as the only way to draw some attention to such things as a research request. Via these direct recommendations the researcher was able to get in touch with the CEO Company A, the CEO and founder of

Company B and the CEO and founder of Company C. From Company C there was a direct referral to Company D and Company E. From Company B there were no further recommendations while the CEO of Company A enabled the contact to Company I, company A and company B (the companies A and B do not want to be named). While the contacts from Company I and company K agreed to interviews the contact from company L could not support this study due to internal compliance and communications regulations.

However, the success in getting interview partners in the beginning was very limited. In order to reach out to a sufficient number of interviewpartners a second, distinct approach was followed by approaching the business development manager of Company C directly via the social media network Xing. This company came into the focus of the researcher based on the huge public effect of winning the Austrian Blockchain Award 2023. Connecting to this public focus this person was very approachable so that here also email contact could be established. Within Company C there where at the end two interview partners found. The first interview partner within Company C was the business development manager and the second one the technology marketing manager involved in their blockchain projects. Based on the reference of Company the contact to the founders of Company D was established. Also, here it was managed to get two interviews from both managing partners. From Company D there was another direct recommendation to the CEO of Company G, Company K and Company M. However, the final interview with company M was cancelled several times on short notice and could therefore not be included into this research. Overall the process of direct referrals for scheduling interviews worked sufficiently well which lead to a success rate of about 50% percent considering all emails and social network contact requests sent during this data collection. Once email contact was established most of the approached contacts agreed to the interviews and according MS Teams meetings were scheduled. The first interview was performed on 11th of July 2023 and the last one on October 20th, so data collection for this research overall took about three

months. The main interview language was German (11 interviews) as only the interviews with Company H and Company K which were held in English.

Table 14 below provides an overview on the interviews while the rest of this section briefly describes each case.

	Company Name	Interviewee	Country	Role	Size / Employees	Company Type
1	Company A	A	Germany	CEO / Founder	20 - 50	IT solution provider
2	Company B	B	Turkey	CEO / Founder	20 - 50	Sourcing, IT solution provider
3	Company C	C	Austria	Business Dev. Manager	150 -250	IT Operations and solution provider
4	Company C	D	Austria	Technology Marketing Manager	150 -250	IT Operations and solution provider
5	Company D	E	Austria	CEO / Founder	< 20	Trust node provider
6	Company D	F	Austria	Leading Architect	< 20	Trust node provider
7	Company E	G	Germany	CEO / Founder	< 20	Blockchain startup
8	Company F	H	Germany	Leading Architect	> 10.000	IT solution provider
9	Company G	I	Austria	CEO / Founder	< 20	DID solution provider
10	Company H	J	US	Leading Architect	> 5.000	Healthcare Network
11	Company I	J	Germany	Strategic Architect Decentralized Systems	> 400.000	Technology provider
12	Company J	L	Austria	CEO / Founder	< 20	W3 Web Agency (Blockchain solutions)
13	Company K	M	Switzerland	CEO / Founder	< 20	Climate Tech Company

Table 14 - Interview Overview

Prior to the main interviews the interview guide with the interview flow and question areas was piloted with two personal contacts of the researcher who are IT experts and practitioners interested in blockchain, as suggested by Babbie (2015). The pre-test candidates were directly addressed via email and asked to participate in pilot interviews and to provide feedback regarding the form and content of the interview. This approach helped to fine tune the interview guide and focus on the relevant questions. Based on the outcome of this pre-test, several changes were made to the interview guide.

The following sections provide details on the cases which have been selected for this research.

3.3.1 Company A

Company A is located in Dortmund, German and specialized on building decentralized identity management solutions. Currently the company has around 30 full time employees in Germany and delivers international projects. Further they are very active in the German blockchain community and diverse networks. Different to most other companies Spherity operates (with partners) successfully a blockchain based solution for regulatory compliance in the pharmaceutical supply chain area in US.

3.3.2 Company B

Company B is a software and solution provider based in Cologne, Germany and Istanbul, Turkey. While they are mainly delivering software projects for MMCs in Germany, Austria and Turkey they also act as human resources provider. The blockchain interest here is relatively fresh and mainly driven by one concrete use case in the area of distributed time management.

3.3.3 Company C

Company C is located in Sistrans, Austria and a 100% subsidiary of the biggest telecommunications provider in Austria. Their main business is software development but also the operations of IT infrastructure like data centres. As innovation is part of their agenda they have collaborated with the company

Company C and won the Austrian blockchain award 2023 with their common project on climate data. This research project meanwhile has become productive.

3.3.4 Company D

Company D is a technology start-up, found in 2020 located in Traismauer, Austria. Company D is part of the Chainlink (2023) network and primarily provides managed oracle services for blockchain applications. Within the Chainlink (2023) network Company D acts as so-called “validation node”. In this role they have partnered with Company C and won the Austrian blockchain award 2023 with their common project on climate data.

3.3.5 Company E

Company E was located in Gelsenkirchen, Germany and aimed to build a distinct blockchain platform for Self-Sovereign Identities (SSI). As start-up it was found in 2019 and had during its peak times about 11 full time employees. In 2021 it was impacted by a dwindling demand for consortia blockchain solutions which led to the shutdown of the business in 2023.

3.3.6 Company F

Company F is located in Ismaning, Germany and sees its core in the realization of customer projects but also IT operations. Company F has more than 10.000 employees globally and their blockchain related focus is mainly on digital identities and decentral ecosystems in order to create new business models or improve existing ones. The interview partner from msg is actively involved in diverse international standardization organizations in order to create the needed regulatory frameworks in the blockchain area.

3.3.7 Company G

Company G is a blockchain start-up founded in 2015 which currently has about 6 employees. Their main focus is on the provisioning of SSI solutions which are developed in their location in Vienna, Austria. The founders are active in the web 3 consortium (W3C) in order to bring the standardization and regulatory in this area forward. By now they have delivered several prototype applications for government agencies and large companies in Austria but also provided trainings and educational services around blockchain and web 3 technologies.

3.3.8 Company H

Company H is a large integrated health care organization in California, US. The interviewee was the principal enterprise architect who is generally involved in emerging technologies and new computational concepts like blockchain particular since about 2014. Their main use case for blockchain is a general-purpose consortium providing a blockchain environment for the health care sector.

3.3.9 Company I

Company I was founded end of the 19th century in Stuttgart, Germany and has become one of the biggest MNC's in Germany. The interview partner for this research was the chief automotive strategist who directly reports to the CTO of Company I. Based on his strong involvement in all kinds of blockchain related initiatives, strategies and he is seen as the public face of blockchain in Company I. He is since years driving the mobility strategy of Company I as product owner for all decentral technologies. Company I is investing and researching in the blockchain area since the very beginning and also actively driving the upcoming regulations and standardizations.

3.3.10 Company J

Company J is a web 3 start-up, founded in 2019. They see themselves as web 3 company and provide very agile solutions with their team of 6 employees. Their customer base comprises the US, UK, Switzerland, Dubai and Germany. Company J is specialised on the provisioning of W3 applications. Examples for this are wallets, NFT's, DAO's, security token, smart contract, etc.

3.3.11 Company K

Company K based in Basel, Switzerland describes itself as climate tech company. They are developing and selling a monitoring and reporting system for the verification of environmental claims based on real time atmospheric greenhouse gas monitoring. In their context blockchain is used infrastructure technology providing transparency and trust for the validation of environmental claims of the reduction or removal of greenhouse gases.

After this short summary of the individual cases the next chapter describes in detail the analysis method used within this research.

4 Analysis

For analysing the qualitative data obtained in the interviews first, the general method is defined. Next the first order findings are analysed based on the defined method which is followed by the analysis of the second order findings.

4.1 Analysis Method

In general the analysis of the collected qualitative data follows the three basic steps of summarising, categorising and structuring as suggested by Saunders et al. (2009) . These steps and the resulting activities are listed in Table 15 below.

Step		Activity
1	Summarising	Condensation and organization of the collected data
2	Categorising	Grouping of data – overall categorising
3	Structuring	Ordering of data – coding, analysing

Table 15 – Qualitative Analysis Process

In the time after “Corona” online working has become normal in many businesses but especially in IT therefore all interviews are held as online meetings using the MS Teams account provided by the University. This approach allows very efficient and flexible scheduling which helps to find suitable time slots in the schedules of the participants. It also allows to overcome geographical and time zone constraints. Based on the explicit agreements of the interviewees the MS sessions are recorded with the build in features of this tool. In addition to this also the automatic transcription feature of MS Teams is used. The resulting recording and transcription files are saved for the analysis. During the initial steps of condensation and organization of the collected data it was found that the automatic transcripts created during the interviews with MS Team were not useful at all as they were mostly wrong and incomplete. One particular issue found there was for example a wrong language setting in MS Teams. Based on this the software tried to transcribe a

German (Austrian German) interview with English text and so created not useful results. However, still after aligning these settings according to the interview language still the MS Teams transcripts were found not being insufficient. In order to manage the workload created by transcribing 13 interviews with almost six hours overall duration a two-step, semi-automated method is applied. First the interview recordings in form of MP4 video files are uploaded and processed via the payed online transcription service “Amberscript”. In order to keep the cost balanced here only the automated machine transcription service is used. Then in a second iteration each transcript is manually checked and corrected as the machine-based transcription shows major deficiencies in processing German and Austrian dialects as well as IT or blockchain specific terms. This time-consuming manual process was needed to ensure the necessary quality and correctness of the transcripts. It must be noted that most of the interviews are in German language and therefore the transcripts are also in German. A full translation of the transcripts to English is not considered as it would lead to a loss of nuances in the wording and meaning and also considering the resource and time limitations of this research. Therefore, only the needed parts of the transcripts are manually translated by the researcher. Next, the complete set of transcripts and the additionally obtained data on the cases and organisations is reviewed and sorted into data folders per case before the actual coding process started. As outlined by Rossman and Rallis (1998), before creating a meaning out of information these have to be organised in in to chunks or segments. The process of doing this is called coding.

4.2 Coding

According to Creswell (2009a), a detailed analysis of qualitative data should begin with the coding process. The coding is done by creating labels and categories and applying them to the collected data. To support the coding process and handle the interview data in a most efficient way the NVivo software package is used, as suggested by Creswell (2009a). It supports for example multiple code categories, renaming and shifting of codes without the need to review all existing coding’s and multiple codes per text segment which advances NVivo compared to manual methods using for example MS Excel. Especially the features of renaming existing codes and the creation of sub codes and applying multiple labels to one code segment are found being most valuable while also other functions like code statistics and counting are very helpful during the analysis. However, it must be noted that the use of an advanced coding tool does not guarantee a higher level of trustworthiness in the coding as this is still a manual and interpretive process. The coding in NVivo starts with uploading the transcripts into the tool and applying first categories.

In this research project, an open coding approach is used where the data is broken down into discrete parts which are labelled, closely analysed and compared for similarities and differences to other parts. Parts found to be similar are given the same label, following Saunders et al. (2009). By performing several iterations of re-reading key concepts contained within the information are identified. During this process of labelling, a piece of text can be given more than one label. The chosen open coding approach allows the creation of new codes which are discovered or emerge during the coding process contrary to a closed coding process where pre-defined labels are applied. With regard to general coding categories, Creswell (2009a) suggests the following basic structure:

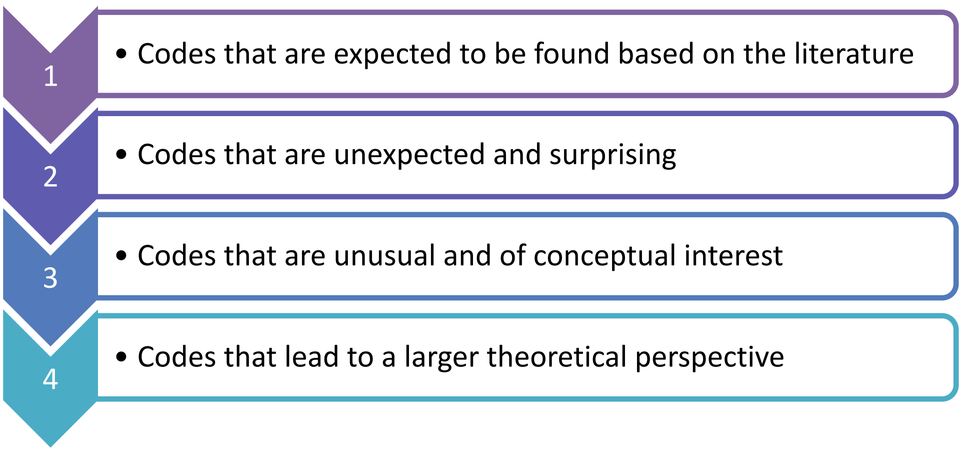


Figure 18 Basic Coding Scheme

The general coding scheme consists of 4 basic categories (expected codes, unexpected codes, unusual codes and codes of larger theoretical interest). Based on this scheme, used as a starting point, the actual data coding was approached with the features of research model and the underlying theories such as the UTAUT and the TFM in mind. This approach leads to code categories (1-4) for the initial codes and sub-codes shown in Table 16 below. These codes primarily reflect the constructs from the research model but also some additionally codes that were discovered during the initial coding rounds.

Category	Code	Sub-code
1	UTAUT	BI (Behavioural Intention)
		PE (Performance Expectancy)
		SI (Social Influence)
		FC (Facilitating Conditions)
1	Technology Feature Mindfulness	TU (Technology Understanding)
		TQ (Technology Uniqueness)
		OA (Openness to Alternative Use)
		TE (Technology Environment Awareness)
4	Other findings	
3	Trust	
2	Weaknesses	

Table 16 – Categorising and Coding Scheme

The method, using the generation of meaning units out of significant statements, is common in case study research as described by Creswell (2009a). In general, the analysis of the data is an iterative process of repeated readings of the interview transcripts and comparing the meaning units with each other, the base theory and the theoretical literature. Due to the approach of re-reading and re-coding codes shifted, are separated in sub-codes or merged into parent codes. Based on the open coding approach several sub codes emerged but also orphan codes are moved into the corresponding code groups. The handing of these changes is nicely supported by the NVivo tool by allowing the renaming but also moving codes per drag-and-drop function into parent codes or between code groups. The final list of 20 codes reflects constructs from the research model, known codes from literature such as trust but also new codes created by the research such as hype behaviour and weaknesses. Table 17 below shows the final distribution of codes in the interview data including the additionally discovered sup-codes after several rounds of rereading, renaming and redistribution of the codes.

No.	Codes	Number code references	Number of interviews with this code
1	**UTAUT \ BI**	5	4
2	**UTAUT \ FC**	24	12
3	**UTAUT \ PE**	13	4
4	**UTAUT \ PE \ Economic value**	38	11
5	**UTAUT \ PE \ Innovation**	7	5
6	**UTAUT \ PE \ Social Value**	7	3
7	**UTAUT \ PE \ Technological**	22	8
8	**UTAUT \ SI**	48	13
9	**UTAUT \ SI \ Scandals**	4	3
10	**UTAUT \ SI \ Hype behaviour**	12	6
11	**TFM \ OA**	72	11
12	**TFM \ TE**	13	6
13	**TFM \ TE \ Interoperability**	14	8
14	**TFM \ TU**	32	13
15	**TFM \ TQ**	27	12
16	**Weaknesses**	54	11
17	**Weaknesses \ Regulatory**	25	6
18	**Weaknesses \ Technological**	14	7
19	**Trust**	43	9
20	**Other findings**	18	7

Table 17 - Coding Table

In addition to the final codes shown in Table 17 also provide some statistics on the number of code references found in the interview data and the number of interviews where a particular code is found. The number of code references can be seen as an indicator for the strength and importance of a single code for the discussion. In addition to this the number of interviews reflecting a particular code could give some indication on the generalisability of the topic and the general importance of a code as this particular topic is mentioned by several independent interviewees. However, such statistics must be considered very carefully as the number of codes and their allocation depends on the individual person performing the coding process, the coding approach, the interview questions, the interviewee and what in the moment of the interview is most important for her or him. Based on the multitude of potential biases these numbers are treated very careful to avoid wrong conclusions. Some of these biases could be controlled by applying multiple rounds of coding by different researches which is exceeding the limitations of this research while others which for example depend on the interviewee will still persist.

The detailed codes discovered during the coding are used as basis for the discussion of the findings in the next chapter.

5 Findings

The findings from the interview data are categorised into fist- and second-order findings where the first order findings cover the categories one and two from the categorization outlined in Figure 18 and the second order findings comprise the categories three and four and by this all the new and unusual findings outside the research model. Both first-order and second-order findings are crucial in qualitative research. First-order findings ensure that the research accurately reflects the participants' perspectives, while second-order findings provide the interpretative analysis that helps to draw meaningful conclusions and contribute to theoretical understanding. Similar to previous qualitative research using UTAUT based models some direct determinants for the base models (UTAUT and TFM) such as performance expectancy, social influence and technology environment awareness were treated as parent nodes in the coding (Mogaji et al., 2021). Table 18 below provides the distribution of the codes and code references to the interviews and shows that all interviews contain at least 11 or more codes while no interview covers all 20 codes described in Table 17. With regard to the number of references per interview there are also bigger differences visible. These differences are not simply related to the duration of the interviews as the data in Table 17 shows. Instead this data points to different levels of maturity in the area of blockchain technology but also differences in the personality of the interviewees with regard to their willingness to openly share information and their opinions.

Interview number	Number codes	Number of references	Duration (minutes)
1	15	76	40:11
2	11	22	18:23
3	11	23	21:32
4	12	33	27:29
5	13	29	24:30
6	14	33	16:23

7	14	66	29:18
8	16	55	23:45
9	13	23	20:54
10	17	83	45:10
11	13	64	24:48
12	11	48	26:36
13	13	33	27:01

Table 18 - Code Distribution

The next sections provide the detail findings for each construct from the research model. In case of direct quotations, the numbering before included in the quotation indicated the source interview.

5.1 First Order Findings

The first order findings are directly related to the constructs from the research model and reflect the mapping of these towards the interview data. Further these findings are also directly used to answer the research question on the role of the unique technical features of blockchain for its adoption. The first construct discussed is the behavioural intention from the UTAUT model.

5.1.1 BI

In the interview data there are only a few direct connections to a behavioural intention from the UTAUT part of the theoretical framework found. In these direct statements the interviewees mention for example that they have no intention to use blockchain unless some customer directly demands it. This is expressed by statements like “4 - we do not sell blockchain in general” or “3 - if we get a new project request we do not consider blockchain but rather alternative SQL technologies” or “12 - we do not say no if a customer insists after we have explained the alternatives”. This shows that there is no general intention to adopt blockchain rather the interviewees are looking for good reason based on their understanding of the pros and cons of this technology.

The lack of behavioural intention to adopt blockchain technology can be seen as a general concern for its adoption and the creation of blockchain-based solutions. This aligns with the theory of planned behaviour, where the intention to perform a behaviour (in this case, adopting blockchain) is influenced by attitudes towards the behaviour, subjective norms, and perceived behavioural control. The interviewees' statements reflect a cautious attitude and perceived barriers to adopting blockchain, such as the preference for familiar SQL technologies and the need for compelling customer demand to justify its use.

Furthermore, the overall missing intention to adopt blockchain highlights the need for greater awareness and education about the technology’s potential benefits and limitations. It suggests that without clear and substantial advantages, organizations are hesitant to commit to blockchain adoption. This underscores the importance of providing realistic and grounded information about blockchain capabilities to influence positive behavioural intentions towards its adoption. Next the findings for the performance expectancy construct from the UTAUT model are analysed.

5.1.2 PE

Performance expectancy is one of the key constructs from the UTAUT model and the most often found code in the transcript data and included in every interview. However, during the coding process, it quickly became clear that the about 89 occurrences of PE can be clustered into sub-codes like social value, innovation value, technological value and economic value. Further it became also clear that there are statements providing positive expectations but there are also statements expressing negative performance expectations for blockchain. So, the interviewees are strictly differentiating cases where blockchain makes sense and can provides benefits but also where they see the limitations and rather prefer different technologies. Examples for this are statements like “1 - where could decentralised technologies make sense and where not” or “4 - it’s most often the case that blockchain is not the best solution”.

The biggest sub-code within PE are the economically driven performance expectations. For economic or monetary driven performance expectations there are about 38 distinct text segments found which are distributed to 11 interviews. By this the economic expectations can be seen as a very strong driver for using or considering blockchain technology. However, this is of course not surprising as all the interviewees are managers and decision makers in firms which have the purpose to create economic value. Examples for economically driven performance expectations are statements like “1 - if we don’t find a positive product-market fit than we will not do it with blockchain”, “5 - we are constantly looking for valid business models when we consider blockchain” or “2 - there are numerous use cases where I believe they will be profitable”. Another interviewee also sees blockchain as enabler for new business by stating “4 - we see blockchain as enabler for other new businesses, entry into new networks”.

The next group of sub-codes within PE are the technologically driven performance expectations. These sub-codes were found it 8 interviews and represented by 22 according text segments. Here the interviewees expect that blockchain technology delivers its basic promises in terms of being temper proof, open readable, providing full transaction history and being trustable and secure. These expectations are expressed by statements like “6 - the combination of being temper prove and confidentiality, being decentralised”, “ 2 - being temper prove so that you cannot manipulate it regardless of how much dept of friendship there is” or “13 - the benefit we expect is that we can grasp any changes and get to know if something is changing”.

Another sub-code of performance expectation is the topic innovation. Codes for this group are found in 5 interviews and represented by 7 text segments. Some examples for this are “10 - you create ecosystems that are very more loosely coupled, don't need this humongous monstrosity of EDI and B2B and all that to establish this on a point to point basis”, “3 - we are starting some research initiatives in this area and then we will proceed step by step”, “2 - there might be an approach where we could create new business models” or “4 - we will prepare ourselves for future projects in the blockchain context". These examples show that the innovative power of blockchain is also a relevant factor for protentional adoption decisions.

In addition to the above, there are some performance expectations with regard to social value represented by 7 text segments in 7 interviews. These expectations point to the liberating potential embedded into blockchain which is also connected to the general trust concept and so another distinctive factor for blockchain adoption. Examples here are statements like "1 - free from discrimination and publicly readable, everybody can access is", "6 - they have created a huge partner network and we are very positive that this will continue" or "10 - internet that's controlled by a few large, actually American companies the value comes from getting a chance to change that".

Overall the performance expectations can be seen as the main driver for blockchain adoption while the concrete direction of these expectations strongly depends on the preferred individual use case. However, what becomes also very clear is that the interviewed decision takers know in detail what to expect from blockchain adoption at the current stage of technological development. On the other hand, the variance found in the performance expectations also shows that there is no clear and simple view on the benefits of blockchain technology available which can lead to a general uncertainty among decision makers with regard to blockchain adoption. The next construct from the UTAUT model is social influence.

5.1.3 SI

Social influence is found in 48 text segments covering all 13 interviews. In this research social influence refers to perceived importance of other opinions for the intension to adapt blockchain technology from an organizational perspective. For this construct, similar to most others there are positive but also negative aspects mentioned influencing the decision to adopt or use blockchain technology. One of the main concerns regarding social influence are scandals, fraught cases and other publicly discussed cases of misuse of this technology. This theme constitutes a sub category in the findings for social influence and is reflected by statements like “6 - by the diverse media scandals in the crypto area many people have become cautious with regard to this new technology”, “4 - the story, now, where this prosecution happened because of the financial scandal, these are things which have a quite negative impact on the topic” or “11 - yes sometimes the bitcoin goes up to 60000 and then its breaking down, this creates an overall bad impression”. Despite the partially bad reputation of blockchain also all of the interviewees see the positive aspects resulting from the publicity around blockchain which is reflected in statements like “5 - it’s much easier to realise a new topic when the stock market is exploding in this area” or ”6 - there is in general a very positive perception towards blockchain, that’s how I experience it in my speeches and presentation”.

Another sub category of social influence is the hype behaviour. The hype around blockchain technology is one of the unexpected but frequently mentioned themes emerging from the interviews. As this hype behaviour is found being closely related to the UTAUT construct of social influence this is treated as subconstruct of SI. Overall this topic is mentioned in 5 interviews. While the interviewees are well aware of the hype, their view on the hype is mixed which is reflected by statements like “10 - certainly a very important call this is nowadays these hype cycles for technologies whether it's Gartner or another way to look at it, you know exactly has this this total exuberance, irrational exuberance at the beginning about it and then it has to first cool down before and then it dies or it comes back up again”, “13 - this hype doesn't lead to anything good” or “13 - I think it can be counterproductive in the market”. Other interviewees use the remaining hype interest as marketing booster or selling point and express this by statements like “3 - this is somewhat a selling point for us”, “3 - this was the same for us, this means there is a relative or perceived value while the true economic value is still limited” or “7 - yes, it was blockchain at that time and we really wanted to implement something”. In summary these statements show that the remaining hype still increases the attraction of blockchain technology as it creates some additional attention for blockchain projects which can potentially be used as selling point. By this the hype state is still a relevant factor for adoption decisions. In some aspects the hype behaviour is connected to social influence from the UTAUT model and could also be seen as a special, exaggerated form of social influence. However, the core of hype behaviour is different. It has a wider focus and cannot directly be influenced by an individual or organization while social influence more describes the impact of the social environment on a particular adoption decision.

In summary the social influence can be regarded as one important, positive factor or selling point of blockchain technology however here it must be distinguished between normal, moderate social influence and the exaggerated hype behaviour which is discussed in section **Fehler! Verweisquelle konnte nicht gefunden werden.** below. In order to promote blockchain technology further public scandals should be avoided and a clear separation between crypto currencies which are in the focus of most of the scandals and blockchain as technology should be fostered. In the end managing the factor of social influence and the public perception on blockchain technology could be crucial for stimulating blockchain adoption. , , Next the UTAUT construct of facilitating conditions is discussed.

5.1.4 FC

The construct of facilitating conditions is found in 12 interviews and represented by 24 texts segments. Similar to the previous constructs the facilitating conditions from the UTAUT model these aspects are also mentioned as supporting but also as hindering factor. The perception regarding facilitating conditions has improved over time which is expressed by statements such as “13 - resources and personnel who are really knowledgeable and know how to build with this I think it's quite accessible right now, and it's only growing more and more at the end of the day“, “10 - fast forward to 2019 you now really have some serious players around, which offer blockchain as a service“ or “6 - there are not enough developers in the blockchain area”. Overall the facilitating conditions were more perceived as a kind of hurdle or factor of inconvenience which is mitigated with different strategies like for example partnering or building up own skills. Other strategies for overcoming this are for example active shaping the facilitating conditions by the creation of the needed frame conditions or actively working in committees or building up own knowledge. Generally, or from the view of policy makers, tackling the gaps in the area of the facilitating conditions, such as the availability of skilled developers and resource allocation, could support smoother adoption processes.

Following the analysis for the finding of UTAU constructs from the research model the next sections focus the constructs from the TFM concept in detail. The first construct here is technology understanding.

5.1.5 TU

The technology understanding construct from the TFM concept is comprising an organization's awareness and attention towards blockchain technology. Codes reflecting this aspect of technology feature mindfulness are found in all 13 interviews which is not surprising as all interviewees are working in the technology area. Although the level of technical understanding varies from a marketing person to a technical architect, the data shows that technology understanding is a base skill which is closely related the performance expectancy as the codes here are partially overlapping. Codes reflecting TU are for example "6 - of course we must know how Ethereum is working and how the layers on top of it function" or "10 - blockchain is, decentralized data, data integrity and computational integrity like both together". So, a deep technology understanding was natural for the interviewees and by this can be seen as basis for all their doing and decisions with regard to blockchain technology. Further examples for this are statements like "12 - we communicate open and direct with our customers and partners on when blockchain makes sense and when not" or "13 - so I was familiar with it. So, from the origin of the idea and the inception of my company, we knew we were going to utilize some technologies like blockchain because of the perks and benefits from it, but always kind of kept it in the background". By this the technology understanding can be regarded as one base pillar for the technology decision with regard to blockchain. Next the technology uniqueness construct is analysed.

5.1.6 TQ

The Technology uniqueness construct as another aspect of mindfulness from the TFM model is reflected in 11 interviews by 26 text segments. This aspect describes the extent to which an organization is engaged in constantly comparing blockchain technology to existing technologies to identify and understand its uniqueness. Examples for TQ are statements like “10 - blockchain is, decentralized data, data integrity and computational integrity like both together”, “13 - so you really got to let the technology speak for itself” or “9 - well let’s say, some of the most important features of blockchain, so the immutability and the fact that everyone can view the data and therefore has full transparency with regard to transactions”. All this points to a very high awareness on the unique features of blockchain amongst the interviewees. However, technology uniqueness also covers the knowledge about the limitations of the technology which were also found very being present in the interview data and reflected by statements like “9 - I can implement all of this with or without blockchain” or “7 - this means we don’t need blockchain with these particular features”. In summary the role of technology uniqueness is mixed while the interviewees are well aware of the unique features they are also well aware where these features are really needed and see where these features are not needed or not helpful. Based on this balanced view the interviewees are able to choose the right technology for the right purpose. For the wider adoption of blockchain technology such balanced view is also essential in order to avoid misperceptions, exaggerated expectation and failed projects. Next the findings for the TFM construct of openness to alternative use are discussed.

5.1.7 OA

The openness to alternative use construct is found in 11 interviews reflected in 72 code segments. Despite that many of the interviewees are currently using blockchain for one or more very specific use cases in their companies most of them seem to be very open for alternative use of this technology. Examples for this are statements like “8 - we have concrete analysis projects ongoing where we are testing different applications for different customers with DLT”, “8 - I have different other use cases like tokenization or supply chain in mind – especially supply chain where I have to cross many borders, interact with many different partners who do not trust each other”, “11 - all these digital services around micro transactions could be much better implemented with blockchain” or ”7 - we are thinking about what else could be done with this technology”. So, overall the openness to alternative use is also a fundamental concept for the interviewees which is closely linked to future performance expectancy and technology understanding. The interview data also shows that once people have really understood blockchain technology to their hearts they are also thinking about potential alternative use cases. An open innovation culture and environment could further support the openness to alternative and new applications of blockchain technology and therefore be beneficial for driving its adoption. Next the findings for the final TFM construct, the technology environment awareness are discussed.

5.1.8 TE

The construct of technology environment awareness is represented in 9 interviews and 27 text segments in the coding. The interviewees are found being very well aware of the surrounding technological environment. The need to interact and integrate is therefore a basic philosophy for most of them which is reflected by statements like “11- yes sure also in a hybrid model, this means we cannot ignore the big hyper scalers totally. Very clear, for this they are already too big and have too much power. We must use cloud technologies, we must use their other technological innovations”, “12 - in general, a technology can only function long term if it is compatible with other technologies” or “13 - we have a very strong foundation with some of our technology partners, and we're always keeping an eye on the space and seeing what's happening, what's evolving, what new toolkits are being developed”. Within the technology environment awareness, the sub-code of interoperability emerged which is represented by statements like “12 - the interaction between central and de-central is often certainly not good or event not there or not at all documented”, “6 - this is a big topic for us as we are generally connecting web2 and web3. We say this is a linkage and very important for us as we for example bring very old data formats into blockchain” or ”8 - at the end DLT is the infrastructure which orchestrates and manages overarching transactions”. Technology environment awareness from the TFM model implies that organizations are conscious of the way blockchain technology might support their objectives, as well as the inconveniences the adoption of blockchain technology might impose The findings above lead to the conclusion that the technology environment and especially the interoperability of blockchain is one of the very important features and determinates for decisions towards or against this technology. Overcoming the current prevailing interoperability challenges can be seen as another crucial factor for the long-term success of blockchain technology.

Beyond the above-mentioned primary findings which are directly connected to the research model, the interviews also provided a substantial amount of connected data which must be considered in order to understand the broader context of the first order findings. These complementary results are classified as second order findings.

5.2 Second Order Findings

The discovered second order findings do not directly answer the questions for the role of technology features in blockchain adoption, but have a strong relation to this. These findings are especially relevant as they show the limitations of the research model and point to possible extensions or adjustment need. As some of these second order findings can be related to previous literature or research the respective existing codes are used. For all other text segments, the label “other findings” is used or some new codes have been established. Next, these second order findings are discussed in detail, starting with trust.

5.2.1 Trust

Trust is one of the main themes around blockchain technology. The trust which is embedded in the blockchain paradigm is mentioned by many previous researchers and the construct of trust has found its way into many research models. Also, in the course of the interviews for this research the topic of trust is mentioned by several interviewees. Overall the trust theme is found in 9 out of 13 interviews and reflected by 43 different text segments. This embedded trust is expressed by statements like “1 - blockchain is naturally a compliance continuum”, “1 - discrimination free could be written into a blockchain”, “10 - the digital transformation requires digital trust. Decentralized mechanisms around decentralized identity creates”, “12 - I don’t not trust someone, or I want to transfer some value internationally or zero knowledge and so on” or “13 - which means not that it's not to be trusted, but that there's not trust required. So that you don't put your trust into a brand”. So, the trust which is embedded into the blockchain paradigm can be seen as a significant factor for blockchain adoption decisions but also a selling point for blockchain solutions and applications.

Despite this positive trust in blockchain technology which is expressed by the interviewees, they are also very clear on the downsides and limitations of these trustworthiness. This becomes visible by statements like “1 - therefore no confidential data, business related, person related data in the blockchain, everyone is writing, every transaction created meta data and metadata cannot be controlled” or “13 - then I tell you which data types must not be stored on the blockchain like customer data, transaction data, asset data, what other data”. Another interviewee mentions that “10 - it would even more seem that our competitions could use this to start looking like us in simpler ways”. Therefore, trust is on the one hand seen as one of the key drivers for blockchain adoption but it has also become visible that this is not the blind trust anymore which might have led to the hype behaviour seen in the past. In any case the factor of the embedded trust in blockchain must be regarded in order to understand adoption decisions. Next to trust also particular weaknesses were found as second order finding which are discussed next.

5.2.2 Weaknesses

The interview data revealed a wealth of aspects supporting potential adoption decisions for blockchain technology but also numerous weaknesses are mentioned by the interviewees. While the fact that next to supporting factors also weaknesses influence potential adoption decisions is not surprising at all, it's the multitude and different categories of these hindering factors found in the interview data which is unexpected. Overall such reasons hindering a use or adoption of blockchain technology are found in 11 interviews reflected by 54 text segments. As within this category some themes are re-appearing also here a sub-grouping is applied.

The first sub-category are the technological weaknesses. Here one often mentioned aspect is the missing technical maturity of blockchain and blockchain related technologies which are seen as impediment for the potential use and implementation. This is reflected for example by statements like "4 - all this privacy preserving smart contracts are still in an infancy stage", "11 - certainly the technological maturity is still not there where I can start a product which might produce millions in revenue" or "3 - I still believe we are at the beginning when I have to wait more than 40 minutes to have my Bitcoin transaction confirmed".

The second sub-group found in the interview data is about the missing standardization and regulatory frameworks as main limiting factors. This is especially true as based on missing standards the German "Bundesamt für Sicherheit in der Informationstechnik" (BSI) has effectively banned the use of blockchain technologies for all regulated industries in Germany by now. One interviewees even compared the current regulatory situation in the blockchain context with the "1 - wild west where everything is possible". Other interviewees mention for example "8 - by now there is nothing qualified and there are hurdles in this process so I believe that will become really interesting in the next years to watch how the whole topic around qualified DLT's will develop" or "5 - every bigger company must solve this if they like it or not because the regulations will be coming". Also, unsolved liability questions as for example the missing ownership in consortial blockchain environments which are colliding with EU regulations like for example the right to delete data are falling into this category and hinder the potential adoption.

Next to the above-mentioned two sub-groups there are also some more general impediments found. For example, one interviewee points towards the internal preferences and struggles for power between innovative forces and the classical IT departments as one particular impediment within bigger organizations. Other weaknesses are rooted in the blockchain technology itself like the unsolved Oracles problem (see 2.3.6). Despite some good ideas like validation networks or digital identities which are under development the connection of the digital blockchain world with the physical reality is still seen as hindering the adoption. In this context another interviewee mentions the missing knowledge on the customer side and missing experienced blockchain developer resources as limiting factors. Other interviewees point out frustration about a general lack of progressive knowledge in companies and the educational system like schools and universities. They see the educational systems lacking at least two years behind the current technical developments in the blockchain area. However, the above mentioned technical, regulatory, legal and other factors do not stop people from adopting blockchain. Instead these factors must be seen as slowing down the adoption and by this hindering the wider success of blockchain technology by now. Next the unexpected and new findings are discussed which are summarised under the category of "other findings".

5.2.3 Other Findings

The category of other findings represents all text segments found during the coding process which cannot directly be connected to the research model, to previous research, to the reviewed literature or to any of the other categories found during the coding process. These other findings represent the new insights or viewpoints shared by the interviewees. Overall there are 19 text segments assigned to this code which originate from 7 different interviews.

One of these codes is concerning the innovative power which is seen in blockchain technology. This innovative power is directed into the future and goes beyond the innovation category which is found in the performance expectations codes. The codes in this group are more about future use cases as expressed in statements like “3 - in future there will be markets on demand, dynamically appearing cyber-physical value chains”, “1 - there will be qualified electronic components with attestations and attributes”. These future predictions are especially interesting and surprising as the interviewees possess deep knowledge and long-term experience with blockchain technology. Further as the interviewees are also very much aware of the limitations blockchain, such far into the future reaching expectations are quite unexpected.

Other interviewees points towards a particular, risk of blockchain technology resulting from meta data correlation by 3rd parties and warns against using it in a careless way. For example, they state “10 - each transaction creates metadata, metadata can be correlated and we have seen case where bombs have been sent based just on metadata” or “11- companies can correlate, so many transactions could mean many products sold, this could lead to skyrocketing financial figures which you could use to bed on the stock markets or the regulator could learn something from it”.

Another code in this category is a repeatedly mentioned future connection of blockchain technology and artificial intelligence (AI). Some interviewees see this connection between blockchain and AI as “the” future use case for both technologies as this connection is expected solve problems on both sides. Examples for this are statements like “11 - machine learning models as AI has a copyright problem not only that, but the copyright and ethical problem. But once we figured out how to make it ethically sort of justifiable, I do think we need these, say, decentralized cryptographic blockchain related type of mechanisms to do so” or “1 - currently one of the most exciting developments is the topic AI, so these large language model topics in connection with a more and more connected environments like in virtual and augmented reality use cases which are more and more coming, there we see the biggest need to introduce also decentral technologies”. While such expectations could have the power to re-ignite the hype on blockchain technology there are further codes found, which point towards more realistic expectations for emerging technologies in general but also blockchain in particular. This call for realistic expectations is for example expressed by following statements “10 - we just kind of have the expectation it pops up and has a good maturity - like even 2006, first iPhone, even that had, a run rate of several years to become somewhat, mainstream. And even that only because of some very interesting way of finance, this expensive thing right through a telco provider”, “10 - that is 20 to 23 years depending on how you look at it - with something so extremely disruptive, like only a few things are and that just can't do”, “11 - it has to for it to become really mainstream. It has to be not talked about. Like when we talk about the Internet, if we talk about the web, we talk about, online Zoom connections. We don't talk about the router networks, the aggregated IP address, mass and all that stuff. Because we talk about the use.”, “8 - we're just awfully impatient with disruptive new technology, it's just not there and it will be there. It just will have to have its runway.” These calls for giving the technological development the time it needs and refraining from exaggerated expectations could provide the universal explanation for the still missing success of blockchain technology.

Another finding in this category is pointing to the potential the role of blockchain and decentral technologies for independence and control over our data in todays connected world. Statements like “11 - by now the ownership on the global data is distributed quite unfair as the majority of all data is owned by the hyperscalers how we call them like Google, Facebook, Amazon and so on, they have the central business model of grabbing all data and keeping them” are expressing a general fear of total control of “our” data and as well the hope and

expectations put in decentral technologies like blockchain to balance the currently perceived imbalance.
Also, the connection towards corporate responsibility is found as being remarkable but not fitting into the existing code categories. This is for example expressed by statements like “4 - yes, the whole context of corporate responsibility, we have to keep this in mind and we are looking at this. The company is responsible to do some good with sustainable objective and so on, so ok we want to become more sustainable so we got a lot support for this project“.
Other findings are touching the regulatory and policy making area with statements like “6 - the world is looking to Europe. We are the first ones who create a regulatory framework for blockchain, with certification requirements, the others are sitting back and waiting to see what works what not and then adopt only the good things”. While considering the long history and world leading role in the creation of legislation and regulations in Europe this is not totally surprising but at least unexpected considering blockchain as a global topic. In this context another surprising statement is “8 - so china is driving these topics also in all the relevant organizations like the OECD or ISO, there where the frame conditions are currently defined, this becomes visible if you have a committee with 20 members where there are 50 of them Chinese, then you can feel how the consent looks like, don’t you” which suggests that China follows its strategic long-term plans also in the blockchain area.
Another interesting finding is the following text segment “6 - for most of the people blockchain is equal to crypto. It is so or simply spoken, crypto equals blockchain equals Bitcoin for most of the people” which brings the most common heuristic regarding blockchain technology to the point but also shows that there is still a long way to go until this technology becomes understood.

It is overall acknowledged that the findings in this category do not directly connect to the research model. However, these codes constitute pieces of original information which could point to fresh insights. A deeper exploration of these unexpected codes in future research could therefore lead to new insights on the blockchain adoption process and open up valuable future research areas. The next section summarises the above outlined first and second order findings and brings them into relation.

5.3 Summary of Findings

The above discovered findings show that codes for all of the constructs from the research model have been found. However, they also show that the combination of UTAUT and TFM constructs is partially still to generic to comprehensively cover all the drivers for technology adoption. Therefore, sub-categories have been introduced for some constructs. Further it has become evident that there are some additional drivers influencing blockchain adoption decisions like trust, weaknesses and hype behaviour which must be considered in order to see the full picture. Beyond this the findings also show that there are many positive drivers as for example economic performance expectations but also negative, non-supporting aspects such as technical weaknesses influencing blockchain adoption decisions. This balanced view presented by the interviewees, points towards a deep understanding of all the aspects of blockchain technology amongst the interviewees. In addition to this the collected data shows that next to the data concerning the research model also personal opinions, experiences and views of the interviewees have been collected. This data comprises information on the environment, general perceptions on blockchain technology, the state of scholarly education and other unexpected topics. Especially this unexpected data is what advances the in-depth interview data collection to purely quantitative, statistical methods when trying to understand of factors which are driving human behaviour. While a quantitative setup must rely on previous research and literature, the qualitative method chosen for this research allows the discovery of new insights and viewpoints based on reality of actual human behaviour.

Following this summary of the findings, the next chapter discusses the results, answers the research question and provides implications of this research.

6 Discussion and Implications

This chapter opens with a summary of the research method and the result validity. Next, the results are discussed and an explicit answer to the research question is provided. This is followed by the theoretical, practical, policy and general implications of this research, which conclude this chapter.

6.1 Method and Result Summary

This study draws on principles of the widely used UTAUT and the concept of technology feature mindfulness (Thatcher et al., 2018, Chokkannan, 2020, Dwivedi et al., 2020, Dernbecher and Beck, 2017). Based on the underlying technology adoption theories, a conceptual research framework has been developed to explain the role of technology features in the adoption of blockchain technology. To the best of the researcher’s knowledge, the current literature on technology adoption and blockchain lacks a consideration of technology features as factor influencing the potential adoption. Therefore, this research introduces new constructs to address this gap and help to predict behavioural intention for blockchain adoption. Behavioural intention, in this context, describes the degree to which a person has formulated conscious plans to adopt blockchain technology (Warshaw and Davis, 1985).

The proposed research model is examined using a qualitative case study approach. Applying a qualitative approach with an UTAUT based model is different to the majority of quantitative UTAUT based studies (Queiroz and Fosso Wamba, 2019, Queiroz et al., 2021). Especially in the area of blockchain adoption most studies using are using quantitative methodologies, which leads to a lack of qualitative studies and data in this area. To tackle this gap a qualitative approach used in this research. Qualitative research has successfully been applied in previous UTAUT based research and allows new and deeper insights into blockchain adoption compared to a quantitative research approach (Mogaji et al., 2021, Gruzd et al., 2012).

As blockchain adoption which is in focus of this research mainly concerns and affects organizations and projects these are chosen as unit of analysis. Following the above outlined qualitative approach the actual data collection therefore comprises of publicly available case and organization data but also semi structured interviews with the persons who are responsible or involved in blockchain decisions within these organizations. The sample selection considers recent literature with regard to the sample size but also covers extreme cases in terms of company size and duration of blockchain engagement to enhance the validity of the results. To ensure research rigour the research quality criteria outlined in section 3.2.7 have been applied like for example the explicit separation of 1st order and 2nd order findings. Further to avoid the common biases affecting qualitative research such as the leading questions and wording bias or the acquiescence bias, all the questions are open ended and formulated in a way to avoid the introduction of bias. Also, all findings and codes have been triangulated with the literature and across the interviews. The chosen approach and methodology is seen as distinctive factor for this research and provides the foundation for the result discussion in the next section.

6.2 Discussion

The results of this research show that today's blockchain deciders know this technology in detail and take their decisions based on their deep technical understanding, economic considerations but also keeping the social environment in mind which in the end leads to very realistic expectations. The findings outlined in chapter 5 show that all of the constructs from the research model where found being relevant for the adoption decisions. However, the most constructs are not simply affecting the adoption decisions in a positive way but also have some negative characteristics. So, for example the performance expectations are seen as one main of the drivers for blockchain adoption decisions but also factor limiting blockchain to specific use cases. Next to this there are also other weaknesses, such as technical maturity, regulatory gaps and organizational challenges seen as barriers for adoption. Overall, the data confirms that the interviewees are well aware of the benefits but also on the downsides and limitations of blockchain technology. This enables them to clearly differentiate when blockchain makes sense and when not.

Further, beyond the constructs from the research model also other important factors influencing adoption decisions, like trust, weaknesses and hype behaviour were discovered. As these concepts constitute important factors influencing blockchain adoption decisions they should be considered in future research models investigating blockchain adoption. From these additional concepts especially trust is also found in previous research on blockchain adoption (Queiroz et al., 2021, Alazab et al., 2020). However, different to previous research where trust is directed towards other parties, the trust related statements found in this research point to the embedded trust into blockchain which is reflected by statements like “13 - and you sort of let the science and the data speak for itself and you say, okay, you don't need to trust us. Trust the data, trust the information, and you can openly see that for yourself and make your own assessment”. While this trust is holistically comprising blockchain it is still based on a realistic view of the technical capabilities but also the limitations of blockchain technology. These limitations are reflected in the “weaknesses” category of the findings. Weaknesses in this context are of general nature like the overall missing regulation in the blockchain area or security issues reflected by statements like “1 - there is the justified reproach that for DLT the major security questions are unsolved or at least not standardised”. Also, here the data shows that many of the deciders which have been interviewed for this research are well aware of these issues. Based on the depth of knowledge and the individual adoption motivation these factors have a different weight for the adoption decision. Considering the overall balanced view which is reflecting pros and cons of this technology it can be assumed that today most of blockchain adoption decisions are taken in a mindful manner founded on deep knowledge.

However, the wealth of failed blockchain projects and the findings with regard to hype behaviour point to the fact that this was and still is not always the case. Still today there are blockchain adoption decision taken based on the hype effect. This is also reflected by statements like “13 - good example is what was happening with NFTs, the whole NFT bubble and boom, I thought was the most ridiculous thing from the beginning of when it started to happen. And all that said to me was, this is a lot of hype and this is a ton of people washing money. That's the purpose of this is to wash money and then other people that are exploiting it to get rich". While another interviewee mentioned "6 - the hype, at least for Europe is dead" there are also contradicting findings as some interviewees fully rely on the hype effect and the data on hype behaviour shows that name blockchain still works as selling point. However, addressing this hype behaviour, fostering realistic expectations and maintaining trust in blockchain solutions is critical for widespread adoption.

Building on this discussion the next section focusses on answering the research question.

6.2.1 Answer to the Research Question

The analysis and discussion above have identified that blockchain adoption decisions today are taken based on detailed knowledge and understanding. Further todays deciders know the technical capabilities and limitations of this technology in detail which leads to very realistic expectations with regard to performance, use options and benefits. Especially the findings for the PE, TU and TQ constructs point towards the view that the unique technological features of blockchain technology are one very important factor for adoption and implementation decisions. Based on this it must also be noted that the initial assumption that blockchain adoption decisions are taken in mindless manner was refuted. Further, these insights also provide the response to the research question "How does the awareness of distinct blockchain characteristics influence the behavioural intention to adopt blockchain technology?" by clearly showing that the unique technology features have become one very important factor for adoption decisions. However, this answer is of course not generally valid as the still existing hype behaviour shows that even today there are blockchain adoption decisions taken without considering the technical fit, but rather purely building on the selling effect of the name "blockchain". Based on this it can be summarised that there is no simple answer to the research question which points to several implications which are discussed next.

6.3 Theoretical Implications

The findings of this research lead to theoretical implications for technology adoption in general and blockchain adoption in particular. Regarding the underlying theories, this study has successfully linked the UTAUT model with the concept of technology feature mindfulness and applied the combined model in a new setting and context, namely blockchain adoption. In doing so, this study contributes to the technology adoption theory by introducing technological characteristics as factor influencing potential technology adoption behaviour and, so, combining social, psychological and technological factors into one model.

The findings in the area of trust show, that for this particular technology the trust factor should be included into any research model aiming to address its adoption. However, while trust is embedded in the blockchain paradigm and is also crucial for its understanding this does not imply that this dimension should be considered when conceptualising the adoption behaviour of other emerging technologies. Another theoretical implication is that specially when researching the adoption of a rather complex, emerging technology like blockchain it is very important to clearly define and understand where and how the required data can be collected. Blockchain is still not mature nor an end user technology which is understood and used by the public. Therefore, asking for example large groups of supply chain managers for their behavioral intention with regard to blockchain adoption might not lead to the best results as these people most likely will never have to take any blockchain technology related decisions nor possess the necessary knowledge to take mindful decisions on when to use blockchain or not.

Therefore, one central theoretical implication from this research is the call to researchers focussing on technology adoption but especially for blockchain adoption to carefully answer the question about their unit of analysis in order to produce meaningful results. The maturity of blockchain technology and the public knowledge about it are completely different than for example for mobile banking applications. Still today most people apply the misleading short cut (heuristic) of setting blockchain equal to Bitcoin which might lead to useless results with regard to research on blockchain adoption.

This leads to another important theoretical implication of this research, which is based on the observation that there is a tendency in blockchain-related literature to underestimate or neglect the general role of the distinctive technology features.

Even today there is a wealth of reports, use cases, applications but also scientific publications on blockchain technology available, which do not consider the unique features of this technology. By this the unique benefits, but also the limitations of this technology are not considered which leads to exaggerated and unrealistic performance expectations. Base on the missing balanced view such publications heat-up the hype around this technology and support mindless adoption decisions. As the wealth of failed blockchain projects proves this view, it is necessary for researchers and practitioners to re-think the way how emerging technologies are treated and evaluated in general. Scholars and practitioners need to understand and recognise the benefits but also the limitations of blockchain, based on its unique technology features. This will enable the creation of more realistic performance- and use-expectations based on the real technical capabilities of this technology. While the high attention towards a new field or technology is seen positively it must be avoided heating-up a technology hype as this leads failed projects and, in the end, harms the reputation of the technology. In this sense, this study contributes to the current knowledge by providing a clear view on the current state of blockchain technology and by explaining its unique features, as well as their technological sources and interactions with complementary technologies, in detail, which is highly relevant for scholars and practitioners.

Further, this study responds to the call from Alazab et al. (2020), who have emphasised the need for more explanatory studies considering blockchain adoption, especially as previous blockchain research focuses on the creation of conceptual models (Verhoeven et al., 2018, Treiblmaier, 2018, Subramanian, 2018). Therefore, this study addresses these blind spots and contributes to the progressive literature on blockchain technology by providing first hand data on blockchain adoption that is industry and user group independent.

Apart from the theoretical implications, the findings of this study are also providing important suggestions for management and practitioners.

6.4 Practical Implications

From a practical perspective, the findings of this research emphasize the need for a proper understanding of blockchain technology. The interviews show that today's decision makers know the technical capabilities of blockchain and have established a realistic information basis for their project decisions. Considering the practical problem of the rather limited success and the high number of failed or abandoned projects in the blockchain context, despite it being a highly potential technology, this was not always the case. Therefore, it is highly relevant for practitioners to rely on realistic information grounded on technical characteristics. This knowledge is a prerequisite to manage and neutralise the oftentimes still exaggerated expectations towards blockchain technology. To be precise, managers and practitioners must first gain sufficient understanding beyond the current predominantly high level of knowledge. This is especially important as blockchain is neither a simple nor cheap technology. Therefore, this research introduces technology features as universal and objective basis for understanding the technical capabilities of blockchain technology and highlights the practical importance of the distinct blockchain features by connecting them to the unique benefits but also to the limitations of this technology.

Deep knowledge about these distinct features and the capabilities of the technology will significantly improve the ability of managers to make mindful decisions with regard to blockchain adoption. This is especially relevant, as a dominant reason for the high number of failed or abandoned projects relates to the exaggerated expectations based on the lack of understanding of the technology prior to adoption attempts. More generally, decisions about whether or not to use blockchain must follow a careful evaluation of the technical requirements, which have to be matched with the technical features. Managers must ask whether blockchain is the best technology available to solve the problem at hand instead of just implementing a blockchain project. Before adopting blockchain, it is essential to ensure that the technical requirements match blockchain's features. For example, if a healthcare organization evaluates blockchain for patient data management it should perform a detailed needs analysis to identify specific problems and technical requirements within their current system. Mapping these requirements against blockchain features allows the organization to assess the technology's suitability. They should also compare blockchain with other technologies to determine the best fit, considering factors such as cost, complexity, and scalability. This approach ensures that the organization makes an informed decision about whether blockchain is the best technology for its specific needs. Another example, could be a logistics company considering blockchain for supply chain management. In such case the organization should organize workshops and training sessions for their decision-makers and IT staff. These sessions should focus on deepening their understanding of blockchain's technical capabilities and limitations. Additionally, engaging blockchain experts to provide realistic insights and case studies about successful and failed projects in the logistics industry can be highly beneficial. Further launching a small-scale pilot project to test blockchain applications in a controlled environment would allow the company to gather data and refine their understanding of blockchain's practical benefits and constraints. This approach enables decision-makers to make informed decisions and set realistic expectations for the technology's implementation.

Next to this the results of this research show that blockchain technology is still far away from being mature and readily available. While there are already some technical basics available as services, the missing integration and standardization currently still hinders its wider usage. Therefore, this research calls for setting expectations right for blockchain, as this relatively young emerging technology still has a long way to go before it reaches a maturity state which can be compared for example to the internet as we see it today. Setting realistic expectations for blockchain's maturity is crucial. For example, a government agency exploring blockchain for secure voting systems should evaluate the current state of blockchain technology, focusing on integration and standardization issues. Developing a clear roadmap that sets realistic expectations for blockchain deployment, considering its developmental stage, is important. Educating stakeholders about the ongoing research and development required for blockchain to reach full maturity can help set appropriate expectations, reducing the likelihood of premature or misinformed adoption.

This research also shows that while the search for blockchain use case goes on there are already many ideas on utilising the immense potential of this technology as for example in balancing the data ownership or in the combination with AI to overcome existing limitations of both technologies. However, as mentioned above blockchain technology will require still many years of research and development until the benefits of these use cases can be explored and become visible for a wider public. To identify superior use cases for blockchain, companies considering blockchain should conduct workshops to brainstorm potential use cases. The focus should be on areas where blockchain's unique features offer clear advantages over existing technologies. Distinguishing blockchain features from those of complementary technologies like IoT and smart contracts can help identify opportunities for meaningful integration. Performing feasibility studies on selected use cases to evaluate technical, economic, and regulatory aspects ensures that the company identifies and prioritizes blockchain use cases that provide significant advantages, leading to a targeted and effective adoption strategy.

Overcoming the prevailing knowledge gaps must become a priority for managers and practitioners to be able to find use cases where blockchain is really superior to other technologies. Further, the understanding of the distinct technology features allows blockchain features to be distinguished from features of complementary technologies, like smart contracts or the IoT, which is important as these technologies can also be meaningfully combined with other more mature database technologies. Following these practical implications, the next section focusses on policy implications.

6.5 Policy Implications

Next to the theoretical and practical implications the findings of this research also point to implications for policy makers. These findings show clearly, that the missing standardization and regulation in the blockchain and DLT context currently blocks its dissemination and use. As mentioned by several interviewees, especially in Germany the de facto ban of using blockchain in public, governmental and regulated environments based on the missing certification options must be understood as a call for action for policy makers.
In this context for example the question “how to ensure the cryptographic security” or “who will be liable in a blockchain consortium” must be clarified and answered in order to create an environment of reliability and safety. Today, based on the missing security standards for DLT’s the customers and industry are hesitating and waiting to see how and in which direction these technologies will develop. Therefore, the lack of standardization is seen as the biggest impediment for using blockchain technology today. Standards are the basis for regulation and regulation itself is the basis for the safety the customers need to gain trust in the long-term availability of this technology and finally adopt it.
Another direction for policy makers is the sector of education, as the findings point to a significant time lack between technical reality and educational programmes offered at schools and universities. This time gab leads to a

knowledge gab which is then passed on to the industry and at the end leads to uniformed project or adoption decisions. Further this educational gab also leads to challenges with regard to the availability of skilled developers and resource allocation which also hinders a smooth adoption process.

Next to these policy implications the findings of this research also point to some general implications of blockchain and its adoption which are directly affecting our society. These general implications are discussed in the next section.

6.6 General Implications

From a society point of view blockchain has already proven its disruptive impact for instance by enabling the creation of crypto currencies like Bitcoin and others. These alternative currencies impact our economic systems by allowing anonymous, non-taxed and mostly unregulated transactions which can be used for legal and ethical purposes but also for illegal purposes. In many countries independent online currencies can be a valuable, inflation prove alternative to traditional local currencies. Unfortunately, the reality shows that also criminals but especially cyber criminals use for example Bitcoin as preferred currency. This points to governance issues associated with blockchain based crypto currencies as without a clear ownership it is difficult to apply tax laws to crypto currency transactions. Further the immutability feature which on the one hand ensures that no data can be deleted also inhibits that wrong data can be corrected or erased. Further, based on the missing legal entities owing a public blockchain also legal claims are hard to execute which also leads to challenges for the society which relies on laws to ensure the public order.

Next to this, the findings of this research point also to the potential of blockchain technology to facilitate advances in data equity which could help to overcome the currently progressing data and information monopolism executed for example by the large hyperscalers like Google, Amazon or Microsoft. Furthermore, the distributed and ownerless nature of public blockchains could also effectively be used to mitigate problems arising from central data ownership like falsification and deletion. Especially in the context of digital identities blockchain could become the game changing technology which could enable the individual to own and control their data and so help to empower and liberate the individual.

Following these implications, the next chapter provides a conclusion and outlines the limitations of this research.

7 Conclusion and Limitations

This research is rooted in the lack of success of blockchain technology despite the high attention and the predicted game-changing, disruptive power of this emerging technology. It aims to identify the role of technology features in blockchain adoption and, by doing this, help to provide an explanation for the lack of success. Therefore, the research model integrates the TFM concept with the UTAUT. The resulting model is evaluated the using a qualitative case study approach based on interviews with blockchain deciders from different industries and countries.

While the different interviews reflect individual preferences or focus areas there are common themes found in all interviews which constitute the base factors influencing blockchain adoption decisions. These base factors are mostly reflected by the research model but also by the additional categories found, like trust, weaknesses and hype behaviour. The fact that next to the classical UTAUT constructs also the TFM constructs are reflected in the findings, leads to the conclusion that this combination of both models is useful as it allows a wider and more detailed assessment of blockchain adoption than one model alone would do. While the obtained interview data overall confirms the proposed research model it also points to the need to consider additional aspects like trust, hype behaviour and weaknesses when aiming to understand blockchain adoption.

One of the main contributions of this research is that it provides implications with impact on theory, practice, policies and our society. Further it advances current knowledge by highlighting the role of technology features for the adoption of blockchain technology in a cross-industry context. This research proves the need to understand the unique technical features of blockchain technology in order to allow mindful decisions about its adoption and use.

In summary, the findings of this study imply that blockchain is still young and in many aspects' immature technology. In order to deliver the high expectations and have this technology enjoy wider success, the needed frame conditions with regard to standardization and regulation must be established. However, even with having these conditions in place it will take much time, effort and knowledge sharing for blockchain technology to become self-explained which is the precondition to allow more people to understand its real benefits and uniqueness and so avoid further disappointments resulting from failed projects.

“it will be there - it just will have to have its runway”

Despite the theoretical and practical contributions of this work, there are some limitations to be considered which are detailed in the next section.

7.1 Limitations and Future Research

This research has specific limitations and constraints that need to be considered, which in turn, could provide rewarding opportunities for further research.

First, this research was accomplished within a limited time frame, in a part-time environment and by a single researcher. Therefore, there had to be an editorial deadline for information applied, especially as the number of published documents on blockchain technology and knowledge is still growing rapidly. Based on this, it must be understood that the results reflect the knowledge of the author at the time of submission and disregard future advances in the knowledge. These constraints also explain why further measures to avoid biases like having multiple people to code the data or the review of the findings with peers were not implemented in this research. Furthermore, these time and resource constraints have also influenced the sample size and by this the amount of obtained data as well as the depth of analysis which influences the generalizability of the findings.

Second, the presented research model uses a limited number of constructs to assess the adoption of blockchain technology, therefore future research could extend the proposed model by integrating further constructs. Here especially the newly discovered constructs like hype behaviour, weaknesses but also the often-referred aspect of trust are seen as useful for future advances.

Third, as the research model is validated by explaining the blockchain adoption in limited context using a limited sample of blockchain deciders, this study could be replicated in a different context e.g. focussing on a different technology, other countries, with different sampling approaches or applying a strict industry focus to advance a generalization of the model. Such an approach could also help to further deepen the understanding on emerging technology adoption.
Fourth, there are limitations to the model components, like the UTAUT framework, which mainly considers extrinsic factors motivating adoption decisions while it disregards intrinsic factors (Francisco and Swanson, 2018). In this respect, the choice of the mindfulness components as an extension to the UTAUT model should be confirmed by future studies. Another potentially fruitful direction for future research could be hype behaviour in the context of emerging technologies. As this phenomenon has led to substantial economic losses in the case of blockchain technology answering questions like “how does the hype effect impact the adoption of emerging technologies” can lead to significant new insights. Finally, as the findings indicate that blockchain adoption decisions today are taken in a mindful manner considering both, the technical benefits and limitations, the question why so many blockchain projects have failed based on unrealistic adoption decisions for this technology still has to be answered in detail. Therefore, this research can only be seen as a first step towards a generalised model for mindfully evaluating emerging technologies while also considering their unique features, which may be also a promising direction for future research.

Appendix 1 – Interview Details

Every interview started with the general introduction and is following the interview flow below.

Introduction

- Thanks for your time and having the meeting
- Introduction researcher, reason for research and the organization: DBA dissertation @ Durham Business School
- Introduction of the research topic: Interest in the role of the distinct technical blockchain characteristics for the adoption of blockchain technology
- Estimated duration: 15 min
- Consent given: (yes - no), consent for recording given: (yes – no)
- Statement of confidentiality, anonymity, right not to answer and stop at any time.
- Written documentation wanted: (yes – no)
- Researchers contact information wanted: (yes – no)
- Any questions from the participant:

Questions:

- Please shortly describe your role in your company (organizational context)
- How would you describe your personal role in the (or possible) implementation of blockchain technology in your company? (decision maker check)
- Please elaborate the ideas and thoughts which lead to the implementation of blockchain technology in your company (general start frame)
- PE: What do you expect from a blockchain implementation in your company?
- SI: How do you think will the implementation of blockchain be perceived by environment of your organization/company? (e.g. other companies, shareholders, …)

- FC: How would characterize the support for the implementation and use of blockchain technology in your organization? (e.g. knowledge, resources)
- TU: How would you describe your companies’ level of engagement and interest in blockchain technology (e.g. information collection and exchange)?
- TQ: Can you describe what makes the difference of blockchain compared to other technologies for your company?
- OA1: How would you characterize your companies’ interest in different use cases for blockchain technology?
- OA2: Where do you use or expect to use blockchain technology in your company in the future?
- TE: How would you describe the integration of blockchain technology into your work environment (e.g. other solution/tools you are using in your company)?

Appendix 2 – Ethics Form

Singed and approved research ethics forms

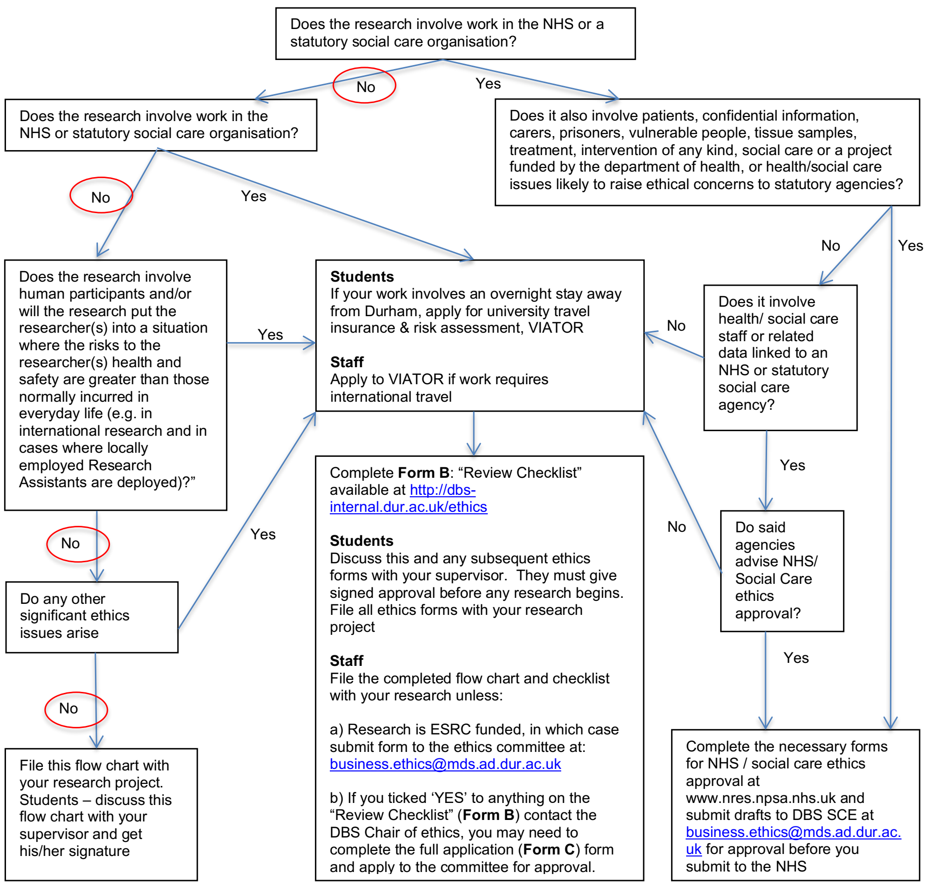
Durham University Business School

BETTER BUSINESS THINKING

ETHICS FORM 'A' – Process flow chart for students & staff

Title of Project: Mindful technology adoption: Exploring the role of technology features in blockchain adoption ……

……………………………………………………………………………………………



X ☐ ☐

Tick one box only

Signature of Principal Researcher or Supervisor:

Signed:………. [signature] ………………………………………Date:07.07.2023…………………

ETHICS **FORM B**: REVIEW CHECKLIST

"DUBS SCE" refers to Durham University Business School's Sub-Committee for Ethics throughout.

This checklist should be completed for every research project that involves human participants. It should also be completed for all ESRC funded research, once funding has been obtained. It is used for approval or to identify whether a full application for ethics approval needs to be submitted.

Before completing this form, please refer to the University's "Ensuring Sound Conduct in Research" available at http://dbs-internal.dur.ac.uk/ethics/default.aspx – all researchers should read Sections A, B and F; Principal Investigators should also read Section D. The researcher and, where the researcher is a student, the student and supervisor are responsible for exercising appropriate professional judgement in this review.

This checklist must be completed before potential participants are approached to take part in any research.

Section I: Project Details

1. Project title: Mindful technology adoption: Exploring the role of technology features in blockchain adoption

2. Start date: 1.12.2017 Expected End date: April 2024

Section II: Applicant Details

3. Name of researcher (applicant)
Or student: Martin Braches

4. Status (please delete those which are not applicable)

   Postgraduate Research Student

5. Email address
(staff only):

6. Contact address: Martin Braches, Schönbrunnergraben 1A / 3; 1170 Vienna; Austria

7. Telephone number: +43 (0) 664 8121873

Section III: For Students Only

8. Programme title: Doctorate of Business Administration

9. Mode (delete as appropriate)

   Part Time

10. Supervisor's or module leader's name: Professor Kiran Fernandes

11. Aims and Objectives: Please state the aims/objectives of the project

The general purpose of this research is to provide a better understanding and possible explanations for the ongoing slow adoption of blockchain technology. In order to fulfil the general purpose this research aims to explore the factors influencing the individual adoption behaviour for blockchain technology.

12. Methodology: Please describe in brief the methodology of the research project

For this research a case study strategy based on semi structured interviews is used as primary data collection method.

13. Will data be collected from participants who have not consented to take part in the study e.g. images taken from the internet; participants covertly or overtly viewed in social places? If yes, please give further details. - No

*Does the research take place in a public or private space (be it virtual / physical)? Please explain: -
Explain whether the research is overt or covert: -
Explain how you will verify participants' identities: -
†Explain how informed consent will be obtained: -

*Ethical guidelines (BPS, 2005) note that, *unless consent has been sought, observation of public behaviour takes place only where people would reasonably expect to be observed by strangers.*

†It is advised that interactive spaces such as chat rooms and synchronous and asynchronous forums be treated as private spaces requiring declaration of a research interest and consent.

Additional guidance on internet research can be obtained at:
http://www.bps.org.uk/sites/default/files/documents/conducting_research_on_the_internet-guidelines_for_ethical_practice_in_psychological_research_online.pdf

14. Risk assessment: If the research will put the researcher(s) into a situation where risks to the researcher(s)' health and safety are greater than those normally incurred in everyday life,

- 2 -

please indicate what the risks are and how they will be mitigated. (Please note that this also includes risks to the researcher(s)' health and safety in cases of international research and in cases where locally employed Research Assistants are deployed).

Research which will take place outside the UK requires specific comment. (Note that research outside the UK is not automatically covered by the University's insurance. See the DUBS intranet site (http://dbs-internal.dur.ac.uk/ethics/default.aspx) for further details).

No

For student research the supervisor should tick the following, as appropriate. The study should not begin until all appropriate boxes are ticked:

- ☐ The topic merits further research
- ☐ The participant information sheet or leaflet is appropriate (where applicable)
- ☐ The procedures for recruitment and obtaining informed consent are appropriate (where applicable)

Comments from supervisor:

Section IV: Research Checklist

Research that may need to be reviewed by NHS NRES Committee or an external Ethics Committee (if yes, please give brief details as an annex)

		YES	NO
1	Will the study involve recruitment of patients or staff through the NHS or the use of NHS data or premises and / or equipment?[1]		X
2	Does the study involve participants age 16 or over who are unable to give informed consent? (e.g. people with learning disabilities: see Mental Capacity Act (MCA) 2005).		X

Footnotes

[1] Research in the NHS may be classified as "service evaluation" and, if so, does not require NHS research ethics approval. In such cases, prior written confirmation that the research is considered to be service evaluation is required from the appropriate authority, and on receipt of this the "No" box may be ticked and this form used for ethics approval. Advice and assistance is available from **business.ethics@mds.ad.dur.ac.uk**

Please note: - That with regard to 1 and 2 on the previous page, all research that falls under the auspices of MCA must be reviewed by NHS NRES.

Research that may need a full review by Durham University Business School Sub –Committee for Ethics (DBS SCE)

3	Does the study involve other vulnerable groups: children, those with cognitive impairment, or those in unequal relationship e.g. your own students? [2]	☐	X
4	Will the study require the co-operation of a gatekeeper for initial access to the groups or individuals to be recruited? (e.g. students at school, members of a self-help group, residents of a Nursing home) [3]	☐	X
5	Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g. deception, covert observation of people in non-public places)	☐	X
6	Will the study involve discussion of sensitive topics? (e.g. sexual activity, drug use)	☐	X
7	Are drugs, placebos or other substances (e.g. food substances, vitamins) to be administered to the study participants or will the study involve invasive, intrusive or potentially harmful procedures of any kind?	☐	X

Research that may need a full review by Durham University Business School Sub –
Committee for Ethics (DBS SCE) (continued)

8	Will tissue samples (including blood) be obtained from participants?	☐	X
9	Is pain or more than mild discomfort likely to result from the study?	☐	X

Footnotes

[1] Research in the NHS may be classified as "service evaluation" and, if so, does not require NHS research ethics approval. In such cases, prior written confirmation that the research is considered to be service evaluation is required from the appropriate authority, and on receipt of this the "No" box may be ticked and this form used for ethics approval. Advice and assistance is available from **business.ethics@mds.ad.dur.ac.uk**

[2] Vulnerable persons are defined for these purposes as those who are legally incompetent to give informed consent (i.e. those under the age of 16, although it is also good practice to obtain permission from all participants under the age of 18 together with the assent of their parents or guardians), or those with a mental illness or intellectual disability sufficient to prevent them from giving informed consent), or those who are physically incapable of giving informed consent, or in situations where participants may be under some degree of influence (e.g. your own students or those recruited via a gatekeeper - see footnote 3). Where students are perfectly able to choose to be involved and to give informed consent then, so long as there is no impact on assessment, the "No" box may be ticked.

[3] This applies only where the recruitment of participants is via a gatekeeper, thus giving rise to particular ethical issues in relation to willing participation and influence on informed consent decisions particularly for vulnerable individuals. It does *not* relate to situations where contact with individuals is established via a manager but participants are willing and able to give informed consent. In such cases, the answer to this question should be "No."

YES NO

10	Could the study induce psychological stress or anxiety or cause harm or negative consequences beyond the risks encountered in normal life?	☐	X
11	Will the study involve prolonged or repetitive testing?	☐	X
12	Will the research involve administrative or secure data that requires permission from the appropriate authorities before use?	☐	X
13	Does the research involve members of the public in a research capacity (participant research)?	☐	X
14	Will the research involve respondents to the internet or other visual / vocal methods where methods are covert, intrude into privacy without consent, or require observational methods in spaces where people would not reasonably expect to be observed by strangers?[4]	☐	X
15	Will the research involve the sharing of data or confidential information beyond the initial consent given?	☐	X
16	Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants? [5]	☐	X

Section V: What to do next

If you have answered '**No**' to all of the questions:
Undergraduate and Postgraduate taught students should discuss this with their supervisor, obtain his or her signature and submit it with their business project or dissertation.
DBA / MPhil / PhD students should discuss this with their supervisor, obtain his or her signature and submit it as part of the transfer / 9 month review process and with their thesis.
Work that is submitted without the appropriate ethics form may be returned un-assessed.
Members of staff should retain a copy for their records, but may submit the form for approval by DUBS SCE if they require approval from funding bodies such as ESRC. *In such cases, the letter of invitation to participate, Participant Information Sheet, Consent Form and, where appropriate, the access agreement should also be submitted with this form.*
Please note that DBS SCE may request sight of any form for monitoring or audit purposes.

If you have answered '**Yes**' to any of the questions in Section IV, you will need to describe more fully how you plan to deal with the ethical issues raised by your research. This does not mean that you cannot do the research, only that your proposal will need to be approved by the DUBS SCE.

Contact the Chair of the DUBS SCE in the first instance to discuss how to proceed. You may need to submit your plans for addressing the ethical issues raised by your proposal using the ethics approval application form REAF, which should be sent to the committee at business.ethics@mds.ad.dur.ac.uk.

(Continued overleaf)

Footnotes

[4] This does not include surveys using the internet providing that the respondent is identifiable only at their own discretion.

[5] In experiments in economics and psychology in particular it is common to pay participants. Provided such payments are within the normal parameters of the discipline, the answer to this question should be "No."

(Form REAF can be obtained from the School Intranet site at http://dbs-internal.dur.ac.uk/Pages/Default.aspx or using the student / visitor access:-

http://dbs-internal.dur.ac.uk/ethics

Username: **dubs\ethicsvisitors**
Password: **durham**

If you answered 'yes' to Questions 1 or 2 in Section IV, you will also have to submit an application to the appropriate external health authority ethics committee, but only **after** you have received approval from the DUBS SCE. In such circumstances complete the appropriate **external** paperwork and submit this for review by the DUBS SCE to business.ethics@mds.ad.dur.ac.uk.

Please note that whatever answers you have given above, it is your responsibility to follow the University's "Ensuring Sound Conduct in Research" and any relevant academic or professional guidelines in the conduct of your study. **This includes providing appropriate participant information sheets and consent forms, abiding by the Data Protection Act and ensuring confidentiality in the storage and use of data.**

Any significant change in research question, design or conduct over the course of the research project should result in a review of research ethics issues using the "Process Flow Chart for Students and Staff Undertaking Research" and completing a new version of this checklist if necessary.

Declaration

Signed
(staff only, students insert anonymous code): Z0990032

Date: 07.07.2023

Student / Principal Investigator

Signed: ....

Date: ...07.07.2023...

Supervisor or module leader (where appropriate)

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