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Investigating the future of digital assets in financial services

Thesis presented by

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Declaration of originality

This is to certify that the work I am submitting is my own and has not been submitted for another degree, either at University College Cork or elsewhere. All external references and sources are clearly acknowledged and identified within the contents. I have read and understood the regulations of University College Cork concerning plagiarism and intellectual property.

Abstract

The growth of digital assets and the underlying technology that underpins them – distributed ledger technology – has been highlighted by their popularity amongst retail consumers and general popular culture throughout their emergence in the last decade. These novel forms of assets and their associated technology have significantly altered perspectives of many retail investors on how currency is managed and distributed in the modern technological era. However, there is still a lack of clarity on if and how large institutions across the financial services could leverage these assets and technology to their benefits. This lack of clarity is a key contributing factor to the overarching research objective of this paper. That being to understand digital assets on a more fundamental level, with a view to how they may be adopted and leveraged by organisations across the financial services industry. Existing literature on the area facilitates a more fundamental understanding of digital assets and associated processes across chapters 2 and 3, whilst chapter 4 delves deeper into their use by stakeholders across the financial services industry. Chapter 2 proposes a framework which can be used to classify digital assets and delves into some of the key detailed information around digital assets in the process. This framework adds to the existing body of information around digital assets and given the lack of an existing framework for classifying digital assets according to their structural properties, provides a useful means of doing so. Following this, chapter 3 further explores digital assets, but with a focus on their associated process of conversion called Tokenisation. Tokenisation is examined by comparing it to the process of digitalisation and a conceptual framework is derived which can be used to evaluate the suitability of traditional financial assets to be converted to digital assets through tokenisation. Once the fundamental concepts around digital assets are thoroughly understood, chapter 4 examines how companies within financial services could leverage these digital assets within their respective organisations. This chapter uses foresight research techniques to garner a more future oriented perspective on the application of digital assets within financial services. Results from chapter 2 show that the digital asset classification framework could be utilised for classification, ownership and regulatory purposes, and identifies a core issue for regulation in

the area as being a lack of a consistent framework based on the structure of the assets themselves. Chapter 3 gives context to the landscape of tokenisation and demonstrates the importance of organisations considering the suitability of an asset to the process ahead of tokenising it. Chapter 4 finds that trust is the key factor to be considered by organisations operating in the financial services industry if they are to leverage the perceived value that digital assets offer, detailing ways that organisations could address this in the process.

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Chris Stanley

1. Thesis Introduction

1.1. Introduction Overview

The first wave of digital assets emerged around 2008 and were commonly referred to as "cryptocurrencies". A cryptocurrency is essentially a form of digital currency, secured using cryptographic techniques. Nakamoto (2008a)'s paper "Bitcoin: A peer-to-peer electronic cash system" detailed a new form of asset or "electronic cash", which is underpinned by a form of Distributed Ledger Technology called "blockchain". It wasn't until approximately 2014 that digital assets and this underlying technology started to gain attention in the media. At this point these "alternative currencies" were touted to have a future but were still in early stages of maturity (Harvey & Tymoigne, 2015). After 2014, when digital assets started gaining traction in the media, many digital assets - in particular Bitcoin - saw their popularity increase (Marr, 2017), particularly among retail investors who used platforms such as Coinbase and Binance to buy and sell cryptocurrencies. Cryptocurrencies and their associated capital raising mechanism "Initial Coin Offerings" raised over $5 billion in just under 800 deals in 2017. This was an unprecedented level of investment in a novel asset given that equity investors deployed just $1 billion in 215 deals across the whole fintech sector within the same time period (Insights, 2018). Despite this unparalleled level of retail investment, several ICOs have led to large-scale scams and scandals and, as a result, the speculative cryptocurrency investment market experienced a decline (Sedgwick, 2019).

Although the most interested parties in digital assets initially appearing to be just retail investors, many organisations began to fund research and development projects in the area with a particular interest in a flavour of Distributed Ledger Technology called "Blockchain". Many large businesses across a variety of industries became interested in this new form of distributed ledger technology (Hackett, 2017) particularly within the financial services industry. Large financial incumbents such as Nasdaq, J.P Morgan, Wells Fargo and State Street seemed to be less concerned with cryptocurrencies such as Bitcoin and Ether, and more interested in the underlying blockchain technology due to potential benefits an adaptation of the technology could offer (Hern, 2015; Metz, 2015). In late 2017/early 2018 the speculative cryptocurrency market experienced a significant crash which caused the price of the most popular cryptocurrencies to drop by large amounts (Russell, 2017). Despite this crash, many large financial organisations continued to invest in research and Proof-of-Concept applications of blockchain with the expectation that it might amend some aspects of financial services by improving upon process and cost inefficiencies in traditional finance (Finextra, 2017; Terekhova, 2017). As a result of these efforts, there was an emergence of a new wave of digital assets or "crypto assets". Digital assets and blockchain technology are potentially disruptive forms of technology that may well change the way financial securities, among other more traditionally illiquid asset classes, are traded and managed. Recent years have seen the continued evolution of digital assets, with Central Bank Digital Currencies (CBDCs) becoming a significant focus of financial institutions (Auer et al., 2022). This shift marks a critical development in digital asset adoption, as institutions such as central banks now explore new forms of currency to complement or replace traditional fiat (Carstens, 2019).

This study examines digital assets and their underlying technology blockchain from a number of alternating perspectives to investigate and determine the feasibility of digital assets becoming widely adopted as financial assets of the future. The chapters are all based around a common research objective: to investigate the future of digital assets within financial services and how they may disrupt the current financial ecosystem. Due to the lack of a robust method of classifying digital assets according to their structural properties, the study begins by examining and defining digital assets, with the goal of creating a framework which can be used to classify digital assets. In a subsequent chapter, the process associated with the conversion of an asset to a digital asset is examined. The chapter attempts to determine if this process would be worthwhile for specific assets and how it may be disruptive for organisations considering the tokenisation of said assets. Once digital assets inherent properties and their associated process had been investigated, the focus shifted to determining how they may impact organisations operating in the financial services industry. More specifically, the focus is on how the potential introduction of digital assets would impact future business models of companies in the financial services industry as well as determining the factors that could enable digital assets. Overall, chapters 2 and 3 offer potential benefits in specific areas for those working closely with digital assets and Distributed Ledger Technology (DLT), whereas chapter 4 is a more high-level investigation of the future of digital assets within financial services.

1.2. Research questions

Based on the areas for research identified, the overall objective of the thesis is to investigate the future of digital assets within financial services and how they may disrupt the current financial ecosystem. As this objective is complex and multifaceted in nature, it is broken down into three separate research questions, all of which contribute to gaps within the existing body of knowledge for digital assets in financial services. Each of chapters 2, 3 and 4 have a single research question. Each topic focuses around a different area pertaining to digital assets with each research question aligning with the overarching objective by focussing on the future of digital assets in financial services and their potential to disrupt the ecosystem. The research questions address gaps in existing research and contribute to the body of knowledge in the nascent field of digital assets, as well as revealing potential avenues for further research. Each research question is proposed in its own respective chapter in this thesis, starting with chapter 2.

Research Question 1: *How can digital assets be characterised and classified according to their properties?*

Digital assets are a novel asset type, and as such they do not yet have a consistent framework for classifying and categorising them based on their structural properties. There are frameworks which classify these digital assets based on their functions, but these tend to fall short in that an asset can have different functions at different points in its lifecycle (Cryptoassets Taskforce, 2018; Finma, 2018; Sec, 2017c). This could be seen as a significant issue from a regulatory perspective, were digital assets to gain widespread adoption within the finance industry, as regulatory bodies across jurisdictions could have inconsistent ways of classifying them. This could essentially nullify the cross-jurisdictional benefits of their underlying blockchain technology. This gap is particularly apparent, given how strict regulation tends to be in financial services.

With this gap in the classification of digital assets in mind, the research question for chapter 2 was formulated. The chapter looked at some of the key literature on the areas of digital assets and blockchain, and in doing so, discovered several common themes across the literature in the form of structural properties. These were then collated and used to create the framework that would ultimately be used to classify digital assets according to their structural properties.

Research Question 2: *How does the process of tokenisation impact an asset?*

Chapter 3 takes a closer look at the associated process of conversion from an asset to a digital asset. This process is called Tokenisation and it allows the economic value represented in assets to be unlocked by converting them into a digital token; this can then be manipulated in a blockchain environment (Sanghavi, 2018; Wachal, 2018). If digital assets are to become commonplace in the future and tokenised markets are to replace traditional financial markets, then the process of conversion of an asset to a digital asset would have to be one that is efficient and worthwhile for an asset to undergo. It was this line of thought that brought about further investigation into the potential impact of tokenisation.

While conducting the literature review, several papers compared the distinct processes of securitisation and digitalisation with that of tokenisation. These lines of comparison then made it possible to create a framework that would in theory facilitate the measurement of the impact tokenisation would have on a non-digital asset.

Research Question 3: *How are digital assets perceived and what factors enable digital assets to change future business models in financial services?*

Now that digital assets and their associated process of conversion had been researched, chapter 4 research pivoted slightly to examine how digital assets and their adoption may impact the companies operating in the financial services industry. The chapter maintains this future focus by employing a foresight research methodology and gathering data from a series of dedicated foresight workshops with industry stakeholders from different aspects of the financial services industry. The chapter initially looks at how digital assets are perceived as impacting on future business models by identifying several digital asset related offerings that could be commonplace in the future and then using the Business Model Canvas (Osterwalder and Pigneur, 2010) to determine what impacts these digital assets could have on business models of the future. Once these perceived impacts were captured, more qualitative data from the foresight workshops was analysed to identify key factors which could impact on the adoption of digital assets. Upon further analysis, this data allowed the identification of factors that would enable digital assets to change business models in financial services.

1.3. Study Background

The research conducted as part of this master thesis was conducted in University College Cork as part of an MSc by Research with the general focus of the study being in the field of financial technology. The research was carried out from September 2018 to January 2020 in the State Street Advanced Technology Centre (ATC) on the University College Cork campus. This is essentially a joint research centre run by State Street Corporation and UCC's Business Information Systems department to give postgraduate students a chance to delve into the emerging area of financial technology through academic research. In the advanced technology centre, guidance and feedback from the UCC academic faculty was provided at regular intervals on the research being conducted. State Street provided funding for a dedicated research lab and to contribute towards some of the research and, in return, insights discovered across the area of Financial Technology could be used by State Street in practice or published in industry reports. Regular conference calls took place between the researchers and relevant personnel within State Street corporation which allowed the researchers to leverage the industry expertise which these professionals possessed.

The research and industry focus culminated in a series of foresight workshops held in State Street's Dublin and London offices respectively in summer 2019. These workshops were designed and conducted with a focus on the topic of digital assets in the future of financial services. Moreover, the researcher was given access to an unprecedented level of seniority and experience for Participants due to the ability to utilise State Street's vast array of industry connections across Fintech companies, financial institutions, legal firms, venture capital firms, and more. This not only was an enriching and fulfilling experience, but also allowed a unique level of insight to which many researchers would not have access to. In addition to this, there were opportunities for networking with many of these key stakeholders to develop connections in an industry of particular interest.

Across the 15 months spent in the Advanced Technology Centre, there was regular engagement with the Digital Products Development and Innovation (DPDI) team in State Street. This was a team co-located across the Dublin and London offices, the main function of which within State Street was to engage with and help develop various digital products that were relevant to State Street business lines. The DPDI team investigate various financial applications of digital assets and distributed ledger technology and as such they were a valuable resource. There were regular conference calls with members of the DPDI team where they would provide subject matter expertise on the area. This not only acted as a guide towards potential areas of interest for future research, but also meant there was regular feedback from industry stakeholders who were actively involved in the area. This added perspective, in addition to that of academics, was key to the research.

From an academic perspective, the master's program started by focussing primarily on establishing and improving research skills which would be applied regularly over the coming months. The first skill which was discussed was that of conducting comprehensive and effective literature reviews. Once the ability to conduct effective literature reviews was established, the identification of research objectives became possible. Other research skills were developed primarily through writing and receiving feedback. In addition to this, there were some workshops on topics such as design science research across the 15 months. This workshop was particularly useful in the context of chapter 2, where a design science research methodology is used.

Presentations were a regular feature of the time in the Advanced Technology Centre from the outset. Regular research updates were conducted in the form of presentations to senior members working in innovation for State Street Corporation. In addition to this, two onsite presentations in UCC and two more in State Street's offices in Dublin were performed. One of these presentations in Dublin was part of their annual "Innovation Showcase" which was performed in front of approximately 40 in-person attendees and was broadcast via video conference to State Street's Frankfurt and London offices. It took place after 12 months in the ATC and gave this researcher a good platform to present in detail their research and their most significant findings. In addition to these presentations an invitation was also received to present at Financial Inclusion & FinTech Conference in SOAS University of London in April 2019 where the research was well received by academics and those working in the industry.

1.4. Individual Contribution in a Team Research Centre

Some of the literature and data gathering work that was used in this thesis was conducted as part of a broader research team within the State Street Centre. My research began in the broad topic of digital assets, along with several other students. Chapters 2 and 3 of this thesis draw on this early collaborative work (however I remain responsible for the content of chapters 2 and 3 as submitted). Likewise, data in chapter 4 was gathered primarily through team run events, but the chapter remains my work.

1.5. Research Methodology Overview

1.5.1. Concept Centric Matrix

A comprehensive and systematic literature review was conducted for each of the research chapters outlined in this study. This was undertaken in line with techniques outlined by Webster and Watson (2002). A Concept Centric Matrix (CCM) was one of the more prevalent research methodologies utilised throughout the course of this entire study. The CCM was utilised in chapters 2 and 3 broadly as a means to collate and classify a significant amount of literature on the areas of digital assets and distributed ledger technology. The CCM was chosen as an appropriate framework for collating and classifying literature across both chapters as it allows the researcher to identify several common concepts across a large amount of literature and therefore quantify the prevalence of these concepts visually. The CCM tables, which can be seen in Table 2-4 and 3-1, facilitated the capture of concepts of interest and, in turn, allowed a relevance assessment of a wide range of literature to a specific topic – in this case digital assets. The use of a CCM not only allowed the efficient categorisation of literature based on the overarching topic, but also allowed the identification of outliers and the ability to exclude papers that were identified as being out of scope. This facilitated the refinement of the literature solely to the studies which would add value. Additionally, the use of the CCM contributed significantly to the findings of this study by identifying recurring themes across a wide range of literature. These recurring themes, which are outlined in their respective chapters, would then be used to form the basis for the creation of the frameworks in both chapters 2 and 3.

1.5.2. Foresight Methodologies

As this study pertains to the future of digital assets in financial services, some future oriented research methodologies were required to garner a forward looking view on this area. It was determined that foresight research methodologies would be an effective means of determining what may lie in the future of digital assets in financial services as these methodologies generally seek to gather data and make sense of it so that people can think in different and new ways about the future (Rohrbeck & Kum, 2018).

There were several techniques used, many of which were interdependent as the output of one technique would be the input for another. The most prevalent future oriented research techniques implemented were scenario mapping, visioning of paths, and trend analyses. Trend analysis is a core strategic foresight method, allowing organisations to systematically identify, assess, and respond to macro and micro trends that might impact their sector over time. In financial services, trend analysis helps to spot gaps and rising opportunities (such as digital assets), which informs scenario-building and future policy decisions (Menke, 2025). Additionally Scenario mapping is an important foresight technique used here as it’s an effective means of exploring different plausible futures, especially in dynamic environments like digital assets and financial services (Van Rooyen et al., 2025). All three of scenario mapping, visioning of paths, and trend analyses were utilised in chapter 4.

Trend identification and analysis was conducted ahead of the foresight workshop outlined in chapter 4 with the purpose of identifying key trends in financial technology and financial services with the aim of spotting gaps that could indicate a higher likelihood of digital assets being used in this area. This analysis involved examining macro trends and micro trends to determine what areas in financial services are in need of reform. This was particularly helpful as it informed much of the content presented as part of the foresight workshops. These trends were taken and analysed to map to a number of potential future scenarios in financial services which involved the use of digital assets. These scenarios were combined into one, which formed the basis for a fictional press release dated 10 years into the future; this was provided to participants. The purpose of this press release was to facilitate and create debate and discussion amongst workshop participants around the area of digital assets. These techniques were essentially interdependent and proved to be crucial in provoking workshop participants to express their own view on where the future of digital assets and financial services lies. Artefacts which were used across these foresight workshops, such as the fictional press release, can be found in the appendix at the end of this document (Section 6.2).

1.5.3. Business Model Canvas

Osterwalder's Business Model Canvas (Osterwalder and Pigneur, 2010) was a key research tool used in chapter 4 of this thesis. At a high level, the Business Model canvas is a managerial tool which enables the user to describe and analyse the business model of a given organisation. In chapter 4, the business model was not used to analyse current business models of organisations in the financial services industry, but as a means of determining the impact that potential adoption of digital assets might have on the future business models of companies operating in financial services. This was done by identifying realistic digital asset related offerings and then working with workshop participants to understand how these offerings would impact organisations in financial services and how they operate. The identification of these impacts then facilitated the understanding of the factors that would enable these digital assets to proliferate in the future.

The remaining research methodologies used as part of this master thesis will be outlined in more detail over the course of the next few chapters.

1.6. Thesis Contents

In summary, the following chapters in this thesis will collectively investigate the future of digital assets within financial services and how they may disrupt the current financial ecosystem. This research objective was chosen as digital assets and distributed ledger technology have garnered mainstream attention in recent years and as such, many financial institutions are experimenting with digital assets to see how they can leverage them to create value and reduce inefficiencies. Therefore, this research objective was considered to be one that is both relevant and interesting.

Chapter 2 starts by defining digital assets and exploring the current state of the art in the nascent field of digital assets and DLT. During this review of the current state, it was determined that there is a lack of a consistent framework for classifying digital assets according to their structural properties. The chapter then identifies key characteristics present in all digital assets which then form the basis for the digital asset framework. This chapter is of relevance to both academics and practitioners as it provides crucial context on digital assets and their characteristics. It provides a framework which could feasibly be used to classify digital assets according to their properties and make complex information on digital assets more understandable for non-technical audiences.

Chapter 3 follows this by looking at the associated process of conversion of an asset to a digital asset: tokenisation. More specifically, the chapter explores the effect that tokenisation might have on assets that undergo this process. It also explores the level of disruption that tokenising assets of such a type would have on the wider market for organisations using them. It explores this by examining the effects that digitalisation and securitisation have had on assets and by using this to extrapolate the potential impacts that tokenisation will have in the form of a framework. The subject matter for this chapter is of particular interest as tokenisation is a crucial process for the creation of digital assets and therefore, if digital assets are to gain widespread adoption, the impacts of this process need to be understood by companies looking to tokenise.

Chapter 4 pivots slightly from the previous chapters to a more future-focussed perspective. The chapter maintains this future focus by using a foresight research methodology. The chapter initially looks at determining how digital assets will impact business models for companies in the financial services industry. It then continues to investigate the factors that will enable digital assets to change business models in financial services. These were investigated predominantly using data gathered as part of a pair of foresight workshops held with various industry stakeholders across the finance and fintech industries. This chapter gathers a large amount of qualitative data from differing perspectives across financial services on the potential of digital assets to disrupt. The findings can be leveraged by individuals working in the financial services industry to understand what factors they must emphasise to enable digital assets within their organisation.

Chapter 5 summarises the findings from each of chapters 2, 3 and 4 and explains how the overall findings of this thesis address the research objective by investigating the future of digital assets in financial services and how they may disrupt the current financial ecosystem.

2. A Framework for Characterising and Modelling Digital Assets

While the use of digital assets is growing, an understanding of their applications for business use is limited. For organisations to gain value from them, and for designers to better utilise them, a deeper understanding of digital assets is required. This chapter examines the properties of digital assets with the aim of creating a framework which can be used to characterise and classify digital assets, according to their properties.

2.1. Introduction

Since Bitcoin's launch in 2009 several competitors have spawned, many of which look to improve upon existing financial infrastructure and payment systems (Buterin, 2013; Schwartz et al., 2014). There are several issues that these offerings attempt to address. An example of such an issue is the inherent lack of efficiency in international, cross-border payments which often entail two to five day settlement times but can take up to seven days to settle (Bis, 2018).

Despite the increasing number of competing cryptocurrencies, Bitcoin still very much remains the market leader and the most traded cryptocurrency, with its price movement having a strong impact on the rest of the crypto market. Bitcoin's underpinning peer-to-peer technology means that it is decentralised in nature and doesn't require financial institutions to facilitate transactions and verify ownership (Plus, 2020). This technology is not unique to Bitcoin alone, albeit it was in the first instance. This technology is called Blockchain and is defined as a growing list of records, called blocks, which are linked and secured using cryptography (Zheng et al., 2018, p. 1). As stated above, blockchain is the underlying technology which enable cryptocurrencies such as Bitcoin as well as other digital assets. In essence, they allow communities of users to record transactions in a shared ledger within their communities. This then facilitates the immutable property of blockchains, which means that no transaction can be changed once published (Yaga et al., 2019). When referring to a blockchain system, there are a number of fundamental elements: public-private key infrastructure, a shared consensus system, and cryptography methods to coordinate a single shared ledger (Ibm, 2017). Blockchain is part of the broader family of Distributed Ledger Technologies (DLTs). DLTs are "particular types of databases in which data is recorded, shared and synchronised across a distributed network of computers or participants" (Biswas & Gupta, 2019, p. 229). DLT has the capability of operating without "needing to use a centralised validation system" (Pinna & Ruttenberg, 2016, p. 6). Blockchain is a key element and value proposition for digital assets themselves. This chapter focuses on the broader extent of distributed ledger systems and, more specifically, on digital assets: a data structure implemented using DLT which can be assigned an owner.

In 2008, the first digital asset, Bitcoin, was conceptualised. Bitcoin and the underlying blockchain were referred to by their creator Satoshi Nakamoto in the bitcoin whitepaper as a "peer-to-peer electronic cash system" (Nakamoto, 2008, p. 1), but Bitcoin and other similar offerings are more commonly known as Cryptocurrencies (Narayanan et al., 2016). Since the Bitcoin whitepaper, the technology has evolved beyond the realm of cryptocurrencies, commonly referred to as digital currencies, to include other asset types that fall under the umbrella term of digital assets (Brusov, 2019). The number of use cases for digital assets has grown; for example, Bachelor's degrees have now been issued via digital assets. MIT is one such university that has issued more than 2000 degree certificates using DLT (Grech & Camilleri, 2017; News, 2019). In finance, digital assets can and have been programmed to represent various different asset types such as currency, commodities, common shares, and real estate (Leiberman & Mirynech, 2019).

The application of digital assets and blockchain technology to traditional securities such as those mentioned above demonstrates a growth and evolution in the area. Figure 2-1 illustrates this growth starting with the inception of blockchain up until the end of 2019. More specifically, the figure depicts several key events in the evolution of digital assets, which can be traced from the emergence of Bitcoin to the end of 2019. The figure was created based on the following: (Axiom, 2017; Buterin, 2013; *CoinMarketCap*, 2019; Nasdaq, 2015; Shirley, 2017).

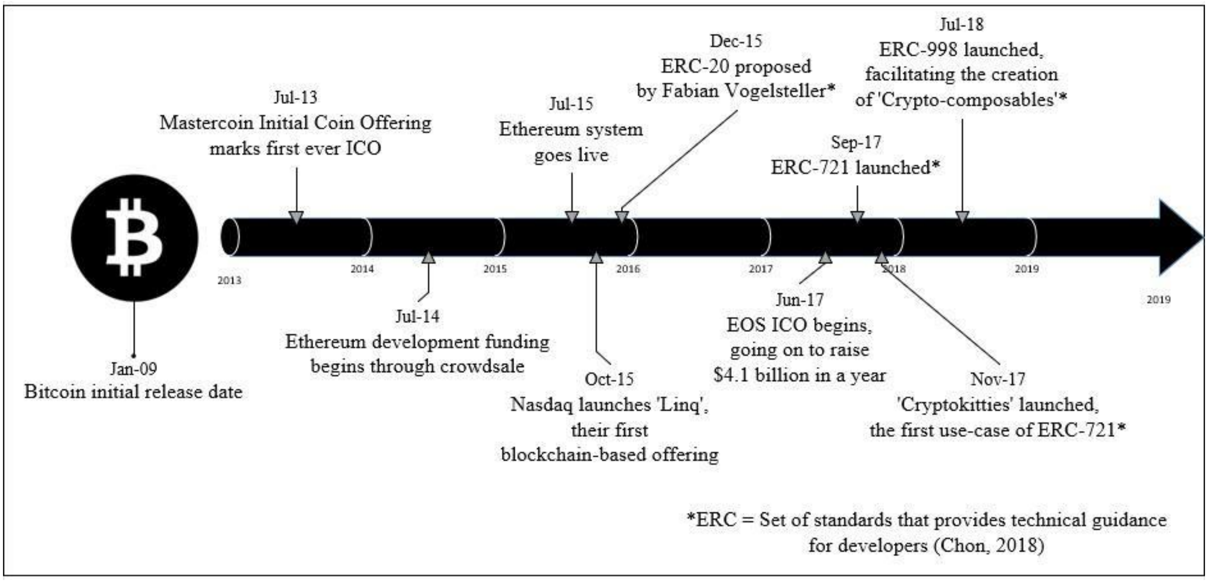

Figure 2-1 - Progression of Digital Asset Timeline

While there has been a rise in interest surrounding digital assets (Ismail, 2019), there is also an ambiguous element to them, typified by a lack of understanding of digital assets. This is exacerbated by the lack of a clear definition of digital assets. From the perspective of the Cryptoassets Taskforce, a state-run joint regulatory research venture in the UK, digital assets are defined as "a cryptographically secured digital representation of value or contractual rights that uses some type of DLT and can be transferred, stored or traded electronically" (Cryptoassets Taskforce, 2018, p. 11). However, one characteristic neglected by this definition is the question of ownership, an integral element of a digital asset. By omitting ownership from the definition, it is not known who owns the asset.

Another issue is that a digital asset's functions can change during its lifecycle. Analysis of existing academic literature during the writing of this chapter shows that little research has been conducted to create a framework or a technique for tracking digital asset functions throughout their lifecycle. As a result, there has been a wave of regulatory concerns in recent times, particularly involving initial coin offerings (ICO's) (Lee and Pilkington, 2017). ICO's occur "when a company (or an open-source project) pre-sells tokens which serve as an internal medium of exchange yet to be built" (Li & Mann, 2018, p. 1). Tokens are a digital representation of an asset which "can be used and exchanged over a digital network" (Deloitte, 2019, p. 9). Regulators have no method of defining digital assets and no framework which tracks and monitors these token sales. Subsequently, the Securities and Exchange Commission (S.E.C), the regulatory body in charge of regulating the U.S. securities industry, has no choice but to investigate each ICO on a case-by-case basis (Sec, 2017b). As with many digital innovations which affect multiple jurisdictions, technology often outpaces regulatory bodies; this is especially true in the of ICO's and the S.E.C(Debler, 2018). In parallel, there has been an increase in market interest, with $6.3 billion in funds raised by ICO in Q1 of 2018, surpassing the total of ICO funds raised during the whole of 2017 (Floyd, 2018). This significant level of growth has put an unprecedented strain on regulatory bodies who still appear to be uncertain on the most effective means of classifying digital assets (Koens, 2019).

As regulatory bodies struggle with classification of every evolving and multi-faceted asset, it is argued herein that a framework is required to model digital assets and decentralised applications according to their properties, instead of their functions which don't change throughout the asset's life. Based on this issue, this chapter will examine the following research question: *how can digital assets be characterised and classified according to their properties?*

Following an analysis of literature on digital assets, their uses and their future potential for disruption, one key theme emerged: classification. The theme of classification emerged as there is a lack of a consistent framework for the classification of digital assets. Regulation is a key element that falls under the theme of classification as there is a lack of regulatory oversight around the various types of digital assets across multiple jurisdictions. In the following section, the need for clarity regarding digital assets and their classification is discussed.

2.2. Qualifying the Problem Area

This study addresses RQ1 by developing a framework for characterising and, in doing so, classifying digital assets. In this section, the theme of classification is explained to help the reader understand some of the pitfalls of the current state of digital asset classification and by extension, regulation.

2.2.1. Classification

An analysis of existing literature from regulatory and other governmental bodies on digital assets reveals two aspects about the classification of digital assets. Firstly, although some of the existing frameworks are similar, there is a misalignment in how they classify digital assets. In addition to this, some frameworks, such as that created by the Cryptoassets Taskforce (2018) classify digital assets by their functions as opposed to their structural features. Functions are dependent on how the digital assets are interpreted by its system (Cryptoassets Taskforce, 2018; FINMA, 2018; SEC, 2017b) and as such, classifying digital assets by their functions may not be suitable. Classifying digital assets according to their functions might not be optimal as some digital assets can have different functions at different points within their lifecycle.

The Swiss financial regulator, FINMA, published a report on regulatory guidelines on digital assets where they classify them into three distinct categories. They state in the report that their categorisation approach is based on the underlying economic function of the asset or token (Finma, 2018). The first they classify as Payment Tokens, which are tokens *"intended to be used, now or in the future, as a means of payment for acquiring goods or services or as a means of money or value transfer"*. They go on to add that they are synonymous with cryptocurrencies. They define Utility Tokens as *"tokens which are intended to provide access digitally to an application or service by means of a blockchain-based infrastructure."* Finally, they define the third category, Asset Tokens, as representing *"assets such as a debt or equity claim on the issuer. Asset tokens promise, for example, a share in future company earnings or future capital flows."* They add that these are analogous to equities, bonds or derivatives (Finma, 2018, p. 3).

Similarly, the Cryptoassets Taskforce (2018) categorises digital assets into three broad types based on their functions: exchange tokens ('cryptocurrencies' such as Bitcoin, Litecoin and equivalents), security tokens (provide rights to the holder such as ownership, repayment of a specific amount of funds, or entitlement to a share in future profits), and utility tokens (provide access to a specific product or service that is typically provided using a DLT platform). These classifications may be similar to those of FINMA, however, it is stated by the (Cryptoassets Taskforce, 2018, p. 9) that "the way a cryptoasset is used, or its features, means that it could fall under several categories at any one time or at different points in its lifecycle”. This is problematic as technically a digital asset could transition through different categorisations depending on its maturity levels. FINMA does not note the fact that digital assets could fall into multiple categories. The differing stance on the regulation of digital assets by two regulatory bodies, who should be closely aligned, demonstrates the lack of a common regulatory understanding of digital assets. A thorough definition and framework could lead to a common language for parties to build a better and shared understanding. Digital assets have structural characteristics and, based on a review of frameworks produced by regulatory bodies such as FINMA and the Cryptoassets Taskforce, it appears that regulatory bodies have not yet classified them based on structural characteristics.

Based on the above, there is a recognition of the need for a means of accurately and consistently classifying digital assets, and some regulatory bodies have attempted to provide regulatory oversight over digital assets already. Regulators are at the early stages of identifying and monitoring digital assets, but the balance between over-regulating and stifling technological advancement must be found(Clayton, 2018). According to the U.S. Securities and Exchange Commission (SEC), digital assets may fall under the definition of a virtual currency, which is “a digital representation of value that can be digitally traded and functions as: (1) a medium of exchange; (2) a unit of account; (3) and/or a store of value” (Sec, 2017b, p. 3). On the other hand, the Cryptoassets Taskforce states that cryptoassets are “not considered to be a currency or money, as both the Bank of England and the G20 Finance Ministers and Central Bank Governors have previously set out” (Cryptoassets Taskforce, 2018, p. 12). Categories laid out by the Swiss Financial Market Supervisory Authority (FINMA) are non-binary in nature, meaning that a digital asset can fall into several of their categories. They are also loosely defined, leading to further confusion around the classification and regulation of digital assets. Recent studies highlight evolving complexities in classifying digital assets within the blockchain ecosystem, particularly regarding their circulation and the technological challenges faced (Zhu et al., 2024). This aligns with ongoing efforts to refine frameworks for asset classification to ensure consistent regulation and management.

A more succinct approach to the classification of digital assets could help industry stakeholders to understand whether an asset falls under securities or anti-money laundering (AML) regulation or both. In the case where there is not an appropriate regulatory policy to cover digital assets, a common framework for the classification and characterisation of digital assets could help inform the drafting of an appropriate policy. This chapter aims to create such a framework.

In summary, the theme of classification emerged mainly from reviewing literature from regulatory bodies and other state funded committees who have published papers and reports on the nascent field of digital assets. Upon analysis of this literature, it became clear that a framework that could be used to classify digital assets according to their properties would not only help to distinguish between different types of digital assets but would also assist regulators in regulating them going forward.

2.3. Research Approach

To address the lack of a framework for characterising and classifying digital assets based on their properties, a framework was developed iteratively to characterise and classify digital assets on an individual basis. This section describes the research approach used and is broken down as follows:

- The research canvas details March and Smith (1995)'s design science framework which acted as a template for the creation of the framework created in this chapter.
- Different research methodologies are required to address RQ1.
- The remainder of this section deals with the literature review and concludes with a use-case of the framework itself.

2.3.1. Research Canvas

The nature of RQ1 looks at how digital assets can be characterised and classified according to their properties, is suited to design science research for several reasons. Design science is referred to as "knowledge in the form of constructs, techniques and methods, models, and/or well-developed theory for performing this mapping—the know-how for creating artefacts that satisfy given sets of functional requirements" (Vaishnavi et al., 2004, p. 4). They go on to say that "design science research is research that creates this type of missing knowledge". The topic of DLT and, more specifically digital assets, is very much in its infancy and, therefore, there are gaps in existing research when it comes to the classification of them.

March and Smith (1995) describe a design science framework with two axes, one for research activities and the other for research outputs – see Table 2.1. Research activities run horizontally and consist of build, evaluate, theorise and justify. In their paper, March and Smith suggest that "building and evaluating IT artefacts is of design science intent" whereas "theorising and justifying is of natural science intent" (March & Smith, 1995, p. 256). Therefore, as this chapter and the information it aims to find is of design science intent and not natural science intent, the decision to concentrate on the building of artefacts columns in the research canvas (Table 2-1) was made. The theorise and justify columns are therefore omitted.

Once the required research outputs were identified, the research canvas template created by March and Smith (1995) was populated with the research activities required to achieve these outputs. Each cell contains at least one specific research activity which should be performed as part of this thesis' digital asset framework research. The *Build* column looks for the basic building blocks that were identified as necessary when developing a framework to be used in conjunction with digital assets and distributed ledger technology. The *Evaluate* column deals with measuring aspects of usability and robustness for the framework.

	Build	**Evaluate**
Constructs	Identification of digital asset key characteristics	Investigate completeness and understandability
Model	Create a framework allowing users to categorise digital assets based on these key characteristics	Investigate robustness using basic real-world assets
Method		

Instantiation	Prototype/framework which can be completed for each individual asset	Apply framework to real dapp* digital assets

Table 1-1 - Research Outputs and Activities Mapped using adapted Research Canvas of March and Smith (1995)

*A decentralized application (dapp) is an application built on a decentralized network that combines a *smart contract* and a frontend user interface (Ethereum Foundation, 2024) .

2.3.2. Methodology Choice

March and Smith (1995) explain that each of the different research activities mapped using the canvas may require a different research methodology. To address this, Table 2.2 has been included. Table 2.2 is adapted from a paper by Palvia et al. (2003) which outlines different methodologies in MIS research. The methodologies that will be implemented are defined below in Table 2.2.

Methodology	Definition
Speculation/commentary	Research that derives from thinly supported arguments or opinions with little or no empirical evidence.
Frameworks and Conceptual Models	Research that intends to develop a framework or a conceptual model.
Library Research/Literature Review	Research that is based mainly on the review of existing literature.

Literature Analysis	Research that critiques, analyses, and extends existing literature and attempts to build new groundwork (for example, it includes meta-analysis)
Case Study	Study of a single phenomenon (for example, an application, a technology, a decision) in an organisation over a logical time frame.
Secondary Data	A study that utilises existing organisational and business data (for example, financial and accounting reports, archival data, published statistics, etc.)

Table 2-2 - MIS methodologies used in the research based on Palvia et al. (2003)

Table 2.3 below refers to which of the above research methodologies have been applied to each of the research activities that were identified in Table 2.2 above.

	Build	**Evaluate**
Constructs	Speculation Literature Review Literature Analysis Frameworks and conceptual models	Literature Analysis Secondary Data
Model	Speculation Literature Review Literature Analysis	Literature Analysis Secondary Data

	Frameworks and conceptual models	
Method		
Instantiation	Frameworks and conceptual models	Secondary Data

Table 2-3 - Research methodologies to be used mapped using research canvas (March & Smith, 1995)

2.3.3. Secondary Data Usage as a Means of Framework Construction

In this study, sources of organisational secondary data were analysed and used as a basis to test and evaluate the validity of the framework. The basis of this activity is a combination of using organisations' open-source GitHub repositories and whitepapers that outline the business use case. Self-governing organisations that live on a blockchain environment take the form of Decentralised Autonomous Organisations (DAOs). Chohan (2017, p. 1) defines a DAO as an "organisation that is run through rules encoded as computer programs called 'smart contracts'". A DAO's financial transaction record and programmed rules are maintained on a blockchain. A list of previous DAO's was compiled through a web search. Next, the DAO scope was further narrowed by focusing on Ethereum-run organisations as information was more readily available on these organisations, likely because of the prevalence of smart contracts on the Ethereum blockchain. In addition, this research had access to GitHub repository open-source code and whitepapers outlining the architecture of the autonomous organisation, which were closely examined.

As well as having access to GitHub repositories and whitepapers, a comprehensive literature review was carried out, as detailed in the next section.

2.3.4. Refining Literature

The literature review process followed the guidelines and instructions of Webster and

Watson (2002). The first step in conducting the literature review involved the identification of relevant literature covering the topic of digital assets and Distributed Ledger Technology. As a starting point, the basket of eight information systems journals were examined for papers on the topic of digital assets and DLT. Keyword searches were performed on titles and abstracts of the papers for keywords: 'Digital assets', 'Distributed Ledger Technology', 'DLT', 'Blockchain', 'Crypto-Assets' and 'Cryptocurrency'. Digital assets are a relatively new phenomenon and because of this, it was found that many of the leading Information Systems Journals were lacking in papers focussing on the area. Therefore, a decision was made to widen the search to other papers outside of the basket of eight as well as industry reports from organisations and regulatory bodies. For reasons of quality assurance all media outlets and for-profit organisations lacking a long-standing reputation in the area of finance were discarded to maintain the validity of the findings. Once the search of papers was complete, a backward review of citations identified in these papers was performed, as per Webster and Watson (2002). After this step, a forward review was performed using web of Science and Google Scholar searches to identify papers citing the key papers identified in the previous steps. Once these steps were completed, there were approximately 50+ papers identified on the area of digital assets and DLT.

This number was reduced by narrowing the scope of the search and refining. Firstly, papers that focussed solely on cryptocurrencies as units of speculative investment and not on the underlying technology or utility were discarded as these papers had a view on the use of digital assets that did not align with the objective of this study. This narrowed the number of papers to 41. Following this, all papers that didn't explore digital assets characteristics or underlying properties were discarded, further reducing the number to 27 papers. At this point core concepts in the literature were then identified.

2.3.5. Review of Empirical Literature

The Concept Centric Matrix in Table 2.4 identifies the core concepts in the literature published on the topic of digital assets. The first two columns of the table include the name of the author and the year of contribution. The following columns reveal the major digital asset concepts and characteristics uncovered and identifies which author has contributed to this area.

The first iteration of core concepts identified were as follows: 'Fungibility', 'Identity', 'Contract', 'Data Store', 'Central Bank Digital Currency (CBDC)', 'State' and 'Composability'. However, it was determined that CBDC, albeit a recurring concept in the literature, was an application of digital assets and not a characteristic. Therefore, CBDC was removed as a core concept from the literature review.

The 'Fungibility' column shows where research discusses whether the asset is unique in nature. An Ethereum standard from 2017 established that digital assets can only be fungible or non-fungible, resulting in the ERC721 token standard (Shirley, 2017). For example, a €1 coin is the same as any other €1 coin, therefore they are fungible. On the contrary, an original oil painting is unique, therefore it would be referred to as non-fungible. The 'Identity' column indicates research papers which examine the ownership of digital assets. An individual or a business who owns the digital asset is an example of the associated identity. The 'Contract' column highlights research that goes into depth about digital assets that contain "smart contracts". The concept of smart contracts was proposed before the advent of digital assets and DLT by Nick Szabo as contracts that "combine protocols with user interfaces to formalize and secure relationships over computer networks" (Szabo, 1997). In this context they are in essence functions that act upon the data in a DLT environment. The 'Store of Data' column specifies research that offers insight into digital assets that have certain data attached to the asset. Sender, receiver, and quantity are examples of such data attached to the asset. The 'State' column indicates papers exploring whether an asset was conceived on a blockchain like Bitcoin or whether it is representative of a real-world asset. Digital assets can either be natively conceived on-chain like Bitcoin or represent real-world assets such as real estate property or other financial securities (Sehra et al., 2018). Finally, the 'Composability' column indicates research that defines whether digital assets are composed of sub-assets or are standalone in nature. Digital assets can only be composable or non-composable, as seen with the inception of the ERC998 token standard (Lockyer, 2015). As an example of this concept, a single share of a company is non-composable as it cannot be broken down into any smaller units. An exchange traded fund (ETF), on the other hand, is a basket of financial securities grouped together and as this can be broken down into the individual shares that make up an ETF, it is composable.

Authors & Year	***Fungibility***	***Identity***	***Contract***	***Store of Data***	***State***	***Composability***
(Ainsworth & Shact, 2016)	*X*	*X*	*X*	*X*		
(Aitzhan & Svetinovic, 2016)	*X*		*X*			
(Ekblaw et al., 2016)		*X*		*X*		
(Brandon, 2016)		*X*	*X*	*X*		
(Danezis & Meiklejohn, 2015)	*X*	*X*			*X*	
(Fujimura et al., 2015)		*X*	*X*	*X*	*X*	
(Hayes, 2016)	*X*		*X*		*X*	
(Korpela et al., 2017)	*X*	*X*				

(Mainelli & Smith, 2015)	*X*	*X*				
(Mettler, 2016)	*X*			*X*		
(Nakamoto, 2008b)	*X*	*X*		*X*	*X*	
(Nguyen, 2016)	*X*	*X*			*X*	
(Lee & Pilkington, 2017)		*X*	*X*	*X*	*X*	
(Rosenfeld, 2012b)	*X*				*X*	
(Sikorski et al., 2017)	*X*	*X*				
(Tian, 2016)	*X*	*X*		*X*		
(Yasin & Liu, 2016)		*X*	*X*	*X*	*X*	
(Y. Yuan & F.-Y. Wang, 2016)		*X*		*X*	*X*	
(Zou et al., 2016)		*X*	*X*	*X*	*X*	

(Westerkamp et al., 2018)	*X*		*X*	*X*		
(Treacher, 2018)	*X*	*X*	*X*	*X*	*X*	
(Sehra et al., 2018)	*X*				*X*	
(Chevet, 2018a)	*X*	*X*			*X*	*X*
(Lockyer, 2018)	*X*					*X*

Table 2-4: Concept Centric Matrix of Digital Asset Characteristics

2.4. The Digital Assets Framework

Table 2.5 presents the six key components of the digital asset framework based on the concepts identified in the concept centric matrix. Being able to aggregate these characteristics into one holistic framework allows a better understanding of existing digital assets or the ability to architect new assets in a clear cohesive manner. The next two sections explain the data and structural components found in Table 2.5 below.

2.4.1. Data Components Explained

	Component	Explanation	Literature
Data	**Owner**	This refers to the identity of the owner of the digital asset. The owner is represented by a public key in the distributed system which acts as a digital identifier.	(Yasin & Liu, 2016)
	Store of Data (Data Fields)	An array of contractual data belonging to the digital asset.	(Wood, 2014)
	Contract	A smart contract is a computerised transaction protocol that executes the terms of a contract for the digital asset. This is intended to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimise exceptions both malicious and accidental, and minimise the need for trusted intermediaries.	(Szabo, 1994)
Structural	**State of Asset**	This refers to whether the digital asset is representative or native in nature. A native (or endogenous) asset is a digital asset whose data exists exclusively within the boundaries of the system and does not require a connection to external systems. A representative (or exogenous) asset is a digital asset	(Rauchs, 2018)

		whose data is exclusively extrinsic to the system and thus requires gateways for connection to the external world and enforcing transactions.	
	Composability	Digital assets can be composed of multiple different digital assets that are combined to form a new asset (composable) or can be structurally independent (non-composable).	(Chevet, 2018a)
	Fungibility	The property of an asset where individual units are interchangeable. A non-fungible asset is common and multiple versions of this asset with the same properties can exist. A fungible asset is one that is unique and has its own value and properties.	(Rosenfeld, 2012b)

Table 2-5 Framework Components Explained

Data components are open to user input in contrast to structural components where a binary decision must be made. This leads to the framework being split into two distinct sections:

1) Data components referring to framework components dealing with the context of the data itself (Identity, Store of data and Contract)

2) Structural components referring to framework components dealing the architectural context of an asset being (State, Composability and Fungibility).

Components such as 'Identity' can establish a clear line of ownership over the asset from its conception. A line of ownership is fundamental for auditing and supply chain systems (Yasin & Liu, 2016). 'Store of Data' (Wood, 2014) and 'Contract' (Szabo, 1997) components distinguish between the data and functions, similar to an entity-relational model. Connecting this to the 'composability' (Chevet, 2018b) and ‘fungibility’ (Rosenfeld, 2012a) components allows for these assets to be modelled more accurately, according to their behaviour in a distributed ledger system. ‘State of Asset’ gives an insight into the regulatory implications of the digital asset at hand (Rauchs, 2018). For example, representative assets referencing assets in an external system place the boundary of regulation on the underlying reference asset itself and not on its digital representation in a distributed ledger environment. This gives users a litmus test on whether the regulation of the digital asset in question should be investigated on a deeper level.

2.4.2. Structural Components Explained

This section describes the structural components. Figure 2.3 below was created to visually represent the components. The figure is split into six cells, each of which illustrates the different characteristics of digital assets: fungible or non-fungible, composable or non-composable, native or representative.

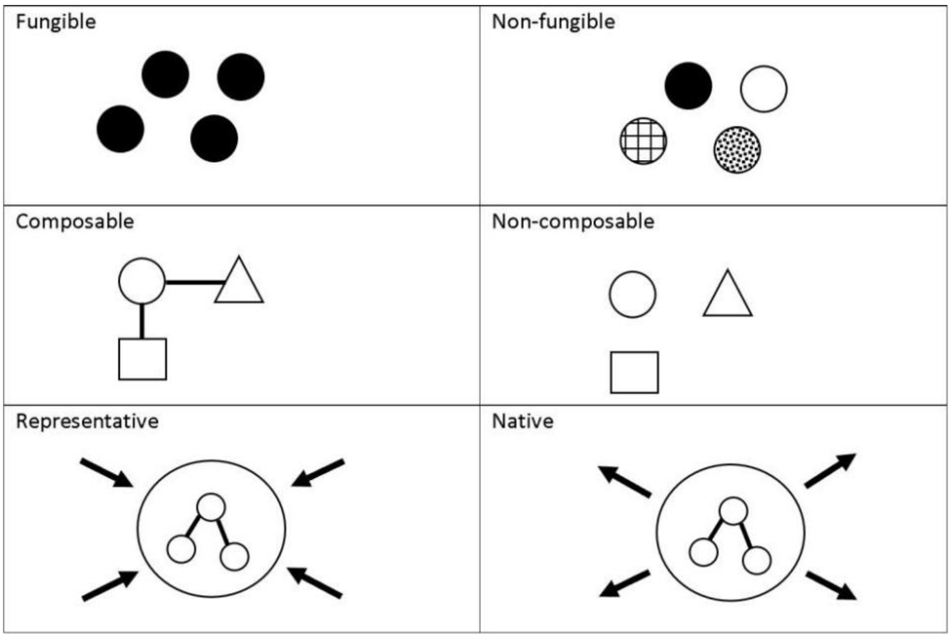

Figure 2-2. Structural Elements of Digital Assets

As presented in figure 2.3, in the context of the ‘Fungible’ cell, the four assets shown are indistinguishable; for example, one unit of Ether (on the Ethereum network) is interchangeable with any other unit of Ether. In contrast, the four non-fungible assets in the section labelled ‘Non-fungible’ are all unique. MedRec, an application used to store individuals' medical records on the blockchain is an example of this(Ekblaw et al., 2016). Composable assets consist of a network of child assets linked to a parent asset. For example, DADA, a crypto-based art network where you can link a non-fungible token representing an art piece to a pre-existing non-fungible token of a CryptoKitty – a crypto collectible (introduced more formally later in this chapter), forming a parent-child data relationship (Chevet, 2018a). Conversely, non-composable assets are standalone digital assets that have no child assets. An example of this is Blockcerts which utilises blockchain to issue university diplomas, which are independently-verifiable and tamperproof (Schmidt, 2015). Native assets refer to data or digital assets that exclusively exist within the boundaries of the blockchain network and do not require a connection to external systems. Essentially these are assets that were conceived on a blockchain network and are therefore "Native" to the network itself. For example, a cryptocurrency such as Bitcoin has all its pertaining data within the distributed ledger environment. Representative assets record referencing data that is extrinsic to the system and thus requires gateways for connecting to the external world and enforcing transactions. An example of this is Everledger's use of blockchain to track diamonds. Data relating to a specific diamond is stored in a referencing asset in the distributed system (Underwood, 2016).

2.4.3. Evolution of Digital Asset Framework

As design science is an iterative research methodology which focuses on creating artefacts as well as developing them over time, the process for the creation of the digital asset framework was incremental in nature. The core concepts that became the characteristics that made up the digital asset framework were not the only ones that emerged from the literature during the literature review. The first row in the figure below depicts the various concepts that emerged in the literature review. These concepts, or key characteristics of digital assets are Fungible, Non-Fungible, Identity, (Smart) Contracts, Data stores, Central Bank Digital Currency (CBDC), Representative, Native, Composable and Non-Composable. As research continued into these areas with the lens of creating a framework applied, the components of the framework were iteratively developed. 'Fungible' and 'Non-Fungible' were combined to form the binary characteristic of 'Fungibility'. Similarly, 'Representative' and

‘Native’ were combined to form the ‘State’ characteristic. In addition to this, ‘Composable’ and ‘Non-Composable’ were combined to form ‘Composability’. In the second iteration of framework creation, the characteristic of CBDC was deemed not to be a characteristic of a digital asset and more so an application or use-case. Therefore, CBDC was removed leaving only the core characteristics which make up the digital asset framework.

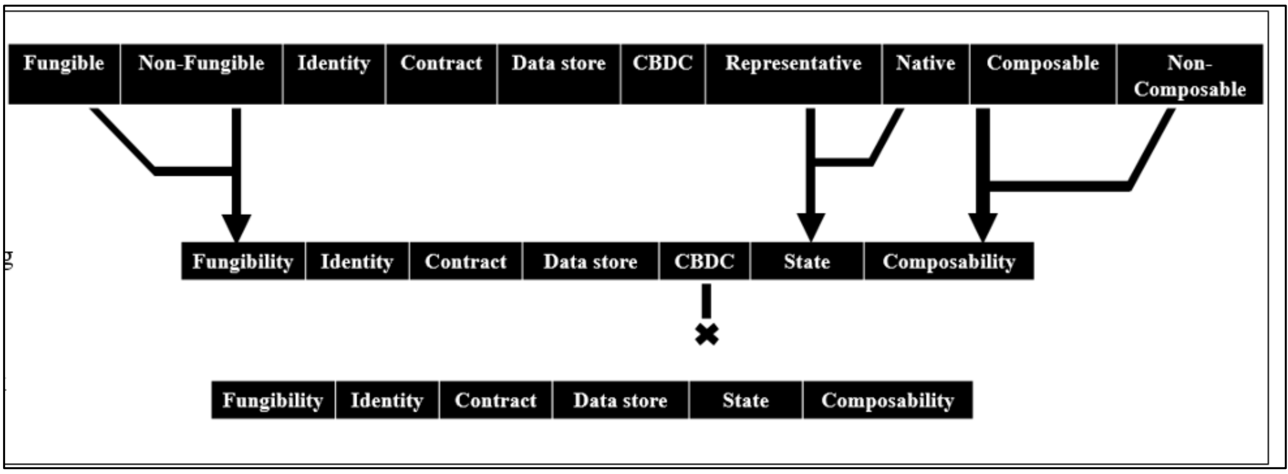

Figure 2-3 – Evolution of digital asset framework components

2.5. Framework Evaluation

To assess the utility of the derived framework, it was applied to two separate ‘isolated’ digital assets to assess the classification functionality. ‘Isolated’ here refers to a digital asset which has been extracted from a blockchain based application. Both use cases include: (1) a background of the application where the digital asset originates from; (2) the isolated asset from the application it’s used in to illustrate classification functionality; and (3) a discussion of the framework applied.

2.5.1. MolochDAO

MolochDAO was selected as a use case as it represents a completely “decentralised, multi-party decision process” that is contained solely within a distributed ledger environment and would, therefore, illustrate the benefits of the derived digital asset framework (Duncan, 2019, p. 1).

Background

Created in February 2019, MolochDAO is a DAO (Decentralised Autonomous Organisation), whereby all organisational governance is found within the smart contracts themselves. This project tries to solve the problems of misaligned parties who have invested in public blockchain infrastructure by coordinating and incentivising groups that could have competing interests (Bhuptani, 2019a; Olszewski, 2019). The DAO structure encompasses pooling of funds and voting on fund allocation to more effectively share costs resulting in a greater ecosystem benefit(Kaal, 2020). As of June 2019, fifty-one members have allocated over $1,500,000 to the fund. There have been 65 proposals so far which consist of both membership (wanting to join the fund) and grant (requests for funding) proposals. The MolochDAO project poses a number of interesting mechanisms for future consideration in decentralised funds (El Faqir et al. 2020). Members' funds are pooled together, and each member has voting rights proportional to the funds invested in the total voting pool. This incentivises members to increase their proportional ownership in order to maximise their voting rights. On the other hand, liquidating shares means sacrificing decision-making capabilities over the future of the pool. Access to the fund is restricted by existing members, who vote on allowing new entrants to the fund (Arikan, 2019). This naturally incentivises members to only admit new entrants who are aligned with the group's interest in order to share costs with them. Existing members voting shares are diluted proportionally which further provokes members to vet new entrants for a longer-term benefit strategy (Withiam, 2019).

A grace period exists after the grant voting proposal has completed allowing withdrawals. After every voting proposal comes to an end there is a 'grace period' to allow members who took a minority position on the proposal to leave the fund and liquidate their position if they wish. This means the remaining members bear the cost of the proposal (Bhuptani, 2019b).

Isolated Asset Classification

PROPOSAL

Owner	Proposer	
Data Fields	Proposer, Applicant, SharesRequested, StartingPeriod, YesVotes, NoVotes, Processed, DidPass, Aborted, TokenTribute, MaxTotalSharesYesVote	
Contracts	ProcessProposal, abort	
State?	Native	Representative
Composable?	Non-Composable	Composable
Unique?	Non-Fungible	Fungible

Table 2-6. Isolated Digital Asset Framework applied to 'Proposal' asset in the MolochDAO system.

The table above presents the ownership, data, and contract of an isolated proposal asset, from the MolochDAO system.

State: As proposals are created on-chain they are native.

Fungibility: As the user decides the specificity of the data that is inserted into proposals and not the system, all proposals are unique and with differing intrinsic value thereby non-fungible.

Composability: Proposals are not composed of any other child data structures. It is therefore non-composable.

The native state of the proposal shows that all data and functions pertaining to the asset can be found within the boundaries of the system itself. The 'contract' field shows that proposals are self-executing via smart contracts. Proposals are processed or aborted after all the yes/no votes are tallied.

Discussion of Framework Application for Businesses

All of the assets in the molochDAO system are native. This means that the system as a whole is located within a distributed ledger system and external system integration isn't needed. The 'PROPOSAL' asset depicted in the framework above is non-composable, as it is not composed of any other digital assets. In fact, all assets in the MolochDAO system are non-composable except for the 'GUILD_BANK' asset, which is composable due to its inherent nature acting as a holding account for tokens in the system. The owner of the 'PROPOSAL' asset is the Proposer, in other words the person who has proposed the investment.

Usage of the framework is beneficial here for several reasons. As illustrated in figure 2.5, using the framework highlights insights that may be of interest to a business analyst, technical architect or developer when developing or analysing decentralised applications. The framework can be used as a tool to help technologists to visualise digital assets in a blockchain based system. From a regulatory perspective, the framework could be a means for regulators, among others, to classify and understand the digital assets that interact with or operate within a decentralised application, such as MolochDAO.

2.5.2. CryptoKitties

As a second use case, CryptoKitties was chosen. Demonstrating the framework for both MolochDAO and CryptoKitties gives individuals an understanding of the wide spectrum of usages for this framework, whether they be financial or not.

Background

CryptoKitties was chosen as a use case for several reasons. The first is that it is an interesting use-case of blockchain technology that aims to provide education of distributed ledger technology through gamification. It allows previously esoteric concepts to be normalised, so users can become familiar with the technology. In addition to this, it's a use-case that is relevant outside of the realm of financial services. Finally, it was the first prominent use-case of the ERC-721 standard as these tokens were used as the backbone of CryptoKitties (Virk, 2018) thus making it an appropriate choice to verify the framework. An important function of CryptoKitties is that it acts as a 'crypto-collectible'. A crypto-collectible is defined as a 'cryptographically unique, non-fungible digital asset' (Chevet, 2018b, p. 5).

CryptoKitties are digital, collectible cats, that can be bought and sold using Ether and bred to create new collectibles with varying traits.

KITTY		
Owner	claimant Address	
Data Fields	genes, birthTime, cooldownEndTime, matronId, sireId, siringWithId, cooldownIndex, generation	
Contracts	bid, getKitty, breedWith, breedWithAuto, giveBirth, createSiringAuction, approveSiring, createSiringAuction, createSaleAuction, getAuction, cancelAuction, transfer, approve, transferFrom	
State?	Native	Representative
Composable?	Non-Composable	Composable
Unique?	Non-Fungible	Fungible

Table 2-7. Isolated Digital Asset Framework applied to 'Kitty' asset in the CryptoKitty system

Isolated Asset Classification

State: Kitties were originally conceived and reside on the Ethereum blockchain and are therefore native.

Fungibility: Due to the ability for the digital Kitties to breed and traits to be combined from parents, Kitties are unique and non-fungible.

Composability: A Kitty asset is composed of a token and the underlying Kitty itself and is therefore composable.

Discussion of framework application

Ownership can be established via the current wallet holder as well as the previous lineage of owners by examining the transactional data. The 'data' and 'contract' fields lay out the objectives and boundaries of the Kitty asset in a transparent auditable manner. The composable nature is what differs from the previous MolochDAO example. The non-fungibility aspect makes this an asset suitable for tracking and supply chain uses. The fact that every unit is unique can limit the regulatory burden as this type is not suited for securities or assets which can be exchanged for one another.

The application of the framework in this instance is beneficial for usage when architecting and designing decentralised applications as per MolochDAO; however, as this application is outside the realm of financial services, the potential regulatory benefits are not relevant. In the area of crypto-collectibles, the framework could be utilised to reflect current and previous ownership of the asset, as well as detailing characteristics of the asset, but on an off-chain basis.

2.6. Summary & Next Steps

This chapter makes an important contribution to the field by enhancing the knowledge of digital assets. It illustrates that digital assets are multi-faceted and cannot just be categorised by individual factors. On a structural level, they are divided by their state (Rauchs, 2018), composability (Chevet, 2018a) and fungibility (Rosenfeld, 2012b). From a data perspective, they can further be defined by their owner (Yasin & Liu, 2016), store of data (Wood, 2014) and contractual functions (Szabo, 1994). In unison, these qualities can be combined to form a framework to analyse digital assets from a new perspective. In contrast to current frameworks in place (Finma, 2018; SEC, 2017a; Taskforce, 2018), this framework characterises and classifies assets on a structural level which is consistent over the lifetime of the asset, unlike current frameworks which model based on functions which may change over the asset's life cycle.

The value of the framework derived in this chapter can be divided into three parts, 1) utility of classification 2) definitive responsibility, and 3) understandability of regulatory implications.

The Digital Asset Framework most significant contribution is that to the areas of digital asset characterisation and classification. The framework will allow several different stakeholders whom interact with digital assets to classify them according to their structural properties, as opposed to by some looser functional properties, as other frameworks do (Cryptoassets Taskforce, 2018; Finma, 2018). This type of classification of digital assets not only benefits regulatory bodies who may look to classify digital assets and regulate them specifically based on which category they fall into but could also prove crucial for use by business analysts and technical and/or solution architects when looking to design decentralised applications. The framework should allow these users to map and understand the data and structural characteristics of any digital asset being used in their application and therefore could be a useful tool in decentralised application design.

The framework has instrumented a method to define responsibility in relation to digital assets in the form of ownership. Using the framework one can more easily track ownership of a digital asset from their inception which is fundamental for various forms of auditing and supply chain provenance systems(Yasin & Liu, 2016).

Finally, this framework has helped to highlight some potential regulatory implications. For example, the state of the asset, whether the asset is native, or representative of an underlying asset is a determinant of the regulatory environment. Composable assets can come under heavy scrutiny due to different regulatory environments, especially when multiple child assets are in different states and/or industries. Effective regulation is more manageable on the organisations interacting with the digital assets themselves rather than on an asset level where it can lead to a case by case examination (Finma, 2018; SEC, 2017a).

Next Steps

Another potential use of the Digital Asset Framework realised when researching this chapter was the potential to utilise it to model digital assets and decentralised applications according to their properties. Using tools such as Unified Modelling Language or UML to visualise the relationship between entities. In a future version of this chapter, further exploration needs to be conducted to build upon the existing tools seen in UML-based entity-relationship diagrams and to enhance modelling conventions to make it applicable to decentralised applications. By using a framework like this, the decentralised characteristic of an asset can be illustrated in a more intuitive way. It also empowers developers and analysts to see the characteristics of an asset and how they work at a systems level (1976). Some further research was conducted into this potential use-case, but was not within the scope of RQ1 and as such, has been included in the appendix of this thesis (Section 6.1).

In addition to this, while researching digital assets and their characteristics, a research gap relating to the key process of tokenisation was identified. The gap was discovered when trying to understand how suitable some assets are to tokenisation - the key process of conversion of a non-digital asset to a digital asset. Tokenisation emerged frequently as a theme in the literature review for chapter 2. If digital assets such as tokenised securities are to be adopted and utilised across the financial services industry then it will require traditional financial securities to be converted to digital assets, which requires tokenisation. However, non-digital assets are diverse in nature and there are indicators that some assets may be less suitable for tokenisation then others. Therefore, the next chapter illustrates this gap in the tokenisation research, presenting a novel solution in the form of a tokenisation suitability framework.

3. A Framework to Evaluate the Impact of Tokenisation

3.1. Abstract

Chapter 3 formally introduces the concept of Tokenisation into this study by investigating the area and proposing a framework which looks to determine the impact that tokenising an asset will have on an organisation. The framework is proposed by first looking at the processes of securitisation and digitalisation and comparing the impacts that these respective processes would have with tokenisation. This then allows the creation of a framework which doesn't just determine a general impact of tokenisation on assets but quantifies how much business value is derived from tokenising an asset as well as how much it would disrupt an organisation and its industry.

3.2. Introduction

Tokenisation is a process which allows the economic value represented in assets to be unlocked by converting them into a digital token; this can then be manipulated in a blockchain environment (Sanghavi, 2018; Wachal, 2018). Tokenisation has emerged as a potentially revolutionary approach in asset markets, with blockchain technology at its core. Recent research highlights how tokenised platforms can enable decentralised exchanges of digital assets without the need for intermediaries, significantly improving market efficiency (Juan et al., 2023). Moreover, these developments promise enhanced automation, auditability, and compliance, thanks to programmable tokens and smart contracts (Juan et al., 2023). One novel use case is the tokenisation of real estate property such as an individual's home, a process being undertaken by a company called SwissRealCoin(Luginbühl, 2018). Initial Coin Offering's (ICO's) provide another example of the use of tokens and the broader concept of tokenisation (Laurent, 2018a). On the other hand, tokens offered as part of a Security Token Offering (STO) are financial securities backed by "traditional financial instruments" such as "equity, debt, revenue sharing rights or any other mechanism in the form of a cryptographic token" (Hermansen, 2020). Security tokens offer the same functionality as traditional security, however, distributed ledger technology or DLT, is used to confirm ownership of the security (Zaki, 2018); this makes the possibility of fractional ownership of security more feasible (Lintner, 1965). The concept of fractional ownership and tradability, giving assets the ability to be traded on global markets, originated with securitisation. Securitisation has since gained a digital element that has evolved to form an STO. To understand the importance of this evolution, this change will be compared to tokenisation in two ways: (1) a comparison with securitisation and (2) a comparison with digitalisation (the process of giving assets a digital identity). Both elements are foundational to the inception of the framework derived in this chapter.

3.2.1. Securitisation and the Tokenisation Landscape

Asset securitisation describes a company decoupling itself from an asset by transferring the asset to a "Special Purpose Vehicle" or SPV (PWC, 2016b, p. 9). The resulting SPV is a separate legal entity from which shares can then be issued in order to raise funds (PWC, 2011). Tokenisation has commonly been compared to securitisation as a means of financing (Levine, 2019). Securitisation can be considered as a "top-down" approach that starts at an organisational level with the establishment of a SPV (Schwarcz, 2013). Tokenisation, on the other hand, can be thought of as a "bottom-up" approach, as it enables one to unlock the economic value represented in assets by converting them into a digital token (Sanghavi, 2018; Wachal, 2018).

Securitisation involves several intermediaries: from a legal perspective to establish a SPV, from a financial perspective to issue the securities, and from an administrative perspective. With the establishment of a standardised token model such as Ethereum's ERC 1400, the goal was to disintermediate some of the legal, financial, and administrative overhead from the securitisation process (Dossa, 2019; Micheler, 2015). Another similarity between the approaches ensues from the purpose of the asset. Both securitisation and tokenisation are used as a means of financing (Schwarcz, 2013). However, tokenisation goes a step further and can also be used for: (1) verification of the rights of ownership of an asset; (2) tracking the transfer of ownership from one individual to another; and (3) digitising an asset to allow for integration with external systems (Kim, 2018).

Similar to the process of securitising an asset, the ability to embed functions of a traditional financial asset (for example, allowing an asset to be subdivided and traded) are important components of tokenisation (Hubbard & Hubbard, 1994).

3.2.2. Digitalisation and the Tokenisation Landscape

Digitalisation refers both to a transformation from “analog” to “digital” (for example, a shift from cash to electronic payments) and to the facilitation of new forms of value creation (Guo, 2016). Accessibility (increased access to data), availability (always online and ready to be used), and transparency (full access to the transaction history of all users) are examples of value creation (Bauer et al., 2018)

Asset tokenisation in financial markets involves transforming existing financial processes such as settlement, asset reconciliation, or general infrastructure by leveraging blockchain technology (Fehrenbach, 2019). It also promotes transparent use of existing data through a distributed ledger (Roeck, 2019). Transforming an asset from analog to digital, whether through tokenisation or digitalisation, attempts to unlock more functionality, and DLT-based networks enable increased functionality. Transforming an object from its current form can open up its digital counterpart to new and previously unknown potential and functionality (Hagberg et al., 2016).

Therefore, the research objective of this chapter is to investigate whether this transformation of assets is worthwhile for an organisation. To achieve this objective, a framework was created as a decision support tool with the goal of helping to facilitate a discussion on evaluating how suitable an asset is to the tokenisation process. To ground this chapter’s research in traditional finance where tokenisation evolved from, tokenisation is viewed as a combination of securitisation and digitalisation, and these will provide the foundation for the framework. To evaluate the impact of tokenisation, the change in the underlying asset characteristics must be examined. The characteristics of the as-is version of the asset are compared with the tokenised to-be version of the asset. In order to determine if the process of tokenisation impacted the asset, the impact to its business value and its disruptiveness are determined. An examination of how to evaluate the impact of tokenisation leads to the following research question: *How does the process of tokenisation impact an asset?*

The remainder of this chapter begins with a systematic review of the key relevant literature. An analysis of the literature finds the key concepts from which a tokenisation impact framework is created. Three organisations are used as examples, using the framework to demonstrate the impacts of tokenisation.

3.3. Impacts of Tokenisation

To understand how tokenisation impacts an asset, Webster and Watson (2002) systematic method of literature review was followed. Using Vom Brocke et al. (2009) key terms such as "tokenisation", "securitisation", "digitalisation", "tokenisation of assets", and "distributed ledger technology", were searched for. From this, the concept centric matrix in Table 3-1 was created to summarise existing literature in the areas of securitisation, digitalisation, and tokenisation by identifying recurring themes across a total of 23 papers (Webster & Watson, 2002).

The key concepts synthesised from the literature are liquidity, composability, information, actors, settings, and offerings:

Liquidity shows where the research discussed the degree to which an asset or security can be quickly bought or sold in the market without affecting the asset's price.

Composability shows where the research discussed the degree to which an asset can be pooled to share risk across multiple parties or can be subdivided to aid diversification.

Information shows where the research discussed the degree to which an asset increases information availability, which aids in decision making or reduces the level of information asymmetry amongst parties.

Actors shows where the research discussed the degree to which an asset enables new forms of agency for traditional actors, supports the separation of different actors' roles, or disintermediates existing actors or creates new actors.

Settings shows where the research discussed the degree to which assets can change existing marketplaces/platforms, cause a merging of current platforms and marketplaces, or enable the creation of new marketplaces and platforms.

Offerings shows where the research discussed the degree to which assets enable changes to traditional products or services, the extension/reduction of traditional product/service offerings, or enables the creation of new bespoke products or services on a mass scale

Author & Year	**Liquidity**	**Composability**	**Information**	**Actors**	**Settings**	**Offerings**
(Ainsworth & Shact, 2016)	X		X		X	
(Aitzhan & Svetinovic, 2016)	X		X	X		
(Ekblaw et al., 2016)			X		X	X
(Brandon, 2016)			X		X	
(Danezis & Meiklejohn, 2015)	X		X		X	

(Fujimura et al., 2015)	X		X	X		
(Hayes, 2016)	X		X		X	
(Korpela et al., 2017)	X			X		
(Mainelli & Smith, 2015)				X		
(Mettler, 2016)	X		X	X		
(Nakamoto, 2008b)	X		X		X	
(Nguyen, 2016)	X					
(Lee & Pilkington, 2017)			X	X		X
(Rosenfeld, 2012b)	X				X	

(Sikorski et al., 2017)	X			X		
(Tian, 2016)	X		X	X		
(Yasin & Liu, 2016)			X		X	
(Y. Yuan & F. Wang, 2016)			X	X		
(Zou et al., 2016)			X			
(Westerkamp et al., 2018)	X		X	X		
(Treacher, 2018)	X		X			
(Sehra et al., 2018)	X					
(Chevet, 2018a)	X	X			X	X

(Lockyer, 2018)	X	X				

Table 3-1 Concept Centric Matrix of Factors Involved in Tokenisation

The six key concepts identified in the concept centric matrix were then divided into two categories based on their impact. Three impacted the business value derived from tokenising the asset and the other three impacted how disruptive the asset was for the organisation after being tokenised. Table 3-2 shows the concepts in their categories. Section one details the business value elements of tokenisation: liquidity, composability and information. Section two details the disruption elements of tokenisation: actors, settings and offerings. These disruptive impacts can be positive, neutral. or negative depending on how disruptive the tokenisation of an asset is to the market from the company's perspective.

Section 1: Business Value (Does it impact?)
Liquidity?
Composability?
Information?
Section 2: Disruptiveness (How does it impact?)
Actors?
Settings?
Offerings?

Table 3-2: Introducing the Framework Components

Some of the concepts seen in Table 3-2 are adapted from chapter 2, others are based on the concept centric matrix which focused specifically on tokenisation and the impact it has on business value and disruption for an organisation. As seen below in Figure 3.1, the information component of the framework derived in this chapter was based on the three data components (owner, data and contract) of the digital asset characteristics framework presented in chapter 2 and was examined in more depth with the help of the concept centric matrix. Similarly, the 'State' component from the framework created in chapter 2 was adapted based on the concept centric matrix to become the 'Actors', 'Settings' and 'Offerings' components in the tokenisation impact framework. The 'Composability' component of this chapter's framework originated entirely from the previous chapter. An asset's 'Fungibility' can increase the liquidity of an asset by allowing it access to new markets. Therefore, the 'Liquidity' component of this chapter's framework was also derived from chapter 2. The evolution of the concepts from chapter 2 and their relationship to the framework in this chapter can be seen in Figure 3-1.

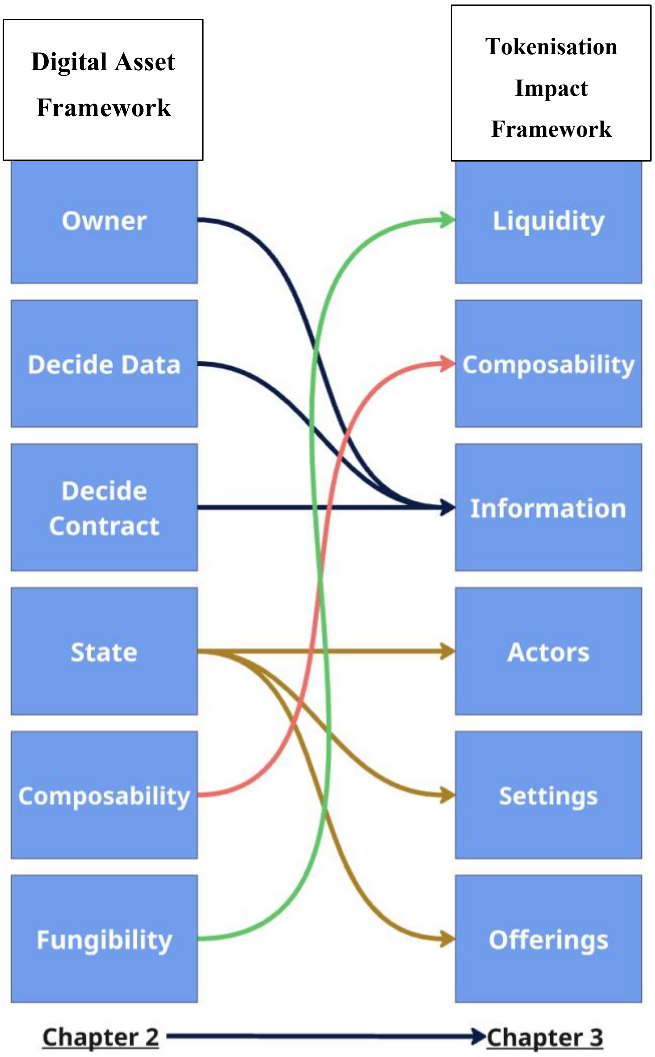

Figure 3-1 – Component Origins of the Tokenisation Impact Framework

Dividing the concepts into two categories allows an assessment of the impact of tokenisation. In the next section, how these categories work as part of the framework is explained. This framework then uses a scoring quadrant to quantify the impact of tokenisation to facilitate a discussion on whether an asset should be tokenised.

3.4. The Tokenisation Impact Framework

This chapter uses existing literature to derive a framework that helps measure the impact of tokenising an organisation's assets. Therefore, as a conceptual framework, it acts as an enabler for a discussion to happen around two areas: (1) how much business value is derived from tokenising a specific asset and (2) how much would tokenisation disrupt an organisations asset and its market. The purpose of the framework is not to theorise whether tokenisation will work. Instead, it frames decision making in such a way that it will help people decide if it's beneficial to tokenise the asset in question. As such, the framework gives individuals a strong foundation for further research to be conducted on tokenisation as an enabler. The following section details how this framework works. To clarify the explanation, in section 3.5, three concise examples of how the framework is applied are detailed. These demonstrate real examples applicable to business.

Figure 3-2 presents the six components of the Tokenisation Impact Framework. The framework is divided into two distinct sections which are based on the asset's impact on business value and organisation disruption upon tokenisation. Section 1 deals with concepts gathered and adapted from digitalisation literature (liquidity, composability & information), mainly from Hooker (1999). This section looks at how much value is created for the business upon tokenising one of their assets. Section 2 relates to concepts gathered from securitisation literature (actors, settings & offerings), mainly from (Merton & Bodie, 1995). This section analyses how disruptive tokenising one of a company's assets would be on the organisation. This disruptiveness can be either positive or negative for the company in question. For example, tokenising a private limited company would remove intermediaries and increase market share. Therefore, it would be a positive disruption for the company. In contrast, if a publicly listed company chose to be tokenised, they could lose access to partners and investors causing negative disruption.

Several 'environmental conjectures' are required when applying the framework on a theoretical level. Environmental conjectures refer to conditions that must be stated when applying the framework to set the situational context for the asset. Environmental conjectures would not be required if using the framework in a practical business context as the information would be readily available (Jones, 2003). It is imperative to clearly define the nature of the asset, as well as defining the conjectures about the nature of the asset and the regulatory environment surrounding it. This process requires the user of the framework to explore different asset characteristics that may be fundamentally changed after the tokenisation process. To investigate the impact of tokenising an asset, those elements are outlined across both sections in Figure 3-2.

Section 1: Business Value **Does it impact:**	**Yes (+1)**	**No (0)**
Liquidity?		
Composability?		
Information?		
Total (e.g. +2)		

Section 2: Disruptiveness **Impact:**	**Negative (-1)**	**Neutral (0)**	**Positive (+1)**
Actors?			
Settings?			
Offerings?			
Total (e.g. -1)			

Figure 3-2: Overview of Tokenisation Impact Framework

In section one there are three binary decisions regarding the 'Liquidity', 'Composability' and 'Information' aspects of the asset. The user answers a series of questions on a specific asset that is to be tokenised with each question getting a 'yes' or a 'no' answer, where yes indicates that tokenisation would result in a change of business value and a no indicates that there would be no change in business value upon tokenising the asset. In section two there are three decisions regarding the actors, settings, and offering aspects of the asset. By tokenising an asset, the company can be negatively disrupted, neutrally disrupted, or positively disrupted. An example of negative disruption would be a business losing money as a result of tokenising an asset. For neutrally disruptive, the organisations place in the market would stay the same; tokenisation wouldn't disrupt the organisation in either a positive or a negative way. Finally, positive disruption would give companies who tokenise assets access to new markets or increase their market share.

The sum of these ratings provides a "tokenisation impact rating". In section one this rating ranges from zero (0) to three (3). For section two the ratings range from negative three

(-3) to positive three (+3). Therefore, the highest accumulative rating would be (3,3) and the lowest would be (-3,-3). If an asset receives the highest rating (3,3) it's a strong indicator that tokenising this asset would create large amounts of business value while having a very positive disruptive impact on the organisation and its place in the market. In contrast, assets that achieve the lowest rating (0,-3) are seen as unlikely to create any business value and it's likely that the organisation would be negatively disrupted by tokenising the asset. This could cause them to lose money or market share. To see the impact the asset would have in terms of business value and disruptiveness of a specific asset, the totals from section one and two are plotted on the Tokenisation Impact Quadrant. As seen below in Figure 3.3.

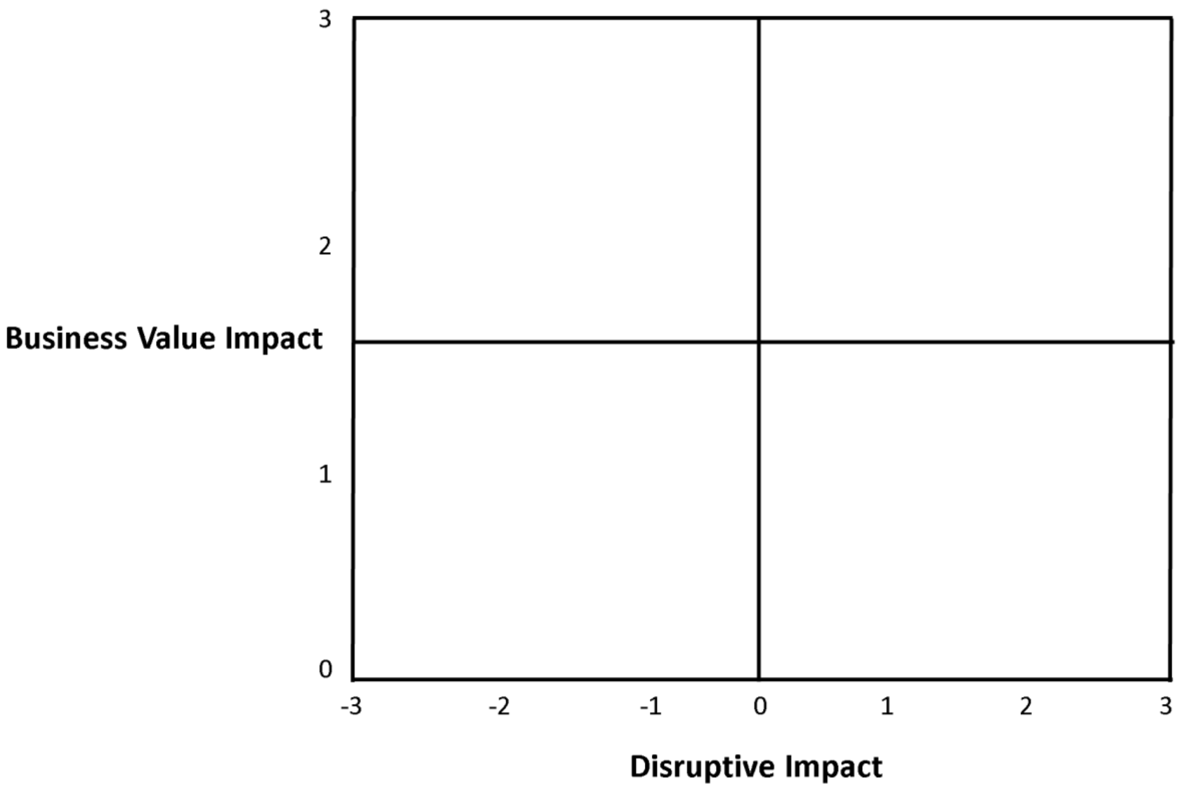

Figure 3-3: Tokenisation Impact Quadrant

This quadrant gives businesses a visual representation of the impact tokenisation of an asset would have on their business. This quadrant acts as a tool to facilitate a discussion around tokenisation and whether businesses should tokenise their assets or not. In the next section, three real examples of assets are selected and examined with the framework. The ratings received by these assets are then plotted on the tokenisation impact quadrant to demonstrate the impact of tokenising these assets.

3.5. Application of the Framework

To evaluate the utility of the framework, as mentioned in section 3.3, several environmental conjectures must be listed to frame the potentially disruptive effects on extrinsic elements (actors, settings, and offerings). In the next section, three assets are examined using the framework: a private limited company; a publicly listed company; and an in-game currency. For each of the assets, the information collated during an examination of literature on the respective assets consisted of the background information on the asset class, why that asset was chosen, uses of the asset class, the asset using the framework and justifying framework choices.

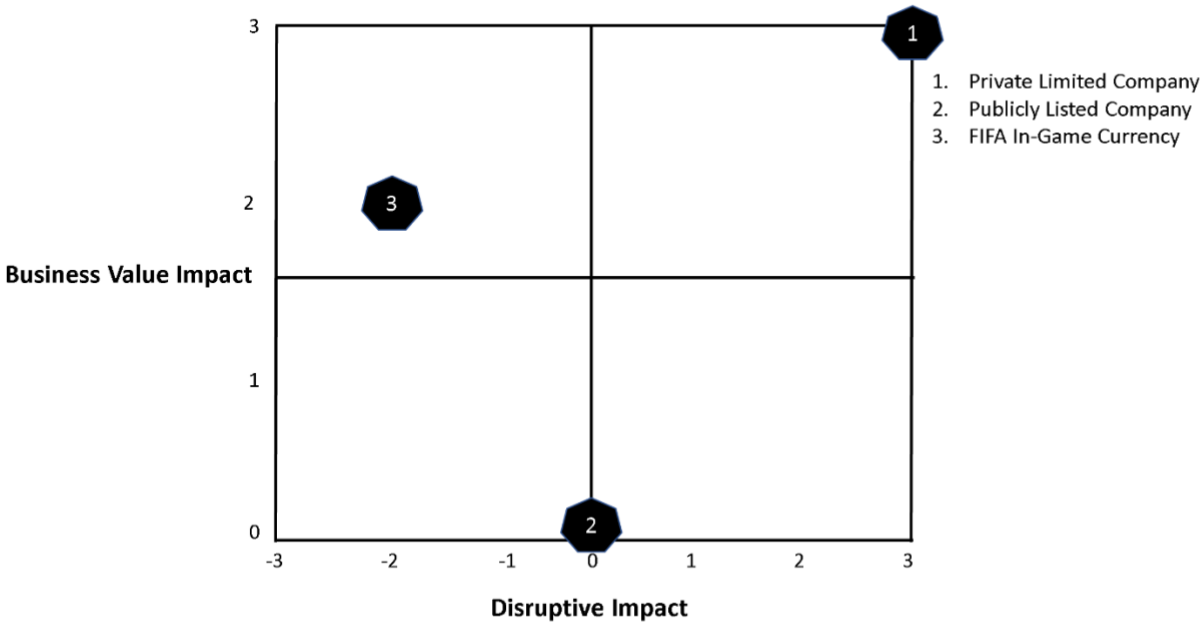

Figure 3-4: Illustrating Three Use-Cases of the Tokenisation Impact Quadrant

3.5.1. Private Limited Company - Single company

In this section, a Private Limited Company (PLC) was reviewed using the tokenisation impact framework to assess the impact tokenisation would have on the organisation. A PLC is a business entity that is privately owned and run by its members (Acharya et al., 2009). PLC's are limited to fifty shareholders, shares which are forbidden from public trading, and liability is limited to the corresponding shares that were issued

(Winston, 2016). A PLC was chosen specifically to highlight one of the extremes of the tokenisation framework while also analysing how tokenisation would affect the long-standing tradition of going public to unlock liquidity.

Section 1: Business Value **Does it impact:**	**Yes (+1)**	**No (0)**	
Liquidity?	X		
Composability?	X		
Information?	X		
Total: 3/3			
Section 2: Disruptiveness **Impact:**	**Negative (-1)**	**Neutral (0)**	**Positive (+1)**
Actors?			X
Settings?			X
Offerings?			X
Total: 3/3			

Figure 3-5: Use case of a private limited company

Liquidity: Privately owned companies have access to a small range of investors and financing in comparison to their public counterparts. Tokenising unlocks liquidity by allowing the PLC to trade equity positions more easily.

Composability: Tokenising could allow a company's position to be changed over time. For example, a company may change its status from private to public or vice versa.

Information: When tokenising a private limited company new information, such as disclosing certain business and financial information, will aid decision making and decrease information asymmetry.

Actors: As this is a new marketplace, new intermediaries will enter to fill these positions.

Settings: New marketplaces and platforms will be created to transact tokens of private limited companies.

Offerings: New spin-off assets such as derivatives could be extracted upon tokenising a publicly listed company

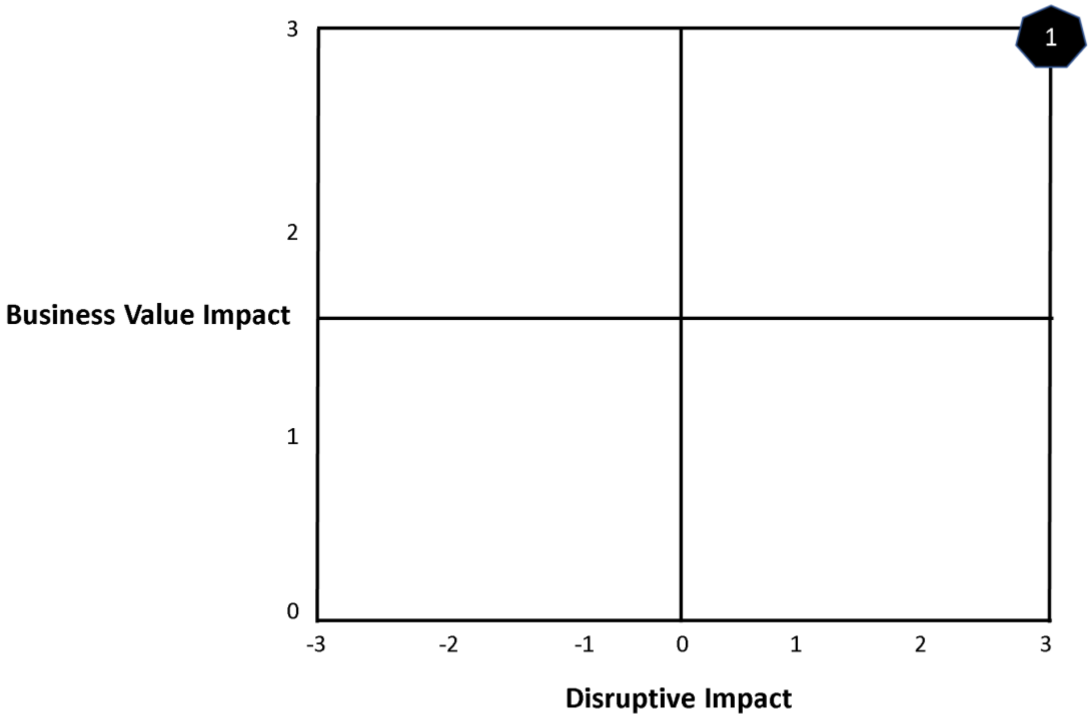

Figure 3-6: Impact of tokenisation on a PLC

As shown in the figure above tokenising a private limited company results in a business value rating of three (3) and a disruptive rating of three (3). This rating implies that tokenising a PLC would be highly beneficial for the organisation. It would increase the company's value and be positively disruptive.

3.5.2. Publicly Listed Company - Single company

A public listed company can be classified by two primary characteristics: the company's securities trade on public markets, the company discloses certain business and financial information regularly to the public (Commission, 2011). An Initial Public Offering involves the issuance of stock to a large number of diversified investors. This provides liquidity to investors who were already previously invested in the company and allows new investors to gain exposure to the company (Ibbotson, 1995). Listing on the public markets, though, brings increased regulatory and compliance burden in comparison to a private company.

Section 1: Business Value **Does it impact:**	**Yes (+1)**	**No (0)**	
Liquidity?		X	
Composability?		X	
Information?		X	
Total: 0/3			
Section 2: Disruptiveness **Impact:**	**Negative (-1)**	**Neutral (0)**	**Positive (+1)**
Actors?		X	
Settings?		X	
Offerings?		X	
Total 0/3			

Figure 3-7: Use case of a publicly listed company.

Liquidity: Publicly listed companies already have access to a wide range of investors and financing in comparison to their private counterparts.

Composability: Shares, index funds and other investment vehicles already allow investors to choose a wide range of investment allocated sizes. Tokenisation of public shares would not necessarily increase range.

Information: By tokenising a public listed company there is no change in information that aids decision making and information asymmetry is not reduced.

Actors: There are many intermediaries involved from the issuance via investment banks to facilitating a market through stock exchanges. Tokenisation, however, would have little effect on reducing the number of intermediaries in the current landscape.

Settings: Existing marketplaces and platforms would be unaffected.

Offerings: There would be no additional asset or offerings as a result of tokenising a publicly listed company.

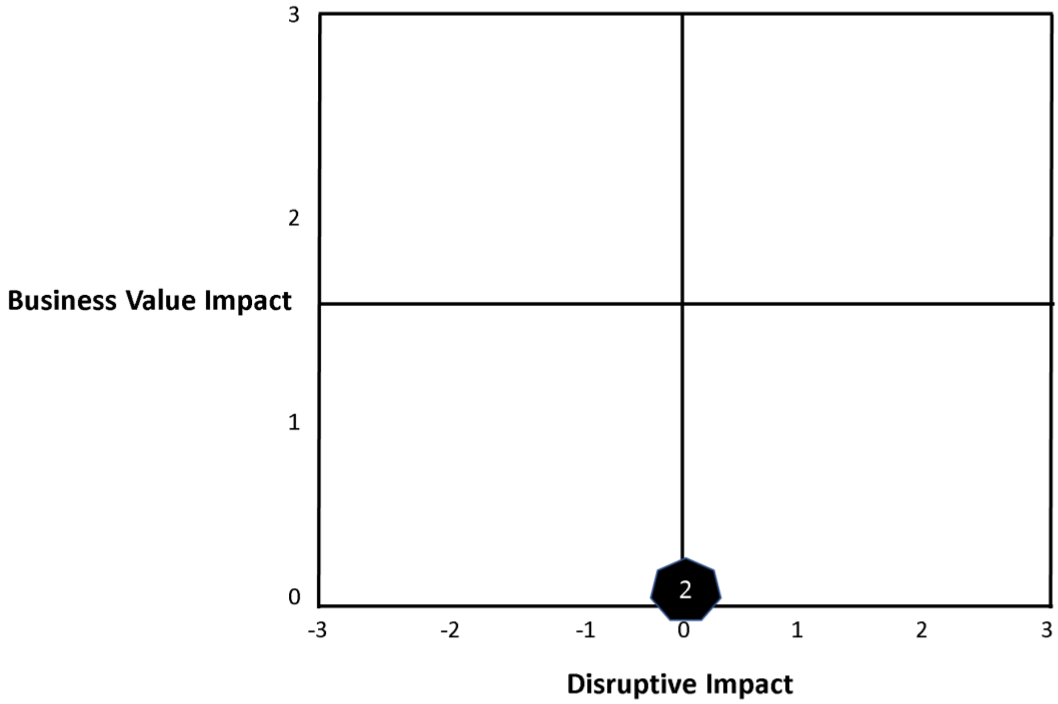

Figure 3-8: Impact of tokenisation on a publicly listed company.

As shown in the figure above tokenising publicly listed companies (number 2 above) results in a business value rating of zero (0) and a disruptive rating of zero (0). This implies that tokenising a publicly listed company would not be worth it. It would not create any business value or positive disruption for the organisation.

3.5.3. FIFACoin: An In-game Currency

The in-game currency for a videogame called EA Sports' FIFA 2020 was reviewed using the tokenisation impact framework to assess the impact tokenisation would have on the organisation. FIFA is a football simulation video game playable on PlayStation, Xbox and PC (ElectronicArts, 2019; Tan, 2019). In the games' 'Ultimate Team mode', a player can receive FIFA Points by playing games or players can use their debit or credit card to purchase more FIFA Points (Vincent, 2019). These points can then be used to purchase individual players or groups of players called FIFA Ultimate Team or FUT packs (Vincent, 2019). FIFA's in-game currency was chosen to see how tokenisation would impact FIFA's ability to monopolise their in-game currency sales.

Upon tokenising FIFA Points, for the purpose of this example called FIFACoin, players would buy the digital currency on any number of token exchanges rather than solely by accessing FIFA's website to purchase FIFACoins. As a result, FIFA would increase business value while negatively impacting the disruption of the companies in-game currency.

Section 1: Business Value **Does it impact:**	**Yes (+1)**	**No (0)**	
Liquidity?	X		
Composability?		X	
Information?	X		
Total: 2/3			
Section 2: Disruptiveness **Impact:**	**Negative (-1)**	**Neutral (0)**	**Positive (+1)**
Actors?	X		
Settings?	X		
Offerings?		X	
Total: -2/3			

Figure 3-9: Use case of FIFA's In-Game Currency.

Liquidity: FIFA Points can only be purchased on FIFA's website and are difficult to convert back into fiat currency. Tokenising unlocks liquidity by allowing FIFACoin to be bought and sold on token exchanges, thus increasing the marketplace

Composability: Tokenising in-game currency doesn't change its composability.

Information: The price of FIFACoin would increase because there are more ways to value it due to the involvement of more people. Information asymmetric is no longer centralised and everyone has a fair way of valuing FIFACoin.

Actors: The only intermediary involved in the issuance of FIFA Points is FIFA themselves. Tokenisation, however, would dilute FIFA's role as players could purchase FIFACoin from other actors.

Settings: New marketplaces and platforms in the form of exchanges could begin to sell FIFACoin.

Offerings: Offerings would be neutral because tokenising FIFA Points could open or close new opportunities for FIFA. For example, as the markets would set the price of FIFACoin, the FUT packs could sell for a higher price. Conversely, FIFA could also lose money because they no longer control of the price.

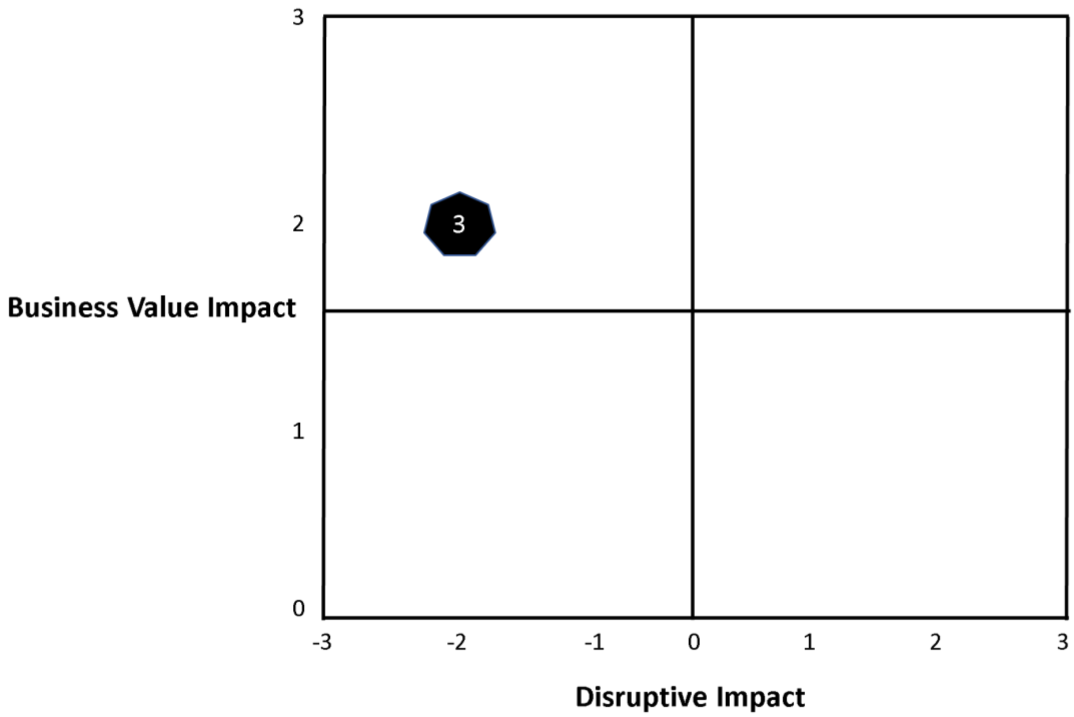

Figure 3-10: Impact of tokenisation on in-game currency.

As shown in the figure above tokenising FIFA's in-game currency results in a business value rating of two (+2) and a disruptive rating of negative two (-2). This rating implies that tokenising the in-game currency would increase FIFA's business value but would negatively damage the company's disruptive impact.

3.6. Chapter Summary & Next Steps

This chapter makes several contributions to the nascent field of DLT research and more specifically around the area of tokenisation. This is achieved by aggregating the existing body of literature in DLT as well as other related fields such as digitalisation and finance. It also gives context to the tokenisation landscape, which encourages further exploration from researchers with cross-disciplinary backgrounds. Analysis reveals some key characteristics pertaining to tokenisation's effect on an asset. Presenting these insights in a framework allows further analysis to be carried out on the effectiveness of tokenisation. Further research is called for in the validation and impact of the framework itself, exploring whether there are additional characteristics or parties to take into consideration and the weighting of their importance towards a tokenisation impact rating.

Additionally, it was observed in the literature that tokenisation can be viewed as a means of digitalisation and the embedding of financial functionality into an asset. To accurately evaluate tokenisation, the intrinsic (liquidity, composability & information) asset structure should be examined as well as extrinsic (actors, settings and offerings) elements involved in the tokenisation or securitisation of an asset which may be impacted by the process.

The creation of the digital asset characteristics framework derived in chapter 2 led to the creation of the tokenisation impact framework. This framework analyses the impact of tokenisation on business value and disruption. At this point the key characteristics of digital assets and their associated process of conversion are understood. It is understood how the tokenisation of an asset will disrupt a market in which a given organisation operates; however, it is not understood more broadly how the adoption of digital assets may impact companies in financial services. For the digital asset framework and/or the tokenisation suitability framework to be willingly used by companies in the financial services industry, one needs to understand the potential impact that the use of digital assets might have on organisations in financial services and how these organisations can leverage the value associated with using digital assets. Therefore chapter 4 shifts slightly to investigate how digital assets will impact business models of companies operating in the financial services industry and what factors will enable digital assets to change these business models.

4. Factors affecting digital asset adoption in financial services

4.1. Abstract

As digital assets and their underlying technology cause disruption in an attempt to modernise financial services, it still remains unclear what impact digital assets and this technology – blockchain – will have on how organisations will operate in the future of the financial services industry. There is yet to be clarity on how organisations will adopt digital assets into their day to day operations and how organisations may focus on certain areas in order to leverage the value associated with digital assets. This chapter looks to investigate what is the perceived impact of digital assets on future business models in financial services. Additionally, the chapter also looks to determine what factors will enable digital assets to change future business models in financial services. In order to address these questions, a series of foresight workshops are held with industry subject matter experts where the future of finance and digital assets is the prominent theme.

4.2. Introduction

The previous chapters in this thesis explore the concepts of digital assets and their underlying technology – blockchain or DLT – within the context of the financial services industry. In chapter 2, a digital asset is defined as "a data structure implemented using Distributed Ledger Technology, which can be assigned an owner". The concept of digital assets' underpinning technology, DLT, is also explained in this chapter. Chapter 2 delves deeper into understanding digital assets as an object and in doing so, defines a framework for the characterisation of digital assets by exploring groups or types of digital assets and their associated structural properties. The new framework laid the foundations for this thesis as it defined what constitutes a digital asset and how these assets can be characterised based on their structural properties. Chapter 3 then expands on digital assets and their structural properties to focus on their associated process of conversion - Tokenisation. Chapter 3 examines how the process of tokenisation impacts an asset undergoing tokenisation. The framework devised as part of chapter 3 determines whether it is beneficial to tokenise an asset (i.e. convert a non-digital asset to a digital asset) and examines the impact of the crucial process of tokenisation. This provided useful context for many of the digital asset offerings explored in chapter 4.

With a better understanding of the types of digital assets available, their structural properties, and an understanding of what benefits can be derived from the use of tokenisation on assets in financial services, this chapter explores how digital assets and their associated use-cases could impact future business models in financial services. In addition, the factors that can enable digital assets to change business models in the financial services industry are examined. This chapter delves into this detail by describing a series of foresight workshops that were held with senior individuals working in the industry with the goal of extracting practical insights from their expertise. These insights are then analysed using Osterwalder's Business Model Canvas as a lens for examining impacts on business models.

This chapter will investigate the impact of digital assets on future business models in financial services, as well as the factors that enable changes to business models, by addressing the following research question:

> *How are digital assets perceived and what factors enable digital assets to change future business models in financial services?*

This chapter investigates the future of digital assets in financial services through a forward-looking technique known as 'Foresight'. The aim of a Foresight study is to establish a vision of the future. It is closely linked with future studies and is closely associated with scenario-building (Rialland & Wold, 2009). The European Foresight Institute for Prospective Technological Studies defines foresight as "a systematic, participatory, future-intelligence-gathering and medium-to-long-term vision building process aimed at present-day decisions and mobilising joint actions" (European Foresight, 2005). Foresight techniques used to gather qualitative data for this study included trend analysis and vision formation, as well as interviews and workshops with several high-ranking individuals from financial incumbents, FinTech companies, and law firms.

In addition to foresight techniques applied as part of the workshop, Osterwalder's Business Model Canvas was used as a lens for analysing the data and findings from the foresight workshops to determine the impact of digital assets on the business models of companies operating in the financial services industry.

4.3. Literature Review

To answer RQ3 posed in section 4.1 above, a literature review was conducted that examined two distinct types of literature. One aspect of the literature review examines literature around the areas of digital assets, with a specific focus on key trends and potential trends pertaining to digital assets. The second focus of the literature review is based on Osterwalder's business model canvas, which will be used as a lens for the findings, to better understand the impact of digital assets on future business models in financial services.

4.3.1. Key Trend Literature

In preparation for a future-oriented foresight workshop discussing the potential impact of digital assets on financial services, literature on various trends and weak signals both inside and outside of the financial services industry was reviewed. A weak signal is essentially the first indicator of a change or an emerging issue that may become significant in the future (Hiltunen, 2010). They are often identified as part of environmental scanning in futures studies and can be used to challenge ones perceptions of futures and expand the selection of alternate futures (Dufva, 2019). This literature served as the basis for identifying the enabling factors for digital assets in financial services and potential digital asset offerings to be discussed at the foresight workshops.

4.3.1.1. Macro Trends

Trend analysis and environmental scanning were conducted on existing literature to identify relevant trends and signals within the financial services industry. Financial service providers are dependent on long-term developments to shape the future, so by taking a similar approach to Deutsche Bank (Rollwagen et al., 2008), the trend analysis was extended to include long-term developments, also known as 'Macro trends'. Macro trends are trends that are long-term in nature and are more akin to shifts across a population in a given direction. They generally involve large populations and last five to ten years or more (Burch, 2018). The macro trends were derived from different sources with the types of literature reviewed, to derive the trends and signals, comprising mainly general reports, industry reports, and whitepapers. There are limited academic papers examining future trends of digital asset and DLT due to the relatively novel nature of the field. Academic literature was found to be relevant when identifying macro trends, as these are longer-term and are generally not industry specific. After identification, these macro trends were classified using a method known as STEEP analysis. This is a method which identifies, analyses and sorts factors under the headings of Social, Technological, Economic, Environmental and Political (Durst et al., 2015). It's worth noting that macro trends are generally not industry specific as these are longer term and have more widespread impact (Rollwagen et al., 2008) than just financial services. Macro trends were identified in this case as they often feed into micro trends and as such would provide a foundational way to research and identify micro trends.

Macro trends identified which related to the wider population were classified as Social. Examples of such macro trends are seen in a United Nations report documenting how the world's population is ageing faster than at any other time (United, 2017) and a paper on how millennial impatience is becoming more prominent through an increasing culture of instant gratification and 'next day delivery' (Stanney, 2017). Trends classified as technological included concepts such as the potential breakthroughs relating to Quantum Computing and the effects that it could have on current technologies (Hurley, 2018), and the advent and adoption of all-inclusive ecosystems and changes this is bringing about in marketplace structures (Li & Chen, 2018). Political trends were those that involved government activity or intervention such as a reduction or fall of trust in governments in comparison with previous generations (OECD, 2017). The Environmental category contains trends that related directly to the physical environment. As one may expect, there was a focus on the increasing levels of global warming and pollution (IPCC, 2018; WHO, 2018). Finally, Economic macro trends were those that related directly to the global economy such as an increasing level of automation and how this will both create and destroy jobs

(Manyika et al., 2017), as well as a report from Oxfam on a widening wealth gap (Hardoon, 2017). The rest of the Macro Trends can be seen in Table 4-1 categorised by STEEP:

Social		**Technological**	
(United, 2017)	Ageing population	(Jonas et al., 2019)	Rise of serverless
(United, 2017)	Population growth	(Victoria et al., 2019)	Increase in FOSS
(World Bank, 2018)	Increase in Life Expectancy	(Gubbi et al., 2013)	Internet of things
(European Data Protection Supervisor, 2017)	Data Privacy Concerns	(Hurley, 2018) (Sood, 2023)	Quantum computing
(Stanney, 2017) (Pollak, 2023)	Impatience and Instant Gratification	(Li & Chen, 2018)	All-inclusive ecosystems/ change in marketplace structures
Economic		**Environmental**	
(Kharas, 2017)	Rising middle class	(Ipcc 2018)	Global warming

(Hardoon, 2017)	Widening wealth gap	(WHO, 2018)	Pollution
(Manyika et al., 2017)	Automation	**Political**	
(Allen et al., 2016)	Spatial economics	(OECD, 2017)	Fall in trust in governments
		(English & Hammond, 2018)	Increasing compliance costs

Table 4-1 – Identification and classification of macro-trends

As these macro trends were not specific to the financial services industry, it was necessary to gauge how they may impact it. The identification of these implications allowed some visibility on how the industry-agnostic macro trends could impact upon the financial services industry. Due to the wide-ranging landscape of financial services, and the various areas of the industry that could be impacted by digital assets, the financial services industry was divided into the following categories: Regulation, Investor, Infrastructure, Funds and Innovation. These categories were chosen as they are areas in financial services where digital assets and blockchain could have some impact. Regulation was chosen as a category based on the findings in chapter 2. Regulation was discussed as a factor that is relevant to digital assets given they are somewhat unregulated thus far. Investor was chosen due to the more widespread institutional acceptance of digital assets such as Bitcoin as assets of value, joining a large pool of retail investors in this sentiment (Baer, 2020). Infrastructure and innovation were selected as categories as digital assets and blockchain could cause a series of changes in these areas of financial services, causing outdated infrastructure to be revamped (McWaters et al., 2016) and more innovation to occur within the financial services industry (Liebenau & Elaluf-Calderwood, 2016). Finally, funds was included as a category due to the impact digital assets and blockchain could have on asset management and the funds industry (PwC, 2016a).

Literature on macro trends was reviewed to determine the implications those trends may have on the wider financial services industry. As can be seen in Table 4-2 below, each macro trend can be interpreted as having an impact in financial services. For example, the increase of global warming issues and awareness (IPCC, 2018; WHO, 2018) could affect investors in financial services by causing an increase in investment in socially responsible causes such as green finance and ESG investments. Similarly, in the context of technology, the macro trend of all-inclusive ecosystems becoming more commonplace (Li & Chen, 2018) could lead to technology giants such as Apple, Facebook and so on moving into the financial space. This logic was repeated for each macro trend until a set of implications that these macro trends could have on the financial services industry became clear. These implications formed the basis for the research which led the identification of the micro trends. The macro trends and their potential implications can be seen in Table 4-2 below:

Macro Trends	Implication for Financial Services	Area of Financial Services
Ageing population (United, 2017)	Smaller workforce proportional to population	Regulation
Population growth (United, 2017)	Larger investor pool	Investor
Increase in life expectancy (World Bank, 2018)	Increased investing time horizon	Investor
	Longer target date funds	Funds
	New types of passive investing (E.G. Acorn)	Innovation

Data privacy concerns (European Data Protection Supervisor, 2017)	Custody solutions standardising for PK storage Data ownership for users	Infrastructure (both)
Impatience and instant gratification (Stanney, 2017)	Increased risk tolerance Demand for t+0/real time transaction settlement (t+0 is an industry term for instantaneous settlement of financial transactions (Law Insider, 2023)	Investor Infrastructure
Rising middle class (Kharas, 2017)	Larger investor pool	Investor
Widening wealth gap (Hardoon, 2017)	Increase in High Net Worth Individuals Need for alternative investment for diversification More tailored High Net Worth funds	Investor Funds Innovation
Automation (Manyika et al., 2017)	Smaller workforce proportional to population Changing jobs more frequently – passive investments	Regulation Investor
Spatial Economics (Allen et al., 2016)	Integrated global financial infrastructure	Infrastructure
Rise of serverless (Jonas et al., 2019)	Server locations and jurisdictions	Infrastructure
Increase in F.O.S.S. (Free and Open Source Software) (Victoria et al., 2019)	Decrease in traditional cyber-attacks and fraud	Infrastructure

Internet of Things (Gubbi et al., 2013)	Increase in retail investors (with ease of access to markets)	Investor
Quantum computing (Hurley, 2018)	Need for quantum cryptography	Innovation
All-inclusive ecosystems/change in marketplace structures (Li & Chen, 2018)	Incumbent led innovation (majority of start-up innovation is incumbent servicing rather than new asset classes) Tech giants moving into finance (E.g. Apple, Facebook)	Innovation (both)
Global Warming and Pollution (IPCC, 2018; WHO, 2018)	Socially responsible investments Activist fund manager	Investor Fund
Fall in trust in governments (OECD, 2017)	Data ownership for users	Infrastructure
Increasing compliance costs (English & Hammond, 2018)	Increase in fees	Fund

Table 4-2 – Macro trends and their associated impacts on the financial services industry

4.3.1.2. Micro Trends

Now that the implications the macro trends could have on the financial services industry are understood, the next step is to identify relevant micro trends. A micro trend is generated by the macro trends. These are smaller in scale and can last 3-5 years (Willimann, 2015). The micro trends were identified as they were more tangible trends, specific to the financial services industry, which were identified in literature. The literature documenting these micro trends were discovered by utilising a series of web searches using keywords from the implications in Table 4-2. For example, web searches using keywords such as “passive investing increase” led to the identification of a report published by Boston Consulting Group on global asset management where they indicate that there has been record growth for passive products and alternative investments in recent years (Fages et al., 2018). Similarly, key word searches based on "incumbent innovation" and "integrated global financial infrastructure" were carried out which led to the discovery of literature documenting a potential future rise in blockchain-based cross-border payment systems (Achanta, 2018).

These micro trends, unlike the macro trends, were specific to the financial services industry. In addition to the micro trends mentioned above, others emerged. For example, a report published by the European Securities and Markets Authority presented a trend around the increased adoption of sandboxes and innovation hubs in the FinTech industry (Esma et al., 2018). Similarly, a report published by IOSCO (International Organisation of Securities Commissions), spoke about a number of trends emerging in FinTech. One specific trend was an increase in technology accelerators, incubators and consortia based approaches for new financial technology including blockchain and digital assets (IOSCO, 2017). Micro trends directly related to the digital assets and DLT that emerged included an increase in the prevalence of projects focussing on the development of blockchain-based cross-border payment systems (Achanta, 2018; Fnality, 2018), potential creation and adoption of a Central Bank Digital Currency (Auer et al., 2020; Griffoli et al., 2018) and an increase in DLT-based Robo-advisors in the wake of the 2008 financial crisis(Jackson, 2018). Other notable micro trends that emerged were a rise in investing in socially responsible causes (Davy, 2018) and some financial securities such as Exchange Traded Funds (ETFs) and blue chip stocks trading 24/7 (Imbert, 2018). It is worth noting, however, that another older article suggests trading volumes remain small outside of standard market hours despite the longer opening times in some markets (Kumar, 2011). In addition to these trends there were others such as real-time integration for blockchain technology with legacy banking systems (CSFME, 2018) and a report discussing differences between various exchange volumes(Fusaro & Hougan, 2019).

Once micro trends were identified and associated literature was reviewed, the weak signals were identified. Weak signals were sought out in the literature as a more focussed look at what type of use-cases and products were emerging from the micro trends, and if they could feasibly happen in the future. The weak signals were identified by conducting a series of web searches on the subject matter presented in the academic and non-academic literature for the micro trends. The literature in Table 4-2 above was reviewed to determine what potential future digital asset or DLT offerings were considered feasible within the financial services industry. Some of the more popular digital asset related use cases identified from the micro-trends were: exchanges relying on DLT for their infrastructure (referred to as DLT Exchanges); stable/intermediary coins' tokenisation platforms where non-tokenised assets can be converted into tokenised assets; blockchain settlement platforms for clearing and settlement of financial transactions; and blockchain based payment systems. Once these weak signals use cases such were identified, exhibits at the fringes of these weak signals were identified. In the context of this study, the exhibits were companies or projects that were actively emitting these weak signals by way of products or services - in other words, organisations offering products or services similar to the use-cases identified from the micro trends. The exhibits were identified as a examples of companies or projects emitting the weak signals, thus providing a potential vision into the future within the realm of digital assets and blockchain technology. For example, for the micro trend of financial incumbents integrating DLT to legacy financial systems, a weak signal was found of these institutions looking to invest in blockchain settlement platforms which integrate into their existing back office (Ing, 2019). Further research on this led to exhibits in the area such as Fnality International and SETL, both of which are companies offering improved operational efficiency for financial incumbents by developing a blockchain settlement platform (Fnality, 2018). This process was repeated for each of the micro trends, however for some of the micro trends there were no weak signals identified which were relevant to the nascent field of digital assets and DLT. For example, a rise in socially responsible investing (Davy, 2018) is certainly a significant trend within the financial services industry, but no weak signals emerged in the literature for this trend with regard to digital assets and DLT.

Once a list of companies or "exhibits" was defined, further information on the companies was retrieved to ensure that they are still active and have enough financial investment to plausibly be successful. Crunchbase Pro is a platform for finding business information about private and public companies which includes investments and funding information, founding members and individuals in leadership positions, mergers and acquisitions, news, and industry trends (Crunchbase). Crunchbase Pro was used to analyse the companies identified to ensure they are currently receiving funding on solving business problems in the financial industry and are using distributed ledger technology as part of the solution. This was done by sorting the list of exhibits by company activity within the 90 days, to ensure that they were still active within the industry. This reduced the list of companies emitting these weak signals to less than 15. The companies and projects emitting these weak signals, known as Exhibits can be seen in Table 4-3:

DLT Infrastructure Based Exchanges		
Deutsche Borse DLT Exchange (FinExtra, 2019a)	Swiss Digital Exchange (B. I. S. Innovation Hub, 2020)	Stock Exchange of Thailand (FinExtra, 2019b)
Decentralised Exchanges		
Binance DEX (Binance, 2020)	0x Protocol (Warren & Bandeali, 2017)	
Stable/Intermediary Coins		
JPM Coin (J. P. Morgan, 2019)	MakerDAO (MakerDao, 2017)	Facebook's Diem (formerly 'Libra') (Diem Association, 2020)
Blockchain Payments and Settlement		
Fnality International (Fnality, 2018)	SETL.io (Basar, 2019)	
Institutional Investment Enablers		

Fidelity Digital Assets (Fidelity Digital Assets, 2019)	Omniex (Omniex)	
Central Bank Digital Currency		
Project Jasper – Ubin (Bank of Canada & Monetary Authority of Singapore, 2019)	Report on a Digital Euro (European Central Bank, 2020)	

Table 4-3 – exhibits (companies emitting weak signals) identified

In summary, Trend analysis and the associated literature were necessary components in this study for a number of reasons. Firstly, the literature reviewed facilitated an understanding of the trends and potential future scenarios regarding Digital Assets and DLT in financial services. The trends identified served as a key component feeding into the foresight workshops. More specifically, the literature review and the flow from macro trends to exhibits, as demonstrated in this section, allowed a number of different potential future scenarios to be devised. These futuristic scenarios relating to financial services and the role of DLT and digital assets in the financial industry were a key component for instigating and sustaining insightful discussion among workshop participants. A version of these potential futures is presented to all participants as a physical artefact with the purpose of developing and leading conversations on topics such as Central Bank Digital Currencies, DLT based exchanges, and other digital asset related weak signals identified through analysis of the literature.

4.3.2. Business Model Canvas

Having identified key trends and weak signals associated with the use of digital assets in financial services as part of the workshop design literature review, it was important to examine what impact the key trends and signals identified may have on business models in financial services. To examine the impact on business models, Osterwalder's Business Model Canvas was used as a lens for this study. The Business Model Canvas (BMC) is a managerial tool which allows a user to describe and analyse the business model of a given organisation (Osterwalder & Pigneur, 2010). The Business Model Canvas was used to take insights on digital asset offerings from the foresight workshops and to determine how these may impact business models of companies in financial services.

In the book Business Model Generation (Osterwalder & Pigneur, 2010, p. 14), a business model is defined as a means of describing the rationale of "how and organization creates, delivers and captures value" (p 14). The suitability of the Business Model Canvas as a lens for identifying the impacts digital assets could have on financial services business models can be seen in descriptions of business models and their use. Towards the start of Business Model Generation, Osterwalder and Pigneur (2010) describe how the canvas is intended to be used as a tool to question, challenge, and transform old, outdated, business models. They continue to add that the BMC help users to determine how they can "turn visionary ideas into game-changing business models that challenge the establishment—or rejuvenate" if you happen to be an incumbent (Osterwalder & Pigneur, 2010, p. 6). Given that it was determined in chapter 3 that digital assets and tokenisation possess an ability to disrupt or change the status quo within financial services, the BMC seemed an appropriate choice of tool to determine how digital assets would impact or potentially "rejuvenate" these business models. Another reason as to why the BMC was chosen as the lens was the way in which it favours practice orientation (Fauvel, 2013). As the foresight workshop involves practitioners, the BMC lends itself to an examination of their practical expertise.

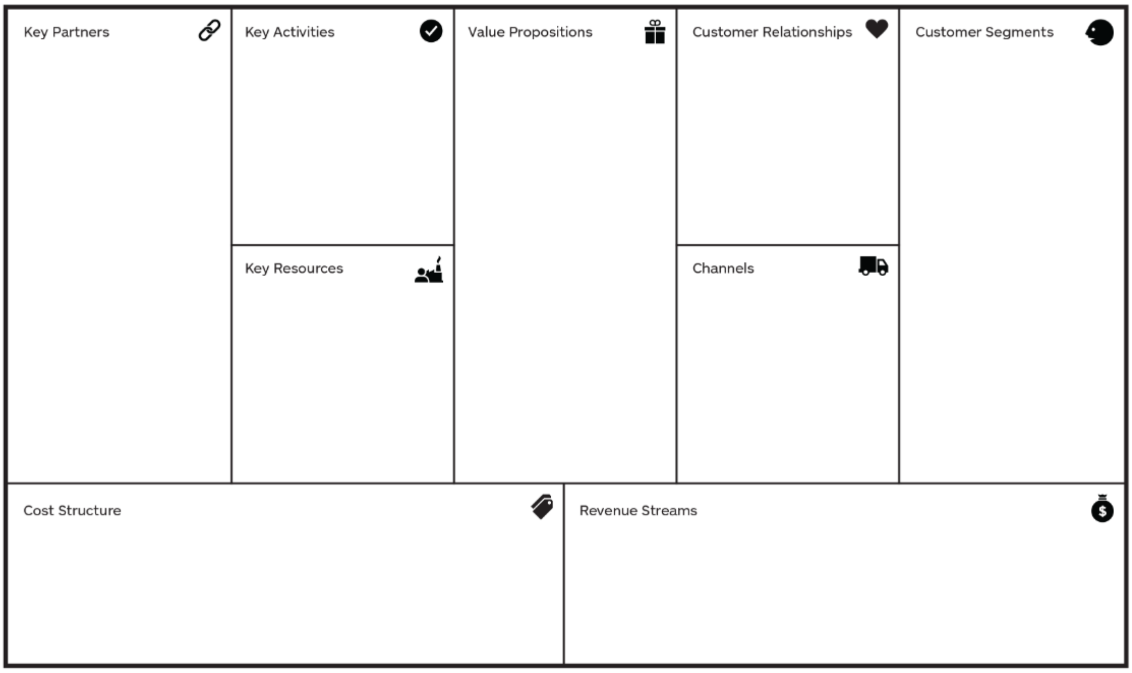

Figure 4-1 – Osterwalder and Pigneur's Business Model Canvas (2010)

The BMC will be used to determine how digital assets and their related offerings in financial services will impact upon business models in financial services. Potential digital asset products and offerings will be identified in the workshop based on the participants expertise. The key trends detailed in the previous section, which informs a physical artefact for use in the workshops, provides the basis to extract these insights from participants. These offerings are the value created – the V in the BVM. Next, how this value is created is determined by mapping the digital asset offerings to their relevant section on the BMC. For example, if an offering provides more ways to reach a consumer than previous non-digital asset-based methods, then this offering can be mapped to channels as it impacts a business model by introducing more channels or ways to reach the consumer. The data extracted from these activities will address the RQ3 – by examining what impact digital assets have on future business models in financial services. RQ3 will also be addressed by workshop participants discussing what is needed to support these offerings or, in other words, what factors will influence the adoption of digital assets. These discussions and factors will also be informed by the trends and weak signals identified in the previous section, with the data from the workshop analysed through the lens of the Business Model Canvas.

4.4. Methodology

As defined in section 4.1, foresight is "a systematic, participatory, future-intelligence-gathering and medium-to-long-term vision-building process aimed at present-day decisions and mobilising joint actions" (Foren Network, 2001, p. 3). Foresight is particularly suited to the study of emerging technologies for a number of reasons. It is argued that new technologies have, and will have a revolutionary impact on society and economics over the coming years (Freeman & Perez, 1988). Similarly, Martin (1995) concludes that foresight is being utilised globally to help identify important areas of strategic research and emerging technologies and innovations that are likely to yield significant economic benefits. This chapter not only aims to identify factors that may impact the future adoption of digital assets in financial services through foresight, but also to identify the changes that digital assets could bring about on business models of organisations in the industry - organisations that are in search of greater efficiencies and other economic benefits such as increased profits. For these reasons, foresight is used as the research methodology that would provide insights into the potential foundational future changes digital assets could bring about on business models in financial services, as well as determining what factors may impact their adoption. RQ3 examines what impact digital assets are perceived as having on future business models as well as what factors will enable digital assets to change future business models, within financial services. In summary, a foresight study is a forward-looking technique which is suited to the area of emerging technologies and, as such, it was selected as the research methodology which forms the basis for this chapter.

4.4.1. Pre-workshop Preparation

This chapter follows guidelines for foresight studies on the dynamic landscape of financial services and technology as described by the Deutsche Bank Macro trends team (Rollwagen et al., 2008). They detail in the paper how the use of conceptual tools are key in leveraging insights in strategic foresights studies, particularly in an institutional context. Moreover, they discuss how the use of tools that facilitate interactions between decision makers and people who specialise in foresight can help to instigate discussions on future developments, challenges, and opportunities.

Additionally, they add that they have "developed a specific, interdisciplinary synthesis of different methods to provide a form of foresight suited for the needs in the financial services" (Rollwagen et al., 2008, p. 11) which combines qualitative and quantitative methods. As the expected output of the workshops would be qualitative data, the qualitative methods were adopted for use in this foresight study. These research techniques associated with foresight studies include horizon scanning, trend analysis and vision formation. These tools were all utilised to promote better interaction between participants during the foresight workshops. Trend analysis was conducted ahead of the workshop as part of the literature review. This can be seen by the identification and analysis of several key trends during the literature review which aided in finding a series of weak signals and exhibits within the financial services industry. These weak signals and exhibits formed the basis for informing some of the key workshop content. These trends in turn informed the vision formation detailed below.

An approach similar to that of (Drew, 2006) was employed to map out potential development paths for digital assets in financial services. Drew details a scenario planning process for disruptive innovation which has the following steps:

- "the research can be structured to draw on an appropriate range of expert opinion and internet sources
- creative approaches to group-work and strategic thinking can be used in process meetings.
- road-mapping techniques widely employed in technology firms can be used to develop the scenarios."

(Drew, 2006, p. 246)

The approach adopted for this chapter is similar in that it draws on an appropriate range of expert opinion and internet sources. It also uses creative approaches to group work and strategic thinking. However, the scenarios or visions created will be used as a catalyst for discussion in place of road-mapping techniques.

A combination of the macro trends, micro trends, and weak signals allowed the formation of several different potential future visons or scenarios for financial services and digital assets, ten years into the future. These visions were then combined to one provocative vision to be presented to workshop participants in the form of a fictional news article dated in the year 2029. A generic newspaper article generator was used to give participants a genuine feel and further provoke any discussion or insights they may have. The idea behind this concept was that if a provocative newspaper article dated in the future detailing applications of digital assets in financial services was presented to participants, then this would spark conversation and debate among workshop participants. This would in turn allow the capture of the insights from these participants as the seemingly unrealistic nature of the article would cause participants to speak frankly about how digital assets would impact business models in financial services, but also on the factors that may enable them.

The article presents some of the concepts identified in the literature review such as financial markets that are open 24/7, multi-asset decentralised exchanges, Central Bank Digital Currencies and several other digital asset related concepts. The concepts were described as being adopted fully in this futuristic vision dated ten years into the future. This potentially over-ambitious view on digital assets adoption in financial services should cause participants to provide their expert opinions on the potential future adoption of these digital asset related offerings, as well as how they may impact organisations and their business models,

4.4.2. Workshop content

The objective of the session is *'to gather thoughts and perspectives on the future adoption of digital assets, their surrounding ecosystem and their viability for businesses in financial services'* which directly feeds into RQ3. Participants detail whether or not they thought digital assets would be adopted widely within financial services, and in doing so they back up their respective arguments by mentioning factors that could positively or negatively impact the adoption of digital assets. In addition to this, the inclusion of "their viability for businesses in financial services" provokes discussion about how organisations may adapt their business models to take advantage of digital assets and DLT within financial services.

The workshop is designed in such a way so as to instigate and provoke discussion among subject-matter experts in the room and encourage intra-table and inter-table discussion. This allows valuable insights and opinions to be noted, as well as contrasting viewpoints and various nuances.

This foresight study is facilitated by State Street Corporation through two workshops in State Street's Dublin and London offices. State Street's position as an incumbent in financial services enabled the inclusion of senior management from prominent companies operating in this space as participants in the workshop. A list of anonymised participants, their titles and relevant teams for both Dublin and London workshops can be seen in table 4-3:

Dublin		**London**	
Title	***Company Type***	***Title***	***Company Type***
Team 1		*Team 1*	
VP Innovation	Asset Management	VP Digital Products	Asset Management
Software Engineer	Blockchain Tech Company	Digital Asset Expert	Blockchain enterprise software
Partner	Law Firm	Digital Asset Consultant	Independent
Funds Servicing	Asset Management	European Business Chief	Multinational Investment Bank
Research Analyst	Asset Management	Head of Product	Asset Management

		CEO & Founder	Decentralised Exchange
Team 2		*Team 2*	
Head of Innovation	Asset Management	Managing Director	Asset Management
Senior Software Engineer	Multinational IT company	Business Development	Blockchain Infrastructure Technology
Partner	Venture Capital Firm	Innovation Manager	Large Financial Service Provider
Digital/Payments Strategy	Banking Federation	Founder	Blockchain Securities Platform
ETF Products	Asset Management	Tech Strategy	Stock Exchange Group
		Professor of Financial Technologies and IS	University
Team 3		*Team 3*	
Professor of Financial	University	AVP Digital Products	Asset Management

Technologies and IS			
VP Digital Products	Asset Management	Partner	Blockchain Technology Software
Founder & CEO	Blockchain Start-up	Finance Associate Solicitor	Law Firm
Founder	FinTech Start-up	Head of blockchain Product	Wealth Management
Head of Capital Markets	Banking Federation	Head of Finance	Large FS Provider

Table 4-3 – Anonymised participants, their job titles and company type

The teams chosen, as seen in Table 4-3, are specifically drafted with the participants respective roles and organisations in mind. Each participant's role at their company as well as their area of expertise are carefully analysed to determine the most suitable team for them. The objective of the team formation is to ensure that each team was balanced with expertise from different areas of finance and financial technology, such as fund management, distributed ledger technology, law/regulation, etc. This provides a well-rounded discussion for each of the individual sections.

The session consists of presenting a fictional news article (see section 6.2) to each participant, generated by the trends, weak signals and exhibits identified in the literature review. Participants are then given time to review the article and answer the following questions:

"Based on the fictional article:

1. *On what grounds is this vison realistic or unrealistic?*
2. *What steps are necessary to prevent or promote this scenario?"*

These questions were chosen with the RQ3 in mind. Question 1 allows the identification of digital asset related offerings that have a feasible chance of happening in the next 10 years, according to industry subject matter experts. This brings about discussion among participants about how the vision and the digital asset applications featured in it were realistic or unrealistic. To back up these arguments, participants provide crucial business context as to why organisations would be likely or unlikely to engage with such offerings and in doing so, how they would pivot their business or alter their business models to utilise digital assets. Question 2 encourages conversation about what steps participants would take to prevent or promote these offerings. This discussion about the factors that would prevent or promote the offerings in this vision from happening leads to the identification of the factors that would enable digital assets to change future business models in financial services. It is also worth noting that there is no expectation that RQ3 would be answered in exhaustive fashion from these workshop questions alone. There is an assumption that these questions and the newspaper article would provoke further discussion which in turn would provide more insight.

Each team has a flipchart with a page divided into four equal-sized quadrants. Each of the 4 quadrants are labelled *Realistic, Unrealistic, Prevent* and *Promote* respectively. Each person is provided with sticky notes and after reading are given time to discuss the questions within their team and answer accordingly using sticky notes and the flipchart. Each team then nominates a spokesperson briefly present the insights of the team. An inter-group discussion then takes place.

Section	Duration	Output
Introduction	5 minutes	N/A
Intra-group Exercise	20 minutes	Populated Flipchart
Present Group Insights	10 minutes	Brief Presentation
Inter-Group Discussion	20 minutes	Discussion

Table 4-4 – Individual session timing breakdown

4.4.3. Post-workshops analysis

As there were two workshops that took place, steps are taken to ensure that common themes and discussion points across both sessions are effectively analysed. Once all the relevant notes are gathered and collated from a workshop session, each flipchart is photographed and transcribed to a text-only version. An initial post-workshop processing is performed on these text-only versions to structure the data so it is more readable and it clearly identifies those involved in the various discussions that took place across each respective workshop. Once both workshops had concluded, these text-only versions are collated into one large master document which is then analysed.

To do this analysis, the next step of the process is to extract the relevant themes from the discussion. The notes are analysed with a specific concentration on the major themes discussed during each session. A round of open-ended coding (Corbin & Strauss, 1990) is then carried out so that several prominent themes emerge from each session. This open-ended coding involved taking this master document containing the raw qualitative data gathered as part of the workshops and reading through it carefully. The data reflecting the discussions held is broken into sub-sections labelled by specific themes within the master document. Conversations on the same theme from separate workshop sessions are grouped together to ensure that all views on a particular theme are considered and cross-referenced. Some notes are also captured in a separate document to highlight the rationale behind the theme identification as part of the open-ended coding. The themes identified from the open-ended coding then form the building blocks for the theoretical analysis conducted in the next section.

4.5. Findings

This section presents the findings from the foresight workshops, organised around RQ3:

> *How are digital assets perceived and what factors enable digital assets to change future business models in financial services?*

The analysis of the workshop data reveals five potential digital asset related offerings which could significantly impact future business models in financial services and seven factors which are perceived to enable digital assets to change future business models in financial services.

4.5.1. Perceived Impact of Digital Assets on Business Models (RQ1)

The following section outlines five digital asset offerings identified throughout the course of the workshops which could impact business models in financial services.

4.5.1.1. 24/7 Exchanges

The first digital asset related offering which is perceived as impacting on business models in financial services is that of financial markets that operate 24 hours, 7 days a week, also referred to as 24/7 exchanges. Digital assets are related to 24/7 exchanges as in these proposed offerings, digital assets such as tokenised securities will be traded on 24/7 exchanges autonomously through the use of smart contracts. Digital assets – and smart contracts - enable 24/7 exchanges as the smart contracts enable the autonomous clearance and settlement of financial transactions without the need for a financial intermediary. This reduction of the number of intermediaries with a human element and automation of processes mean that common time constraints in financial markets could be removed. This removal of time constraints could have a sizeable impact, by enabling access to new customer segments, introducing new revenue streams and improved channels to reach consumers.

While exploring the concept of 24/7 exchanges in the workshops, some participants spoke about the nature of the activity that would occur in these proposed venues. The participants explained that every security on these trading venues would be tokenised and the trading venue itself would run on a Blockchain or DLT network, thus facilitating a level of *"autonomy"* not currently available to other trading venues. Another participant explained that automated nature of tokenised markets and exchanges means that a trade would be *"cleared and settled automatically as a function of a Smart Contract"* facilitating this function to be carried out beyond the 9:30am – 5:00pm, Monday to Friday constraints currently applied to financial markets.

The majority of participants in the workshop believed that a securities exchange operating 24 hours, 7 days a week would be beneficial to the consumer, enabling new value creation for two customer segments: institutional and retail investors. Retail and institutional investors alike could benefit from a 24/7 exchange as the extended opening hours provide more opportunities for trading as well as inducing more responsive markets. Retail investors could actively trade outside of working hours, making it plausible that a casual investor could buy and sell securities outside of their normal 9-to-5 occupation. Both customer segments could benefit from the ability to react and trade off the back of relevant news stories that surface outside of trading hours. This was suggested as a significant benefit at the workshop as it can *"mitigate the rush at 9:30am the morning after a big story surfaces".* Participants also spoke about the benefits of more significant timeframes for institutional investors to buy and sell stocks which reduces limitations.

Another benefit of 24/7 exchanges that would impact business models would be an increase in some existing revenue streams due to the extended opening hours. For example, one product and technology expert at a prominent stock exchange group argued *"I believe there are benefits of an open exchange, operating more than 9:30am to 5pm, Monday to Friday"*. He added *"the time constraints put on stock exchanges limit trade volume in my opinion",* comparing them to foreign exchange markets which now facilitate trading 24 hours a day including weekdays. Another participant agreed, adding that *"trade volume in Foreign Exchange markets dwarfs all of the world's stock markets and I believe time constraints to be one of the more prominent reasons why"*. He added that *"Stocks vs Forex"* is essentially *"Billions vs Trillions"*. Many of the other participants who were in favour of 24/7 securities exchanges also cited *"increased trade volume"* as something that could add value for institutional and retail investors by increasing an existing revenue stream. Participants believed that these extended opening hours, made possible through the use of digital assets such as tokenised securities, would boost trade volume significantly, which in turn could cause stock prices to increase as there is more demand. This increase in stock prices could in turn could boost institutional investment portfolios, creating value for many of those working in the industry by increasing the value of existing revenue streams and adding new revenue streams previously unavailable.

In summary, the data collected across the workshops indicates the trading of tokenised securities on tokenised exchanges operating outside of their current hours would have a significant impact on business models in financial services. As explained above, the extended opening hours are made possible through the ability of smart contracts to autonomously settle and clear trades involving digital assets. The data collected at the workshops shows that 24/7 exchanges could have a sizeable impact on future business models in financial services for a number of reasons. This impact can be demonstrated by looking at 24/7 exchanges' impact through the lens of the Business Model Canvas. 24/7 exchanges would bring about improved Channels due to the less restrictive time constraints, increasing the prevalence of opportunities to reach customers and prevalence of opportunities for customers to reach the market. In addition to this, the extended hours could facilitate additional access to Customer Segments such as retail investors by offering the ability to freely trade outside of office hours. Institutional investors would likely also become more active due to the new level of access available outside of normal hours. 24/7 exchanges could also lead to a boost in trade volume by introducing new and effective Revenue Streams for the business models. The concept of *"more market – more money"* means that financial institutions will experience increased revenue due to expanded opening hours and more customers looking to engage with the market. Nonetheless, increased opening hours would require a significant additional amount of what the Business Model Canvas refers to as "Key Resources" to ensure the exchange meets the security and resiliency requirements for a venue of its type. These are all tangible changes to how organisations operating in this industry interact with financial markets and all of these changes are enabled by the use of digital assets – in this instance, Tokenised Securities – and their underlying technology - DLT. Therefore, a 24/7 exchange enabled by digital assets would introduce significant impacts to future business models in financial services.

4.5.1.2. Securitisation & Tokenisation of Assets

The second digital asset related offering discussed during the workshops which will impact future business models in financial services is the Securitisation and Tokenisation of assets. The findings revealed that the landscape of securitisation will likely change over the next ten years as tokenisation impacts upon the traditional financial process. The process of tokenisation, as explored in chapter 3, will allow individuals to convert traditional assets into digital assets using DLT. This not only means that traditionally liquid assets, such as stocks and bonds can be converted into their digital asset counterparts; but also means that traditionally illiquid assets such as land and real estate can be converted into representative digital assets, making them more liquid and easier to sell for those holding them. This impacts future business models of companies in financial services by enabling new or improved channels for trading these assets, introducing new customer segments and as a result, paving the way for new revenue streams.

Most workshop participants believed the greatest impact of securitisation through tokenisation on business models would be felt mainly by organisations whose current models focus on alternative asset classes such as real estate, land, cars, and so forth.

Those dealing with these alternative asset classes would benefit from this as they would experience a newfound liquidity not previously available to assets of this nature. This point is backed up by a product and technology expert at a prominent stock exchange group who sees value for individuals investing in alternative asset classes as *"Digitalisation of other alternative asset classes such as land doesn't exist in the financial sphere due to these being highly illiquid asset classes"*. He and other participants believe the use of digital assets and their underlying technology to *"securitise and tokenise traditionally illiquid assets"* would increase liquidity for these alternative asset classes, ultimately making them a more feasible investment for institutional investors. Securitisation through tokenisation would make these alternative assets – specifically real estate – more liquid by facilitating things such as *"fractional ownership"* and *"maybe even smart contracts which are legally binding"*.

A workshop participant working in business development for a blockchain infrastructure provider believes this generation could also see the tokenisation and securitisation of individuals such as high-achieving graduates, football players, and other potentially high-income individuals in the near future. Similar to an income-sharing agreement, this would involve these individuals distributing tokens representing equity in their career earnings in return for funding or support earlier on in their careers.

The data collected around this topic demonstrates the potential value created through the use of tokenised securities. As stated above, they could grant individuals working in the industry access to previously illiquid asset classes, opening up new avenues for them by unlocking liquidity. It's clear that securitisation through tokenisation will be a value proposition for many organisations operating in financial services, but it's also important to examine how this application of digital assets and DLT would impact business models in financial services. By examining this from the perspective of the Business Model Canvas it can be seen that it impacts a number of different aspects of future business models for organisations operating in the financial services industry. New Channels to interact with alternative asset classes and investors interested in alternative asset investment could be introduced if platforms emerge for the trading of these alternative assets. This opens up a series of new Customer Segments for those involved, such as Real Estate Investment Trusts (REITs) and also casual retail investors who may be interested in owning 20% of a piece of real estate (for example). As a result of these new Channels and Customer Segments becoming available, business models can expect multiple new Revenue Streams as accessibility to trading of alternative asset classes is improved. By opening up these new Channels and Customer Segments the use of tokenisation and securitisation of assets can introduce additional Revenue Streams, cementing the use of tokenisation and securitisation as a digital asset related offering which will impact future business models in financial services.

4.5.1.3. Selective Transparency for Regulators

Selective transparency for regulators was a concept discussed throughout the course of the workshops whereby a financial regulator would have an exclusive level of access to transaction details, if they so wish. Selective transparency is a feature of blockchain-based systems where an individual or collective can harness the transparent nature of the technology to view details of transactions involving digital assets as well as the details of the counterparties to these transactions. This would allow regulators to view and analyse valuable information pertaining to any digital asset transactions within their jurisdiction which is executed on a blockchain-based system. More specifically, a system using a private blockchain - the type of blockchain which is most likely to be used in financial services. This feature would enable more efficient means of governing for regulators resulting in a fairer regulatory environment. In addition to this, it would enable financial organisations to reduce cost and effort involved in ensuring compliance. This in turn would impact business models of these organisations by altering cost structures, affecting key resources used and key activities performed.

Throughout the course of the workshops, regulation was one of the most frequently mentioned topics. It came up as a factor which could effectively *"make or break"* the future adoption of digital assets and their underlying technology. Selective transparency for regulators was often spoken about as a potential benefit associated with the use of digital assets. There were differing views on this proposed feature of selective transparency and the potential value it could create within financial services.

Participants in the workshops questioned the feasibility of selective transparency and had concerns as to how morally appropriate it is. A participant working for a financial services provider stated that if financial regulatory bodies had access to individual transactions for auditing purposes, then industry stakeholders would have to advocate for a softer role by regulators to ensure they don't over-regulate and, in doing so, stifle the industry. Despite a negative reaction to selective transparency from some participants, others saw significant value creation for financial services. The majority of participants from the London workshops who were more familiar with digital assets were in favour of financial regulatory bodies being able to view transactions as this level of regulatory transparency has never been seen before in terms of financial regulation. The selective transparency would facilitate regulators auditing transactions involving digital assets and, in doing so, would ensure that each and every organisation regardless of size is regulated in the same way, thus ensuring a level playing field. A team from the Dublin workshop agreed that selective transparency is needed for regulators as a *"break glass in case of emergency"* type feature. This means that regulators would have the ability to view one or many transactions in exceptional circumstances but that they wouldn't view every single transaction that falls under their remit, predominantly due to the fact that no financial regulator would have the resources and capacity to do so. This is made possible as digital assets and their underlying technology enable it. The transactions carried out which involve digital assets are performed on a DLT or blockchain based system, which can be completely transparent in nature, depending on whether it is a private or public blockchain, and whether or not measures are implemented to enforce privacy among participants in the system. As a result of this, key stakeholders such as regulators could be able to view details of the transaction despite playing no part in the transaction itself. Notwithstanding resistance to this feature from some participants, the majority of opinions expressed around this feature were positive, indicating that this feature could be beneficial for people working in the financial services industry across several different roles and would in turn impact the associated business models.

The use of a Selective transparency feature would allow regulators to carry out their role in a more effective and efficient manner, thus potentially reducing the effort and high costs organisations incur to ensure they are fully compliant. This could in turn impact many different aspects of organisations' future business models. Firstly, the

Cost Structure of many organisations would be impacted by reducing the monetary cost of ensuring compliance with stringent regulations as the regulator has more direct access to pertinent information they may require. As a result, the regulating body wouldn't have to invest heavily in resources to request details from the companies individually, as they would have access to the details of the transactions involving digital assets which were carried out by the companies in question. Conversely, financial institutions would not require as much labour to ensure compliance if the banks had a direct view, thus reducing costs and impacting the Cost Structures of their future business models. Additionally, the Key Resources such as costly legal expertise used to ensure compliance with existing regulations could be freed up to engage in other Key Activities across the organisation. These points demonstrate that by utilising digital assets, some of which can facilitate regulatory features such as selective transparency, the way in which some organisations will operate in the in the financial services will be impacted. Therefore, selective transparency is an example of a digital asset related offering which would impact future business models of these organisations in a positive manner.

4.5.1.4. Decentralised Exchanges

Decentralised Exchanges, or DeX for short, are cryptocurrency exchanges with no central authority governing the exchange. Transactions are carried out as 'peer-to-peer' transactions with no interference from trusted intermediaries. Digital assets, namely cryptocurrencies, are the only assets traded on DeX. Similar to the 24/7 exchanges discussed in 4.1.1, DeXs are enabled by Smart Contracts which allow trades to be conducted with no central authority to verify the transaction, with delivery and payment of the asset happening in unison. Decentralised exchanges generally only offer cryptocurrencies such as Bitcoin, Litecoin and Ether as there are little to no venues currently offering tokenised securities. A decentralised exchange for tokenised securities and other assets could potentially lower switching costs between providers, but unlike the previous 3 offerings identified, the impact is neutral-to-negative, not neutral-to-positive. In addition to this, the use of a DeX creates a level of regulatory uncertainty as technically there is no central authority overseeing the exchanges, and essentially less accountability. It's for these reasons that DeXs could actually impact business models negatively by incentivising going directly to the market, without the proxy of a financial institution, reducing existing revenue streams.

There were differing views regarding both the value proposition for a DEX in financial services and its feasibility as a trading venue. The difference in opinion was observed across both workshops. Dublin participants were slightly more attracted to the concept than the London participants, which could be attributed to a more significant presence of people working in innovation or FinTech at the Dublin workshop. An individual working in strategy for a stock exchange group was opposed to the concept of Decentralised Exchanges, stating *"there's a value proposition for the existence of a centralised marketplace"* affirming that individuals will benefit from *"a central authority overseeing the exchange and policing it to prevent any form of wrongdoing"*. The data collected as part of the workshops indicates that the feasibility and resulting value of a DEX may not be all that significant. Several reasons were given as potential pitfalls for decentralised exchanges. One participant believed the concept of a multi-asset DEX was unfeasible as *"different asset classes are traded on different exchanges for a reason"* - the reason being that different asset types have different behaviours and regulatory requirements, and as such a single venue may not be feasible. Another reason given as to why a DEX creates less value than a centralised exchange for people working in the industry is the lack of brokers or market makers. A participant at the London workshop stated that *"there's a lack of viability (of DEX's) due to the fact that exchanges have a need for market makers and brokers as liquidity providers for institutional volume"*. This statement expresses the belief that the existence of brokers and market makers increase liquidity and trade volume on the exchange as a large cohort of trades done on centralised exchanges are carried out by these middlemen, whereas on existing DEXs, such as cryptocurrency exchanges it is generally just retail investors interacting directly with the exchange. The founder of a newly-emerging decentralised exchange stated *"decentralisation is a problem for AML/KYC (Anti-Money Laundering/Know Your Customer) measures. Laws (facilitating these exchanges) won't be passed until there's a special (software) application facilitating this"*. Two-thirds of participants attending the Dublin workshop were of the opinion that there is some viability for a decentralised exchange facilitating the trading of cryptocurrencies, but not one DEX for trading assets of multiple types - specifically different types of financial securities.

Based on the data collected around decentralised exchanges there is some potential value in their existence such as the lack of a "single point of failure" in terms of security. "Single point of failure" refers to the potential threat of compromise a centralised exchange faces, which does not apply to decentralised exchanges. Centralised exchanges such as the NYSE are governed by a centralised authority and therefore, if this authority is compromised or goes down, this impacts the whole exchange. On the other hand, DeXs are decentralised, so if one of the blockchain nodes hosting the exchange is compromised or goes down, the others remain unaffected meaning a DeX would have superior resiliency and security in this respect. Nonetheless, exchanges derive value from the existence of a central authority for purposes such as institutional trade volume, as well as the existence of some parties to centralised exchanges such as market makers. If DeX's were to replace centralised marketplaces, there would more than likely be a spike in retail investors due to new-found accessibility. On the other hand, as increased access to markets is available to the average person, they may be less likely to transact with a financial institution resulting in reduced trade volume on an institutional level.

Upon examination of the impact of decentralised exchanges on business models of organisations operating in the industry, the potential impact can be classified as neutral-to-negative. This can be seen by examining the impact through the lens of the Business Model Canvas. Digital assets are essential to existence of decentralised exchanges as it is the assets themselves which are traded on these exchanges, whether in form of tokenised securities or cryptocurrencies. DeXs offer new Channels, but these channels are more beneficial for retail and casual investors. These retail investors would be looking to interact with the market independently of financial institutions such as investment banks. This could negatively impact a financial institution's existing Customer Segments by incentivising these customers to invest directly rather than through a 3rd party. This in turn could reduce the amount of revenue generated by the organisations, thus negatively impacting Revenue Streams. Therefore Decentralised Exchanges are a digital asset related offering which could impact future business models in financial services; however, the impact is neutral-to-negative rather than neutral-to-positive.

4.5.1.5. Central Bank Digital Currency

A Central Bank Digital Currency is a potential digital asset related offering whereby a central bank would commission the issuance of a digital asset in the form of a fiat currency. Blockchain technology would be the technology used to underpin a Central Bank Digital Currency (CBDC), with each unit being a digital asset in its own right. The introduction of a CBDC would enable faster clearance and settlement of financial transactions and would also reduce risk associated with these transactions. This would in turn impact future business models of companies in financial services by altering cost structures. In addition to this, a CBDC would likely be a key resource for many organisations operating in the financial services industry.

The concept of a CBDC was explored throughout the foresight workshops. In the fictional article many futuristic concepts involving digital assets in financial services were proposed to provoke discussion among participants. CBDC was raised in the fictional article within the context of the European Central Bank commissioning the use of a fiat cryptocurrency. This provoked a diverse set of reactions from different participants. The majority of participants were in agreement that, regardless of positive or negative consequences, it is likely that a government will issue some form of CBDC in the next decade. A partner at a law firm specialising in this area stated *"it's (CBDC) more probable to occur than not"* continuing to say that *"the ECB will probably want it"*. On the contrary, an independent digital asset consultant believed that the ECB would be one of the less likely central banks to commission a digital currency: *"the idea of the ECB doing a CBDC is unlikely to me"*.

A significant bone of contention around the topic of CBDC was whether or not to use digital asset tokens for it. A senior partner at a prominent DLT company said: *"Banks currently run 'digital money' in this form, what's different? Everything works perfectly with just 10% cash. Why do I need blockchain for it?"*. CBDC was lauded for certain efficiencies it could provide such as *"traceability"* and *"anti-counterfeiting"*. Both of these contributions came from an associate solicitor specialising in digital assets, to which the senior partner from the DLT company replied, *"do we need more traceability?"*.

Other potential benefits of a CBDC suggested in the London workshop were that it could improve the stability of the payment system by *"reducing the concentration of large multinational companies involved in and controlling our payments systems"*. The multinational organisations being referred to here are financial intermediaries such as clearing houses, settling agents and stock transfer agents. As discussed in the workshops, these parties help to verify and finalise financial transactions, but can introduce additional complexities and risk in the process. Utilising a CBDC would mean that the roles of these parties could be performed autonomously through the use of smart contracts. Another significant advantage of a CBDC, which was identified during the workshop, was how it can *"support existing DLT based assets or digital assets"*. It would do so by providing the necessary *"payment leg"* to buy and sell tokenised securities. If these tokenised securities proliferate and gain adoption, a CBDC would facilitate *"Delivery versus Payment"* which would be a very desirable feature of new age financial markets. When referring to *"delivery versus payment"* the participants were referring to the settlement concept that delivery of a security only occurs after the payment for the security is made. In the current financial system, delivery vs payment occur at separate times, with settlement lag causing a delay between the payment for an asset and its delivery to the buyer.

The use of a CBDC could impact the future business models of organisations operating in the financial services industry in several ways. Transacting with customers and other banks are viewed as Key Activities for almost all financial institutions and as such, a CBDC can be viewed as a Key Resource as it can be used to achieve this activity in a more efficient and low-risk manner. It can do so by acting as the "payment leg" for carrying out several different types of transactions on DLT networks. This could be of significant value to these financial institutions as it reduces time associated with clearing and settling trades but also reduces risk inherent with these types of Key Activities. It reduces clearing times as the smart contracts used to conduct transactions on DLT networks execute the transaction on-chain. Both the CBDC and the asset being traded, such as a tokenised security are *"on-chain"* meaning that as the smart contract for the transaction executes, the payment in CBDC goes from Buyer to Seller at the same time as the tokenised security goes from the Seller to the Buyer. This reduces risk and improves efficiency as the payment and delivery of the security occur simultaneously and without the need for any intermediaries. Through the use of a

CBDC the trade is settled instantaneously, meaning that as soon as the payment leaves your account, the security is delivered in your name, eliminating the risk of a traditional intermediary settling the trade from going bankrupt in the timeframe where you are waiting for delivery. Both the CBDC and the Tokenised security in question here are digital assets, demonstrating the important role they play in the use of a CBDC. This application of digital assets and the associate benefit for companies demonstrates why CBDC would be a Key Resource for businesses in financial services and would as a result, impact their future business models.

In summary, a CBDC can add value in terms of achieving settlement finality through delivery versus payment and reducing large multinational companies stakes in payment systems. Both of these benefits would introduce significant value for people working in the financial services industry and in the process would impact business models significantly by reducing the number of unnecessary Key Partners such as clearing houses as well as reducing Cost Structures by reducing the number of intermediaries taking a percentage of each transaction. A CBDC would also likely be considered a Key Resource for many organisations operating in the financial services industry due to the benefits and efficiencies it could introduce into the trade cycle, and therefore its introduction would tangibly impact future business models.

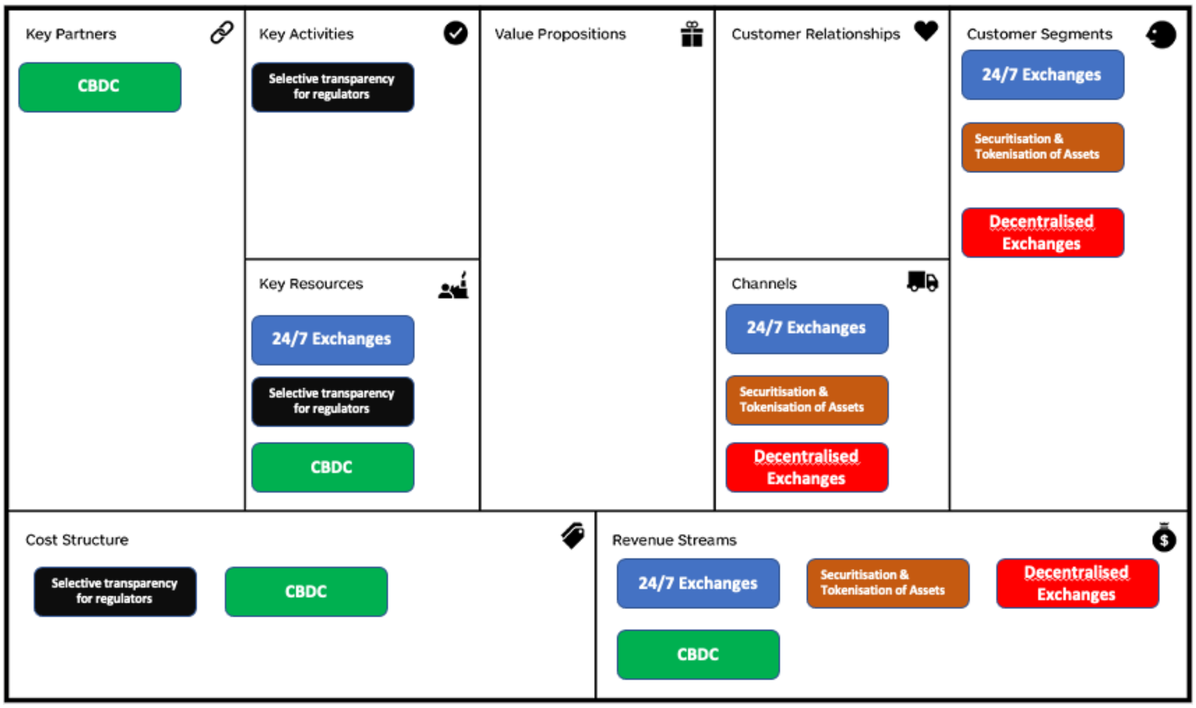

Figure 4-2 – Osterwalder and Pigneur's Business Model Canvas (2010) populated with digital asset-related offerings discussed above

4.5.2. Factors Enabling Digital Assets

In the previous section the impacts that digital assets could have on future business models in financial services were identified. Now, the question is what are the factors that will help industry stakeholders to leverage the positive impacts that were identified. More specifically, this sections looks to determine what factors will enable digital assets to change business models in financial services.

4.5.2.1. The Need for Trust

Trust was identified as the key factor needed to enable digital assets in financial services. In order to leverage the positives of the digital asset related offerings outlined in 4.1, trust must be placed in digital assets. Workshop participants spoke of how many people across financial services don't trust digital assets and DLT, causing a trust crisis. Financial institutions must ensure consumers get over places of mistrust to address this trust crisis. Trust is a key factor for enabling digital assets in financial services not only because trust is an integral part of financial services, but also due to the fact that trust is inherent to DLT. During the workshop three new risks were identified in this area. These risks are Market level or Structural risk, Privacy risk, and Asset level risk. Each of these risks will be explored in this section.

The findings from the workshop reveal that trust is a factor that industry must consider to enable the digital asset related offerings outlined in 4.5.1. Trust was described by a participant from the Dublin workshop as "*the main factor pushing for transformation in the financial services sector"*. Given that the implementation and adoption of digital assets in financial services will involve a significant transformation of the industry, trust is a key factor for enabling digital assets. The general consensus was that trust is a "*pre-requisite"* in financial services and that it forms the basis for successful relationships between various stakeholders across the industry. Approximately 86% of participants believed that in the current ecosystem, there is a good level of trust placed in financial institutions, whereas the other 14% believed that there is a lack of trust between financial institutions and their customers. This finding raised a question around whether this high level of trust would still apply if DLT was being used commonly across the financial services industry. The need for trust emerged as the main key factor that is required to enable digital assets in financial services throughout the course of workshops. Therefore, if one is to see some of the benefits associated with the digital asset related offerings in 4.4.1, trust must not be overlooked.

A subject matter expert on digital assets stated that *"people want trusted parties handling their assets and money"* and continued to say that *"there's a level of trust necessary between regulators and consumers also"*. This opinion was somewhat echoed by a partner from a law firm specialising in this area: *"People trust physical banks. The issue here for mass adoption (of digital assets) is placing trust in a system* *or entity, rather than a friendly face at the bank".* These quotes demonstrate the lack of trust that financial consumers could place in digital asset related offerings in financial services. For example, in the concept of 24/7 exchanges and Decentralised Exchanges, the automation of processes previously performed by people may cause places of mistrust among customers who would be more reluctant to place trust in a *"system or entity"*.

Many participants were of the belief that if organisations in the financial services industry are to leverage the value of the digital asset related offerings outlined in 4.5.1, then they need to ensure that people get over their places of mistrust. A participant initiated this discussion by asking *"How do you garner trust from a consumer?"*. One of the more proven measures considered by a significant portion of participants was that of utilising partnerships with established players in financial services or technology. A partner from a law firm had this to say: "*If people trust Facebook, then they will trust Libra*". These techniques were echoed by a different team, where they spoke about the contrasting implementation techniques of Facebook and Libras partnership versus that of Goldman Sachs and Apple with the new Apple card. The founder of a VC firm operating in the FinTech area affirmed that *"establishing partnerships as a means of garnering trust is an effective technique for increasing adoption of a new technology"* and that *"this needs to be done more to drive adoption and change in this area".* Similarly, garnering trust through partnerships which allows customers to place trust in more established companies, could be an effective way to increase adoption of digital assets.

Notwithstanding the impact of utilising partnerships as a means of garnering trust, there still remains more deep rooted issues or *"risks"* as identified in the workshops. The trust issues discussed throughout the workshop are not just caused by automation or the removal of a human element, but by risks that could come with the adoption of digital assets and their use in financial services. These risks pertain to digital assets themselves and how they can fundamentally affect or change the financial services industry, were they to gain widespread adoption. These risks were labelled as Structural risk, Privacy risk, and Asset level risk, and will be explored in detail in the following sections.

In summary, the data collected as part of the workshops indicates that trust is the key factor to consider when looking at what factors will enable digital assets in financial services. The lack of trust that consumers and other financial stakeholders have in digital assets and their underpinning technology can be attributed to three main risks: Structural risk, Privacy risk and Asset level risk. If industry stakeholders can identify and address these risks appropriately then it's entirely possible that digital asset related offerings such as CBDC, 24/7 exchanges and selective transparency for regulators could be utilised in financial services in the future.

Structural Risk

The first risk identified which could be a contributor to the lack of trust in digital assets is referred to as Structural Risk and has to do predominantly with the existing financial infrastructure in place and roles associated with this infrastructure. If one is to see digital asset related offerings such as 24/7 securities exchanges, then the existing financial system and its associated roles and structures will have to adapt or be removed. 24/7 exchanges, CBDC and other offerings outlined in 4.5.1 will bring with them benefits and efficiencies but they will disrupt the existing financial structures in place, as well as the bilateral dependencies across different parts of the financial system. The adoption of digital assets in financial services will change the status quo by removing some actors, introducing other new actors, as well as new complexities and new risk. Therefore, structural risk will need to be addressed to increase trust among consumers and other financial stakeholders and in doing so, facilitate the entry of digital assets to the market.

While referring back to the fictional article used in the workshop, one individual who works in an innovative products team for an asset management company said, *"what's missing from this consideration of the future is the financial structures already in place"*. This point was reinforced by a senior employee working in innovation for an asset management company who said that *"It's unrealistic to believe that most intermediaries will be removed as they all have a role in the ecosystem"*. These statements reveal a need to effectively manage an interdependent ecosystem when intermediaries with bilateral dependencies are removed. The term bilateral dependency refers to intermediaries such as clearing houses, whose role is depended on by other actors in the financial system, and vice versa. This view of interdependence was certainly the general consensus among most of the participants, with another stating *"intermediaries won't just go away as there's still value being aggregated"*.

However, not all participants were in agreement on this. An independent digital asset consultant stated that *"Incumbents will be displaced through on-chain platforms"* and an individual working with a VC firm believed in a more localised form of disintermediation relating just to the financial role of custodian - *"(the) custodial business function will be boiled down to an on-platform feature rather than a whole business line"*. Both of the individuals expressing opinions that large-scale disintermediation will occur are involved heavily in the FinTech Industry and this may be why they seem to express a slightly more 'tech-centric' view of the future of financial services.

One thing that participants from both sides of this argument were able to agree upon was the inefficient and cost-ineffective nature of the current financial ecosystem in place. Intermediaries were mentioned several times as a potential reason for this inefficiency. Participants spoke of how intermediaries *"introduce unnecessary risk"* and *"delay the settlement of transactions"*. Other participants spoke of how these intermediaries often *"have transaction fees"* as they can take significant cuts of each transaction. Despite this, many participants believed they would remain in some capacity as they are established and have interdependent relationships with other parties in the current financial system.

The findings suggest that the financial system in its current form is highly interdependent and inefficient. Digital assets related offerings such as 24/7 exchanges and CBDC could certainly reduce some of these inefficiencies such as settlement lag but a significant risk they face is that posed by the existing structures in place, or 'structural risk'. This existing infrastructure and structural risk in turn erodes away at the trust which industry stakeholders must place in digital assets in order for them to be adopted and their value to be realised.

In summary, a significant factor affecting the potential successful implementation of digital assets in financial services would be the pre-existing financial infrastructure in place or, as it's referred to in this chapter, "structural risk". The lack of consideration for the existing financial infrastructure when considering the adoption of digital assets in financial services creates this structural risk, which in creates a lack of trust among consumers in the financial services industry. For adequate trust to be maintained and digital assets to become a valuable and regularly used instrument in financial services, it will require a variety of functions in a largely interdependent ecosystem to change their role, requiring significant institutional buy-in and a considerable commitment across competitors. Therefore, if the financial services industry is to enable digital assets and enjoy the benefits and efficiencies associated with the offerings presented in 4.1, then structural risk will need to be addressed.

Traceability/Privacy Risk

Another risk identified during the workshops which could be a contributing cause to the trust crisis referenced in 4.5.2.1 is that of privacy risk. As previously mentioned in the literature review section in this chapter, blockchains are pseudonymous transparent networks and, as such, may cause concern around privacy in financial services, given the sensitive nature of the vast majority of financial data. Offerings such as 24/7 exchanges, CBDC or other offerings associated with blockchain technology – digital assets' underpinning technology – could introduce a level of mistrust among people in the industry as they may perceive that their data as being exposed to or exploited by other users of the systems. This risk causing mistrust among financial stakeholders could have a significant knock on effect on whether or not digital asset offerings such as those in 4.4.1 are enabled and adopted in financial services.

Concerns around privacy were expressed by some of the workshop participants who were worried about the degree of traceability that would be possible in the future. A senior partner from a blockchain software company spoke of how *"traceability is beneficial down to a certain level. The question is finding that balance"* – referring to the permanent nature of DLT and how if digital assets were used as a means of retail payment, that individuals' transactions could be traced back to them, posing a significant privacy risk. Other participants discussed a problem which could stem from the issuance of a CBDC as *"privacy issues in violation of Article 8"* an article in the European Convention on Human Rights, which provides the right to respect for private and family life, home and correspondence. *"ECB's ability to monitor the spending of each token"* could be a breach of this article. Additional concerns around the level of privacy available to consumers with systems of this nature were raised. An associate solicitor from a law firm specialising in digital assets spoke of how *"we should be cautious of our right to privacy"* and referring to article 8 and the general data protection regulation (GDPR). The discussion continued with the main theme being the an outstanding need for a privacy solution on-chain.

Regarding privacy concerns for institutional consumer segments, an individual working in asset management expressed concern about the *"transparent nature of blockchain"* and how this could *"make available institutional transaction data that competitors can use to gain a competitive advantage".* This data suggests that the pseudonymous nature of DLT may cause a privacy risk when using digital assets and their related offerings. The reason being that privacy is an integral part of financial services and transaction data is some of the most sensitive of this data. Transparency is an important feature when viewing it from a regulatory standpoint, but would involve revealing transaction data that is not usually available to parties who aren't a transaction counterparty.

The findings demonstrate the privacy is somewhat of a sticking point with regards to the use of digital assets and DLT in financial services. The views expressed by participants – many of whom work in financial institutions – demonstrate that privacy is a significant risk which can bring about a lack of trust in digital assets and their underlying technology. Therefore, if digital assets and some of the offerings outlined in 4.1 are to become a reality, privacy risk must be addressed in an attempt to negate this perception of risk associated with the technology.

Asset Level Risk

The final risk identified as part of the trust crisis referenced in 4.5.2.1 is that of asset-level risk. At a high-level, asset-level risk is caused by the novelty of new assets. Due to the novelty of these new assets it's hard to know for sure how these assets will behave or be used if they gain widespread adoption. This ties into the trust crisis laid out above as this is reluctance among financial stakeholders to place trust in the actual financial vehicle itself and its associated process of conversion - tokenisation. To ensure that the benefits of digital assets in financial services are realised, stakeholders will have to ensure that the usage of digital assets is sensible, provides actual value and, as such, remains stable. This concept was explored throughout the workshop and based on the data collected it seems as though it may be easier said than done.

Asset-level risk is the idea that widespread usage and adoption of digital assets and tokenisation – especially in financial services – may not be such a positive thing. Based on the feedback provided as part of the workshop, asset-level risk for digital assets was caused mainly by concern around the process of tokenisation. There were concerns that digital assets could lose their purpose and value if institutions and individuals begin tokenising assets to a point of granularity where it somewhat loses its initial purpose and creates an unnecessary level of complexity and confusion. The example of real estate was used by a participant to emphasise this point. The participant asked about if people begin tokenising real estate and engaging in fractional ownership of it, to what level of granularity do they drill down to. He added: *"what's the benefit of owning 10 metres squared of an apartment?"*. The point being made here is, it's one thing to tokenise an entire property but if you engage in fractional ownership of an apartment, where do you draw the line? Some of the other discussions at the workshops consolidate this point - a partner at a blockchain software technology company suggested the idea that *"not everything should be tokenised"* and did not believe that self-tokenising platforms such as Polymath and Harbor are applications of this technology that should be promoted.

In addition to this, some participants were of the view that widespread tokenisation could cause chaos by over-complicating things. This point is summarised by one participant who said that by tokenising assets that don't need to be securitised you *"over-complicate something that was initially intended to simplify"*.

In addition to these points – there is a slight cause for concern on how exactly the link between representative digital assets and their underlying asset would be established. For example, if you have a collection of digital asset tokens which represent a piece of real estate which you don't live in, how do you link the asset tokens themselves to the underlying asset and prove ownership? Ownership deeds can be held up in a court of law as they are legally binding documents, but digital asset tokens are not legally binding when it comes to property ownership and will not hold up in court. A very similar line of questioning was put forward by participants of the workshops, with one participant asking "*what links these assets to the tokens that represent them?"*. Another participant used an example of the Brooklyn Bridge to explain the current legal frailty behind the ownership of representative digital assets: *"What if you have a token saying you own 10% of the Brooklyn Bridge – how do you verify this in a court of law? Trading ownership of the Brooklyn Bridge on Ethereum doesn't change who owns it!"* citing that intermediaries are still required to change names on deeds of ownership.

The findings above indicate that asset-level risk is a genuine concern for financial stakeholders and could be a detrimental factor to the adoption of digital assets in financial services. The issues highlighted above such as increased levels of complexity could in fact act as a deterrent for companies looking to introduce digital asset related products such as those outlined in 4.5.1.

The increased level of unnecessary complexity and question marks around linking representative digital assets with their underlying assets are both examples of instances which could cause people to not trust the technology. For this reason, asset-level risk is certainly a factor which could impact the digital assets and their ability to be enabled within financial services.

Now that the concept around the trust crisis and the three risks identified during the workshop which contribute towards these places of mistrust have been unpacked, 4.5.2.2, 4.5.2.3 and 4.5.2.4 will all look at what factors the financial services industry can focus on in order to make attempts to fix the trust problem.

4.5.2.2. Regulation

The first factor to discuss which could potentially solve the trust crisis is that of regulation. Regulation was identified in the workshops as one of the most important factors which could enable digital assets in financial services. Similarly it was discussed how regulation could also be a factor that could have a negative impact on the adoption of digital assets in financial services. Regulation – if drafted and applied correctly – could help financial stakeholders get over places of mistrust with regards to digital assets and thus is a factor which could help address the trust crisis.

There were several perspectives expressed by workshop participants around digital asset regulation and how this might be implemented in financial services. Some industry stakeholders participating in the workshop believed the best means of addressing regulatory uncertainty around digital assets is through some form of global framework that would allow for a cross jurisdictional approach. This would entail several state regulatory bodies working together to manage a technology which could make financial services *"more global than ever (before)".* Others believed each individual regulatory body would have to address the issue of digital asset regulation themselves on whatever timescales they deem appropriate. Participants at the Dublin workshop considered the concept of a cross-jurisdictional framework to be a more efficient regulatory approach. For example - a member of senior management in an asset management company spoke of how *"a global regulatory framework is necessary for these (blockchain-based) systems to work properly".* This perspective can be contrasted with those of some participants attending the London workshop. The data collected in London indicated that this issue is not one that can be addressed with a cross-jurisdictional solution but that every financial regulatory body should take ownership for their respective jurisdiction. This point is reinforced by an individual working in strategy for a stock exchange group who spoke of how regulation is *"jurisdictional"* and how *"domestic business is subject to local regulation".* The latter seems somewhat more realistic as it was stated that a global regulatory framework would require a herculean effort on behalf of several regulators worldwide to ensure there is alignment in thinking between these sovereign bodies.

Many of the applications of digital assets identified in the previous section - such as decentralised exchanges - propose cutting out middlemen such as brokers and going straight to the investor for the trading of securities. The findings reveal that this may be an unrealistic proposition due to existing regulation potentially impeding companies from doing so. A person working as part of an innovation team at an asset management company spoke of how *"going directly to the investor involves a lot of regulation that will stop it from happening",* with other participants agreeing.

Another facet to the factor of regulation identified during the workshops was the willingness of regulators to embrace and legislate for this new form of technology. The main position on this was that if regulatory engagement was low then establishing trust and adoption would be severely affected: *"There are a number of stakeholders (currently participating), but if the regulator is not on board, other stakeholders will fall away and it won't happen"*- (Head of capital markets for a finance-based federation in Dublin). The general consensus across both Dublin and London was that regulators can and likely would play a *"catalyst role"* here, where they can essentially lead the change by embracing and legislating for the new technology. This catalyst role could in turn impact trust in digital assets across the industry. For example, if regulatory bodies such as the FCA or Bank of England are discussing applications of digital assets in financial services then industry stakeholders should be able to trust the technology and its benefits.

The applications of digital assets presented in the previous section, such as Central Bank Digital Currencies as well as 24/7 exchanges would require significant input from regulators before they could become live, production systems. As stated by participants, regulation can act in *"catalyst role"* and enable trust and innovation in this field. By this line of thinking, without an appropriately defined regulatory approach, companies will more than likely struggle to establish support for digital assets and generate revenue from related products. Conversely, if an appropriate regulatory framework is defined for the use of digital assets in finance then the financial services industry could see trust in this new technology improve among consumers and other industry stakeholders. Companies could then begin to offer new and innovative digital asset products such as 24/7 exchanges and tokenised securities.

The findings suggest that there are some issues with regards to digital asset regulation in financial services. Jurisdictional issues and a potential lack of regulatory body willingness for the technology could become barriers to adoption. However, they also indicate that regulation will likely play a catalyst role in enabling digital assets in financial services. It was also suggested that if regulators view and regulate digital assets in a positive manner then industry stakeholders should have more confidence and trust in applications of digital assets and their underlying technology. Therefore regulation is an important factor which could enable digital assets in financial services and by doing so, address the lack of trust in the technology.

4.5.2.3. Influence of Incumbents

In analysing the workshop discussions on financial disintermediation, the findings reveal that financial incumbents will more than likely play a significant role in driving the adoption of digital assets, rather than becoming disintermediated themselves. The incumbents referred to in this section are existing and established financial institutions.

Team 1 at the London workshop concluded that it would be unrealistic to believe that a large portion of existing financial institutions would lose a significant amount of market share in the next 10 years, as many of them still have a role in the financial system. Nonetheless, it was stated by an individual specialising in digital assets with a blockchain enterprise software firm that *"large players must adapt or die".* This sentiment was independently re-iterated in the Dublin workshop by a senior employee working in the funds industry, who said: *"Big institutions will have to buy or die, otherwise smaller FinTechs are going to swoop in and capture the market share"*. The sentiment of this statement being that if financial incumbents want to remain relevant within the industry that they will also need to get involved in the nascent area of digital assets.

The general consensus across the majority of workshop attendees was that financial incumbents have a significant influence over the adoption of digital assets. Participants made references to *"large-scale digital asset related initiatives ongoing"* from the likes of J.P. Morgan, Deloitte and Fidelity and how companies of their stature have engaged with this technology, allowing it to mature and gain more widespread attention as a result. As a result of this, financial incumbents find themselves in a relatively unique situation as their behaviour could directly affect the adoption of digital assets in financial services, not unlike how regulators can perform a *"catalyst role"* as explained in 4.5.2.2.

However, several participants were of the opinion that this influence exerted by incumbents can be both a positive and a negative factor affecting the adoption of digital assets in financial services. Incumbents can take a stance where they *"ignore this new wave of tech and hope that it fades"* or they can embrace digital assets and their underlying benefits for the industry. The former would mean that some of the largest-scale digital asset related initiatives would cease to exist or may dial down; the latter could push the area on even further.

There was some evidence from the workshops that incumbents and their influence is an important factor that could facilitate the building of trust in digital assets in financial services, and by doing so enable their adoption in the industry. A participant at the London workshop spoke of how these incumbents need to *"stay ahead of the curve and stop others swooping in. Thus, pushing this area even further forward"*. What's implied here is by pushing the area forward through investment and publicising such engagements, digital asset related offerings such as CBDC and tokenised securities from several companies and bodies across financial services gain the traction and trust they need to flourish. The details of incumbent's offerings in innovative spaces of technology are regularly reported by leading financial publications which in turn creates additional interest in the area. This interest could lead to more companies looking to offer their own flavour of digital asset related offering and can also result in increased investment in smaller companies with related products. Other companies may not look to offer digital asset based products such as those outlined in 4.1, but may look to use these offerings and their inherent benefits to operate more efficiently within the industry.

In summary, financial incumbents exert a key influence across the financial services industry. The findings suggest that this influence can be used for good to build trust in the technology for stakeholders. By engaging in public initiatives and utilising digital asset offerings such as those in 4.5.1, financial consumers and other stakeholders will be more likely to trust and adopt the technology itself, therefore enabling it within financial services. Financial incumbents and their influence can be used to enable digital assets in financial services and therefore they are a factor which can help solve the trust crisis with digital assets.

4.5.2.4. The Need for Education

The third and final factor identified during the workshops which could help combat a lack of trust in digital assets across financial services is that of education. During the workshop it was revealed that many financial stakeholders, ranging from consumers to employees in large financial institutions, don't have sufficient knowledge on digital assets and DLT. This lack of knowledge and understanding was identified in the workshop as a contributing factor to some of the places of mistrust discussed in 4.5.2.1. Therefore, in order to address and resolve this trust crisis it is important that education is emphasised as a key factor for enabling digital assets.

Digital assets and their underlying technology – DLT - are often construed as complicated concepts and, as a result, participants of the workshops were confident that education would emerge as a key factor which could enable digital assets and their related offerings within financial services if utilised in an effective manner. Education as a tool for building trust in new forms of technology was a significant talking point throughout a portion of the workshop. Participants in Dublin promoted the idea of *"educating the masses"* as an important method of leveraging the benefits of and increasing trust in digital assets. They referred to implementing large-scale educational programmes to ensure a widespread understanding of digital assets. When discussing the topic of exchanges, a partner at a law firm introduced the topic of education by saying *"It won't be exchanges that change the market, it will be education"*. Others agreed with this statement, adding that if consumers are unable to understand the benefits of utilising digital assets and don't have a basic understanding of the distributed ledger technology which underpins them, then digital assets will struggle to gain adoption in financial services. Several participants across both workshops expressed concerns that if their companies offered tokenised securities in lieu of traditional securities then their consumers would be sceptical and unlikely to adopt due to a lack of trust in the technology and knowledge of its potential benefits within financial services. While on the topic, a senior employee working in the funds industry insisted that one of the most important aspects of education is *"educating the 1.7 billion unbanked and getting them to sign up. This should be the goal"*.

However, there are certain caveats to be aware of when considering any form of educational programme regarding this technology. A senior partner at a blockchain software technology company said, *"Education is a double-edged sword: helpful to inform the end-user but allows and can draw more regulatory scrutiny".* His belief was that even though education on the area of digital assets could help digital asset offerings such as CBDC and 24/7 exchanges become more widespread in financial services, the technology would also give regulators a more clear view than ever before. This in turn could lead to regulators being more stringent than they may have been previously.

Education could be an instrumental factor in fostering more trust in digital assets and by doing so, facilitating the adoption of digital asset related products in financial services. As the findings from the workshop indicate, without education on the benefits of digital assets and a basic understanding of the underpinning technology, organisations would be slow to introduce digital asset related offerings such as tokenised securities due to a lack of trust in this new form of asset. Suggested means of combatting the potential lack of education from the participants included some form of government intervention or initiative as well as updated school curriculums that include lessons on financial services and financial literacy. Others noted that there are already financial institutions providing educational resources on this new age asset in the form of educational videos and knowledge bases hosted on their websites.

In summary, the findings suggest that education is a factor which is needed to ensure that digital assets are enabled within financial services and can help to alleviate the trust issues. The opinions expressed in the workshops by industry stakeholders demonstrate that there is concern among financial organisations that consumers will be slow to adopt if these companies begin offering digital asset related offerings. The representatives attending the workshops from some of the largest financial companies in the world thought that digital assets and DLT are seen as complicated technological concepts. This coupled with the participants' perceived reluctance of consumers to change from traditional systems will reduce the likelihood for companies to offer or utilise products such as tokenised securities, CBDC or 24/7 exchanges. If the industry is to combat this trust issue in digital assets and attempt to boost adoption then they should engage in educational initiatives which bring about a common understanding as to how the technology works and what tangible benefits it brings to consumers and companies alike. For these reasons, education is one of the key factors enabling digital assets in financial services.

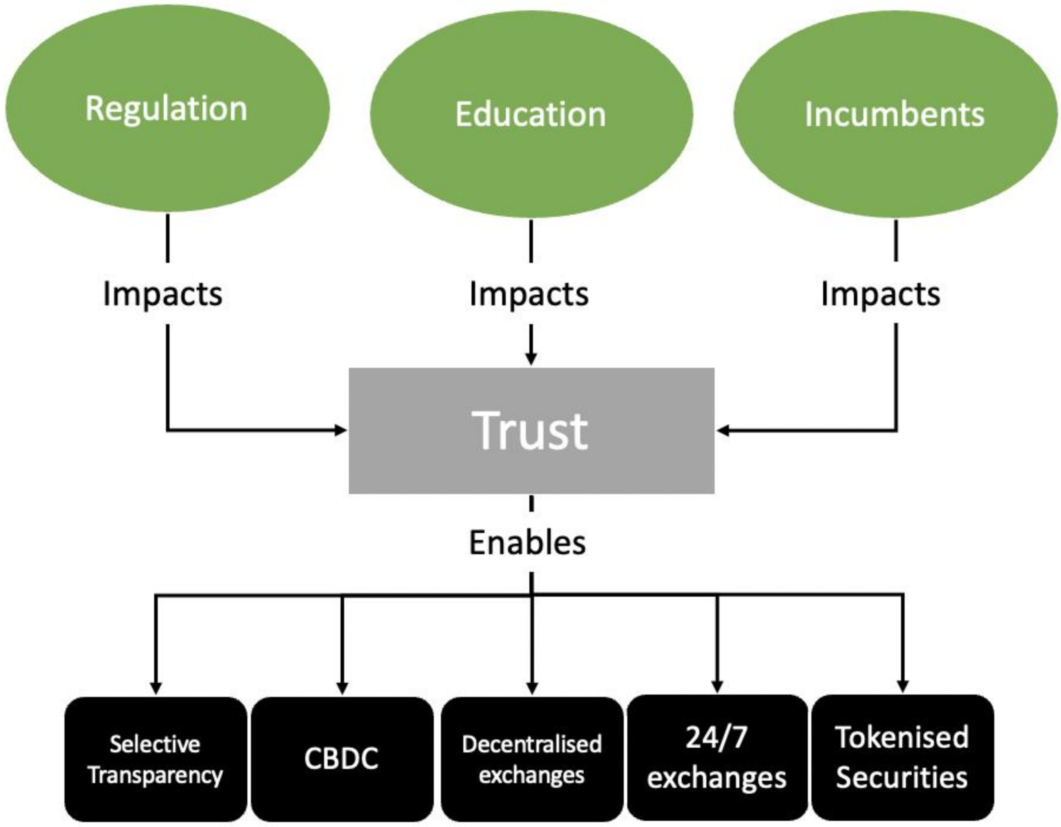

Figure 4-3 – Demonstrates impact flow of factors in 4.2 on digital asset related offerings in 4.1

4.6. Conclusion

This chapter presents an analysis of a set of qualitative data to understand the impact that digital assets and their underlying technology could have on business models of organisations in financial services. This chapter also sets out to determine the factors that would enable these changes or for the impacts to business models to occur. The key data analysed in this chapter was predominantly gathered from a series of foresight workshops held with experienced professionals working in industries such as technology, financial services, and law. At a high level, it was determined that digital asset related offerings such as selective transparency for regulators, Central Bank Digital Currencies, decentralised exchanges, 24/7 exchanges and tokenised securities would impact business models of organisations in financial services in several ways. It was also determined that factors such as regulation, education, incumbent activity and trust would also be key in enabling these impacts on business models to occur, albeit in slightly different ways.

In summary, the findings of this chapter highlight that trust is the key factor to be considered by organisations operating in the financial services industry if they are to leverage the perceived value that digital assets could deliver. The reason for trust holding this place as a key factor is due to places of mistrust across consumers with regards to digital assets and DLT. More specifically, three main risks were found that cause these places of mistrust. Structural risk, Traceability or Privacy risk, and Asset-level risk all contribute to a lack of trust placed by consumers in digital assets. In order to alleviate these issues associated with this lack of trust, organisations in the industry must find ways to focus on or emphasise regulation, education and incumbents. By emphasising these factors and increasing trust, the data indicates that digital asset offerings will be enabled, which will in turn impact business models of organisations in the financial services industry. This is shown by the illustration in figure 4-4 below:

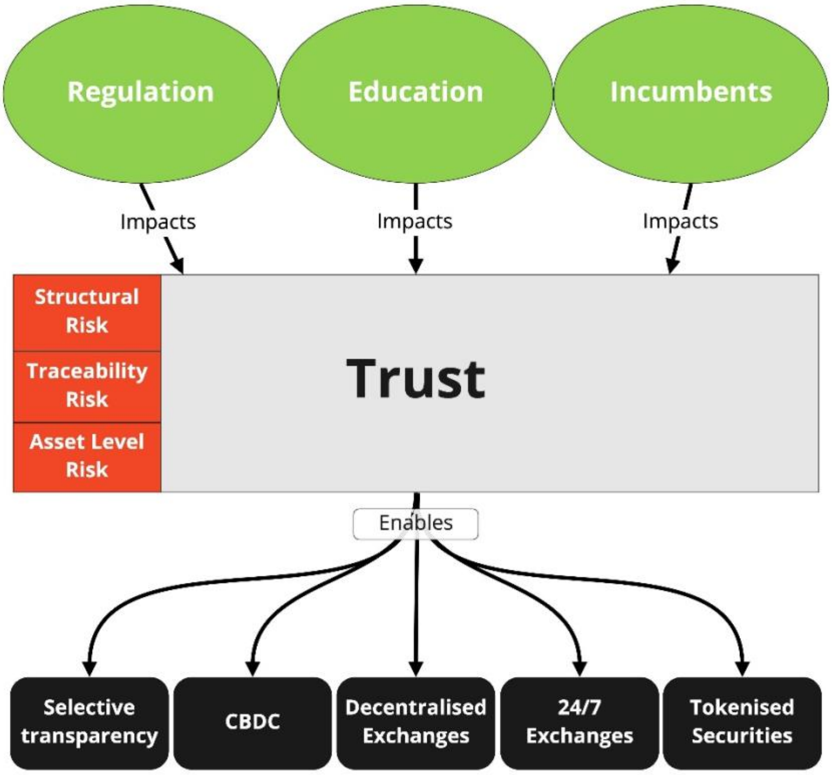

Figure 4-4 - depicts the findings of this chapter and their relationships

This chapter contributes to the theory on digital assets in financial services in several ways. Firstly, it demonstrates how these new age digital assets could impact business models of companies operating in the financial services industry which, as per the literature review conducted at the start of this chapter, was not information that was previously available. In addition to this, this chapter also contributes to theory by highlighting the integral role that trust can and will play in the adoption and enabling of digital assets in financial services. Moreover, this chapter shows how financial organisations and other industry stakeholders can focus on or emphasise certain factors in order to increase trust and in doing so, enable digital assets. In theory, the findings as part of this study could be used as a starting point for a 'blueprint' on how organisations in financial services can enable digital assets in their respective organisations. In other words, it can work as a guide to facilitating the identification of areas that can act as catalyst in their transition into using digital assets especially in the coming years as this foundational technology becomes more utilised.

Finally, this chapter contributes to the existing theory by collating varied perspectives on digital assets and their feasibility as an asset of the future in financial services. As part of the study, qualitative data from several senior financial services industry stakeholders was captured. This has provided some valuable insights into how large financial incumbents, law firms and fintech start-ups view digital assets and their future potential. The discussions that took place, including the various nuances and contrasting opinions could form the basis for a further study as secondary data and as such, contributes to existing theory on the topic. There still remains a number of areas for further research that could provide valuable insights. Firstly, interviewing regulators to get their opinions as part of a similar workshop could prove to be very beneficial to the area as a whole. As identified earlier in the chapter, regulators and regulation will play a pivotal role in future adoption, so the opinions of regulatory bodies would be invaluable.

5. Discussions and Conclusions

This chapter concludes the thesis by providing an overview of the research. To provide this overview, each chapter will be revisited and summarised so the underlying theme in the research can be understood. The associated research questions for each of the chapters will also be presented so it can be seen how the addressing of one research question led to the formulation of the next. Once the research has been summarised, this chapter will examine the contributions to research and practice that this research has made in the nascent field of digital assets. After this, the chapter will detail areas where there are limitations of the research and will present some lessons learned when conducting research in this area. This will then lead into the final section of the thesis which presents the overall findings and potential future research opportunities.

5.1. Summary of the research questions

To address the complex and multi-faceted area of digital assets in financial services, several research questions examining different themes were created. Three research questions were answered in this thesis, with one explored in each of chapters 2, 3 and 4. All 3 research questions share a common research objective: to investigate the future of digital assets within financial services and how they may disrupt the current financial ecosystem. chapters 2 and 3 both address their respective research questions through the creation of frameworks, whereas chapter 4 addresses its research question using a foresight workshop.

Section 2.2 details the problem area for digital assets in financial services. The theme of classification emerges as key topic which can be considered as an enabler for digital assets in financial services. The sub-theme of regulation emerged through classification. The current state of digital assets is somewhat hampered by a misalignment in how digital assets are classified across the industry. At the time of writing chapter 2, the regulatory frameworks available from government classified digital assets according to their functions rather than their structural features (Cryptoassets Taskforce, 2018). This is seen as being an issue as classification by functions could lead to digital assets changing their given classification at different points within their lifecycle. Similarly, regulation was an issue by extension as the lack of a consistent framework for classifying digital assets could lead to inconsistent approaches across different regulators, making them harder to regulate in the future. This can be seen by the discrepancies in some of the proposed frameworks (Cryptoassets Taskforce, 2018; Finma, 2018; Sec, 2017b). This concept of inconsistent classification led to the first research question.

Research Question 1: how can digital assets be characterised and classified according to their properties?

To address RQ1, literature-based research methodologies were used. Firstly, a systematic literature review was conducted which followed the guidelines laid out byWebster and Watson (2002). A concept centric matrix was used to collate the more prominent themes in the literature on the field of digital assets and DLT. These themes were then refined to find those which pertained primarily to structural characteristics of digital assets. Additionally, the research canvas of March and Smith (1995) was used as a template from which the digital asset framework was created. This template was then used in conjunction with the structural components identified in the concept centric matrix to form the framework.

The chapter found that the main binary structural properties present in every digital asset were fungibility, composability and state (i.e. representative or native). These structural elements would form the basis for the framework, but for it to capture all required information on a given digital asset, some data-based fields would also be required. For this, a field for the owner (Yasin & Liu, 2016), data store (i.e. data fields) (Wood, 2014) and (smart) contract functions (Szabo, 1994) were added. Together these elements form the Digital Asset Framework, which was then evaluated by applying it to real-life digital assets. The value of the framework can be divided into three distinct parts. It provides an easy means to classify digital assets, it gives a method to define an ownership of the asset which could make it easier to track throughout its lifecycle, and finally and it contributes to a better understanding of some regulatory implications involving digital assets.

When the structural composition of digital assets was understood through the framework, there was a need to understand how assets could convert to digital assets in the future. The research applied as part of chapter 2 didn't address this important element as the scope of RQ1 was to understand how digital assets can be classified according to their structural properties and not how they can be converted from non-digital assets to digital assets. Despite tokenisation not falling within the scope of chapter 2, during the literature review the topic emerged regularly and its importance became clear. Therefore, tokenisation led to the second research question.

Research Question 2: How does the process of tokenisation impact an asset?

To understand how the process of tokenisation will impact an asset, it was determined that examining previous similar evolutions could provide a useful basis to work form. Therefore, to understand how tokenisation would impact the assets, a comparison of the process with that of securitisation and that of digitalisation was performed. Tokenisation was compared to tokenisation because the ability to embed functions of a traditional financial asset, such as that in securitisation, are similarly important elements of the process of tokenisation (Hubbard & Hubbard, 1994). Similarly, digitalisation occurs when an object transforms from being analogue in nature to digital, such as cash to electronic payments (Guo, 2016). Tokenisation in a similar way involves transforming existing financial processes such as settlement, asset reconciliation, or general infrastructure by leveraging blockchain technology (Fehrenbach, 2019), and it also can involve transforming an asset from analogue to digital to unlock more functionality.

Once the landscapes of securitisation and digitalisation were understood, a literature review using Webster and Watson (2002) systematic method was followed. This once again allowed the creation of a concept centric matrix with key themes extracted from both the literature as well as the previous chapter which relate to digital assets and their associated form of conversion. The six concepts identified here were then divided into categories based on their impact. Those which impact business value (Liquidity, Composability and Information) and those which impacted how disruptive the asset would be for the organisation tokenising (Actors, Settings and Offerings). These themes facilitated the creation of the Tokenisation Impact Framework which can aid as a tool to understand how much business value is derived from tokenising a specific asset and how much tokenisation would disrupt an organisation and its market. The overarching purpose of the framework is that it will help to understand if it would be worthwhile tokenising an asset. This is done by assigning it a numerical value, which gives an indication of the potential business value from tokenising the asset. The higher the number, the more value to be derived from tokenising the asset.

By creating the framework and providing a template to help organisations to understand how tokenisation could create value for them, the focus then shifted slightly to how businesses would in fact create this value and disrupt the future of financial services. To create this value using digital assets, organisations will have to incorporate digital assets into their business models. With this understanding of how the process of tokenisation could impact an asset during the process of conversion, the next step was to understand how these digital assets would impact future business models of companies in the financial services industry. This then leads to the third and final research question of this thesis.

Research Question 3: How are digital assets perceived and what factors enable digital assets to change future business models in financial services?

RQ3 is a forward-looking one, a series of forward-looking research techniques were required to address it. Foresight research techniques were employed which aim to establish a vision of the future. Firstly, key trend literature was examined which provided information on several trends which would contribute in one way or another to the adoption and usage of digital assets in financial services. These trends and as well as some weak signals were used to challenge perceptions of future and expand the selection of alternative futures to be discussed. The identification of the weak signals was done based on the definition by Dufva (2019; 1). Dufva (2019) defines weak signals as “an indicator of a potentially emerging issue, that may become significant in the future”. This key trend literature then led to a series of workshops with industry stakeholders where most of the significant insights into digital assets and their impact were derived. In addition to the key trend literature, Osterwalder’s Business Model Canvas (Osterwalder & Pigneur, 2010) was used as a lens for this study as it allowed an understanding of how digital assets would actually impact future business models in financial services. Several of the digital asset offerings identified, as part of the key trend literature and during the workshop, would impact the future business models in several ways, with all the impacts being positive in nature.

Once it was understood how digital assets could impact business models by using the business model canvas, it was still unclear which elements business would have to focus on to realise this value. This leads onto the second half of RQ3, around understanding what factors enable digital assets to change future business models in financial services. This aims to identify the factors that industry stakeholders can focus on to leverage the benefits of digital assets and bring about change to their future business models. During the workshops conducted with industry stakeholders, the need for trust emerged as a key factor in financial services which is required to enable digital assets. For this reason, when looking at any risks which may impact digital assets in financial services, the potential impact of said risks on trust was a key focus. It was found that despite this key factor of trust was being negatively impacted recently. There were three potential risks identified, bespoke to digital assets, that were negatively affecting this trust. They are traceability risk, structural risk, and asset level risk. It was shown that these risks are likely depleting trust that the industry has in digital assets. In addition to these future risks, there are other factors, which if emphasised and addressed by organisations in financial services in the future, could help to build the trust required to enable digital assets. These factors are education, incumbents and regulation. By focusing on these factors, organisations can offset the risks listed above and ensure any potential negative impacts on trust in financial services are not realised. By doing so and ensuring trust remains, they can then enable digital assets in financial services, and in doing so, impact future business models.

5.2. Contribution to research and practice

This thesis contributes to the field of digital assets and distributed ledger technology in several ways, specifically with regards to their use within the financial services industry. Chapters 2 and 3 contribute primarily through the enhancement of understanding of digital assets composition, their related processes, and how these digital assets can be classified. On the other hand, chapter 4 contributes through describing the impact that digital assets may have in a commercial financial context in the future. The common contribution throughout is that they all describe in some manner the potential future application of digital assets in financial services and how they may disrupt the current financial ecosystem. From the outset chapter 2 sets the scene of digital assets as an asset of the future and continues to present a framework which could aid with their potential classification. Chapter 3 looks to the future by providing a potential framework which shows the disruptive impact that the tokenisation of an asset could have on an organisation.

In chapter 2, shortcomings in existing regulatory frameworks for classifying digital assets are discussed, which in turns leads to the creation of the Digital Asset Framework and the contributions that this makes to the existing body of knowledge. Framework proposals by the Cryptoassets Taskforce in the UK and the Swiss regulatory body FINMA, classified digital assets according to looser functional properties as opposed to structural properties (Cryptoassets Taskforce, 2018; Finma, 2018). Unlike the other frameworks for digital asset classification that came before, chapter 2 classifies digital assets according to their structural properties. Therefore, this chapter contributes to the research by proposing a framework which classifies these assets not by their functional properties, but according to their structural properties. This is a contribution as it is the only framework which classifies according to structural properties, and it negates some of the risks associated with classifying digital assets based on their functional properties, as existing frameworks do. Additionally, the most significant contribution to digital asset classification of chapter 2 is to regulation as it can potentially help regulators to characterise and classify digital assets. This is beneficial to regulators as it provides a consistent means of classifying digital assets which isn't tied to any one regulatory body. As the classification is done based on structural properties, it also means that the classification should remain constant throughout the lifecycle of the asset, unlike the frameworks mentioned previously which classify according to functions which can be subject to change (Cryptoassets Taskforce, 2018; Finma, 2018). However, the framework can also contribute to a more general technology field as it could be used by business analysts or solution architects to display complex details about the digital assets in a decentralised application. It could in effect allows users to map and understand both the structural components and data components associated with a digital asset. This could be useful for both technical and non-technical audiences looking at the digital assets within a decentralised application as they can see the structural and data components of an asset without having to sift through the code in the smart contracts for the information. This would be useful in practice as it would allow technical professionals to present complex details of digital assets which are scattered across pages of code to non-technical audiences such as shareholders, project managers and so on - adding to a more universal understanding of digital assets in decentralised apps across organisations.

Contributions to the nascent field of tokenisation are made in chapter 3, primarily through the creation of the tokenisation impact framework. An element of this chapter which is unique to the field is the comparison of the tokenisation landscape with those of securitisation and digitalisation. This perspective builds on research done previously on securitisation (Levine, 2019) and digitalisation (Hagberg et al., 2016) and opens up the field of tokenisation for further research. The creation of the tokenisation impact framework contributes to the research by identifying key characteristics pertaining to tokenisation's effect on an asset. By utilising the framework, industry stakeholders could potentially gauge if it is worthwhile to convert an asset to a digital asset and understand if undergoing the process is likely to disrupt the market in which they operate. Section 3.4 details the potential value for this in practice as it demonstrates how shares in a private company are more suited to be tokenised than shares in a publicly owned company due the lack of existing venues (or settings as they are described in the chapter) for exchanging these shares, among other factors. This evaluation could become particularly valuable if digital assets are to see widespread adoption and as such, the process of tokenisation is to become more common practice across the financial services industry.

Regarding the commercial applications of digital assets within financial services, chapter 4 contributes to the existing body of knowledge on the application of digital assets in financial services in several ways. Firstly, it demonstrates the effect that digital assets and some of their proposed offerings could have on business models of organisations in the industry. At the time of writing there were no academic publications which use the Business Model Canvas (Osterwalder & Pigneur, 2010) as a lens to determine the impact that digital assets could have on business models, so this chapter contributes to the research by examining how digital asset offerings could impact the various elements of business models detailed in the business model canvas. Moreover, it provides a more generic perspective of how digital assets could impact business models in financial services, without looking at the business models of specific companies. This gives wider reaching and non-specific insights, rather than impacts that are bespoke to a particular company. In addition to this, the study identifies trust as a key factor to be considered to enable digital assets. It not only identifies trust as a standalone factor but shows the factors that both build and deplete trust, thus showing how in practice industry stakeholders can leverage the positive factors and try to negate the risks identified to enable digital assets to change business models within their organisations.

To summarise, the research not only addresses the overarching research objective of this thesis by investigating the future of digital assets and their tendency to disrupt, but also contributes to the research and practice by providing frameworks and key insights for those involved with digital assets in the financial services industry. As can be seen in the research, chapters 2 and 3 talk about the potential use and value of frameworks for digital assets. There are specific potential benefits which these frameworks can provide when applied. While these can provide benefits going forward, chapter 4 looks at potential future benefits at a higher level. In summary, chapters 2 and 3 offer potential benefit in specific areas for those working with DLT, whereas chapter 4 is a broader, higher-level look into the future.

5.3. Limitations of research

As with all academic research, this thesis has limitations. Many of the limitations presented here became apparent either after the scope of the chapter had been clearly defined or once the findings had been identified. In any case, the limitations of the research conducted as part of this thesis are presented in this section.

During the creation of the digital asset framework in chapter 2, the framework was validated with real digital assets to ensure that it could be used easily to classify digital assets. One of the intended uses or applications of the framework was to allow business analysts, solution architects, or other professional involved in technology builds for decentralised applications to map the digital assets from the system using the framework. Despite this proposed use of the framework, there was no element of the research which evaluated the framework for its use by a business analyst or solution architect. This could potentially have strengthened the argument for the frameworks use by technology professionals and could have opened doors for future iterations of the framework itself.

A limitation of this study also arose during the foresight workshops conducted as part of chapter 4. The workshops had attendees from various backgrounds within the financial and fintech industries, but one perspective which was crucially lacking was that of a regulator. Regulation was identified as one of the key factors in enabling trust and digital assets, and as such, the perspective of a regulator would have provided great insight into the future of digital assets in financial services. By including regulators in the workshops, there would have been an extra dimension to the discussions that took place in the room; however, the decision to omit regulators was made before the workshop attendees were finalised as there was fear that their presence may stifle some of the inputs that other industry stakeholders would have in the workshops. Therefore, despite the insights that emerged from the foresight workshops, the inclusion of regulatory personnel would have added an extra element of interest to the findings.

An additional set of limitations to this body of research pertain to the research methodologies used across the study. This study employed a combination of systematic literature reviews, design science research, secondary data analysis and qualitative foresight workshops. Each approach brings strengths, but also carries methodological constraints.

While using Webster and Watson's (2002) and Palvia et al.'s (2003) guidelines provided rigour, there is still potential for selection bias, as the inclusion of studies depended on availability in academic databases and researcher judgement. Rapid technological change in blockchain means that relevant grey literature and industry reports may outpace peer-reviewed publications, potentially omitting emerging but unpublished insights.

The design science methodology used in the development of the frameworks in this study also had limitations. The creation of the Digital Asset Classification Framework and the Tokenisation Impact Framework required subjective interpretation of literature findings. While these artefacts were evaluated with real-world cases, such as MolochDAO and CryptoKitties, testing was not exhaustive across the full spectrum of digital assets. Further empirical validation with broader datasets would be necessary to ensure robustness, especially given the broadening landscape of digital assets currently.

Secondary data analysis performed on GitHub repositories and whitepapers throughout this study also have some limitations associated with them. These sources were selected primarily for their transparency and accessibility but they may not always represent the complete realities of a given project or venture, especially from a governance or operational perspective. Publicly available documentation such as those cited in chapters 2 and 3 could be outdated or selectively presented to reflect more positive aspects of a given project.

A further limitation of this research is its primary focus on the financial services sector. The research conducted throughout this thesis is grounded in the context of digital assets as they relate to financial services. This domain-specific approach enabled in-depth analysis of digital assets adoption within financial services as well as direct engagement with relevant industry experts; however, it also limits the applicability of the findings to other sectors outside of financial services where DLT - the underpinning technology of digital assets - could be used. Digital assets may exhibit different characteristics, uses and regulatory challenges outside financial services such as supply chain management or education. As such, caution should be exercised when generalising the frameworks or conclusions presented here to domains beyond financial services. Broader empirical testing and validation in alternative industries would be necessary to establish the applicability of the findings to other industries.

5.4. Overall findings and future research opportunities

The overarching research objective of this thesis was to investigate the future of digital assets within financial services and how they may disrupt the current financial ecosystem. The research presented as part of this thesis addresses this objective across two distinct streams. Parts of the research in particular address the first element of research objective by investigating in detail the future application of digital assets in financial services, both in practical and theoretical terms. Other parts of the research presented address the research objective by giving an insight into how digital assets may disrupt the financial ecosystem. However, these areas of research are not mutually exclusive and do tend to address the entirety of the research objective to some degree.

The future of digital assets in financial services is delved into through both the digital asset framework as well as the data gathered as part of the foresight workshops. The digital asset framework gives a unique view as it shows how digital assets could be classified by regulators in the future of financial services, thus providing a distinct insight in practice. The prerequisite research done to create the framework as well as the data gathered as part of the foresight workshops also provide an understanding of the future of digital asset in financial services. Digital asset related offerings such as 24/7 exchanges, Central Bank Digital Currency and tokenised securities emerge across the study, demonstrating their prominence as future applications of digital assets in financial services.

As stated above, other areas of the research conducted in this thesis contribute to the understanding of how digital assets may disrupt the financial ecosystem. In particular, the tokenisation impact framework gives a unique insight into how digital assets – through tokenisation – may disrupt the financial ecosystem. It does so by providing a numerical value to the level in which the tokenisation of an asset can disrupt an organisation, and by extension, the financial services ecosystem. Additionally, the digital asset offerings that appear across the study all possess a means to disrupt the financial ecosystem, some in ways that are common, others in ways that are unique to the offering itself. Offerings such as CBDC and decentralised exchanges can disintermediate the current financial infrastructure in place by making redundant financial middlemen such as clearing houses. The research also shows how the ecosystem and industry could be further disrupted by enacting significant changes over future business models of organisations and thus significantly changing how many companies in finance would operate on a day-to-day basis.

To conclude, this thesis demonstrates the potential for digital assets in financial services and shows how if the right factors are considered, the novel asset type could see widespread adoption and application across the industry. Similarly, the research sheds light on the potential disruption that digital assets can bring to the financial services industry if the appropriate factors are considered. Given the reoccurring theme of regulation across the span of this study, a potential area of future research which could be of value is to delve into the future of regulation of digital assets in finance. A deep dive into proposed means of regulation for digital assets could build on the proposals put forth in this chapter to understand more accurately how regulators will classify and regulate digital assets in finance in the future.

6. Appendix

6.1. Modelling

DLT systems require a common data structure to allow the exchange of digital assets across different distributed ledger systems (ITU-T, 2019). Entity-relationship diagrams (ERDs) are a well-established method for modelling a system's data structures and the relationships between them (Borgida et al., 2009). This form of data modelling was conceptualised in the context of relational databases rather than distributed ledger systems. The modelling relies on the system administrator's view of the data as either an entity or a relationship (Chen, 1976, p. 12). The entity is the "object where we want to store data" and the relationship "defines the allowed connections between instances of entities" (Al-Btoush, 2015, p. 1). In a distributed ledger-based system, a common frame of reference must be established between organisations to allow the stable exchange of digital assets(Hancock, 2016). In contrast to entity-relationship modelling, there are working groups such as the Financial Industry Business Ontology (FIBO) project that apply semantic web principles to standardise data across the financial industry (Abi-Lahoud, 2016). This allows for disparate systems to integrate more efficiently and to standardise communication formats, enabling systems to talk to one another (EDM Council, 2018). A balance between standardisation for integration purposes and freedom to create new data structures needs to be found for distributed ledger systems to develop effectively. A framework for modelling the emerging digital asset structures allows industry to expand upon existing systems while keeping integration with legacy systems in mind.

6.1.1. Applying the Framework to Multi-Asset Systems

A multi-asset system is a structure that is composed of several underlying assets that work together to achieve a certain objective. In a distributed ledger system both the data and the functions exist in the same operating environment. This contrasts with the traditional software engineering principle of applying separation of concerns to an application whereby data and the logic which acts upon it are deliberately distinct (Hürsch & Lopes, 1995). This allows for iterative development independently of one another with the intention of minimising rising technical debt (Kruchten et al., 2012). This deviation means that the architecture of distributed ledger applications does not fit completely with object-oriented (OO) modelling, such as in the case of Unified Modelling Language (UML) (Rumbaugh et al., 2004) or Chen's (1976) Entity Relationship Diagrams (ERDs). Since DLT-based applications don't fit with traditional OO modelling, the interaction between digital assets in a system must be formalised. This is essential for the proposed framework to evolve from classification to a modelling context. Applying traditional Chen (1976) crow notation to the interaction between two digital assets allows users to better understand the cardinality of asset relationships. To clarify, crow notation allows the user to visualise the association of data objects. It shows both the multiplicity (one or many) and optionality (zero) of a relationship. In multi-asset systems such as DAOs, maintaining the structural components of the proposed framework gives a conceptualisation of the value formation. While the crow notation gives design for data instantiation.

6.1.2. System Level Modelling

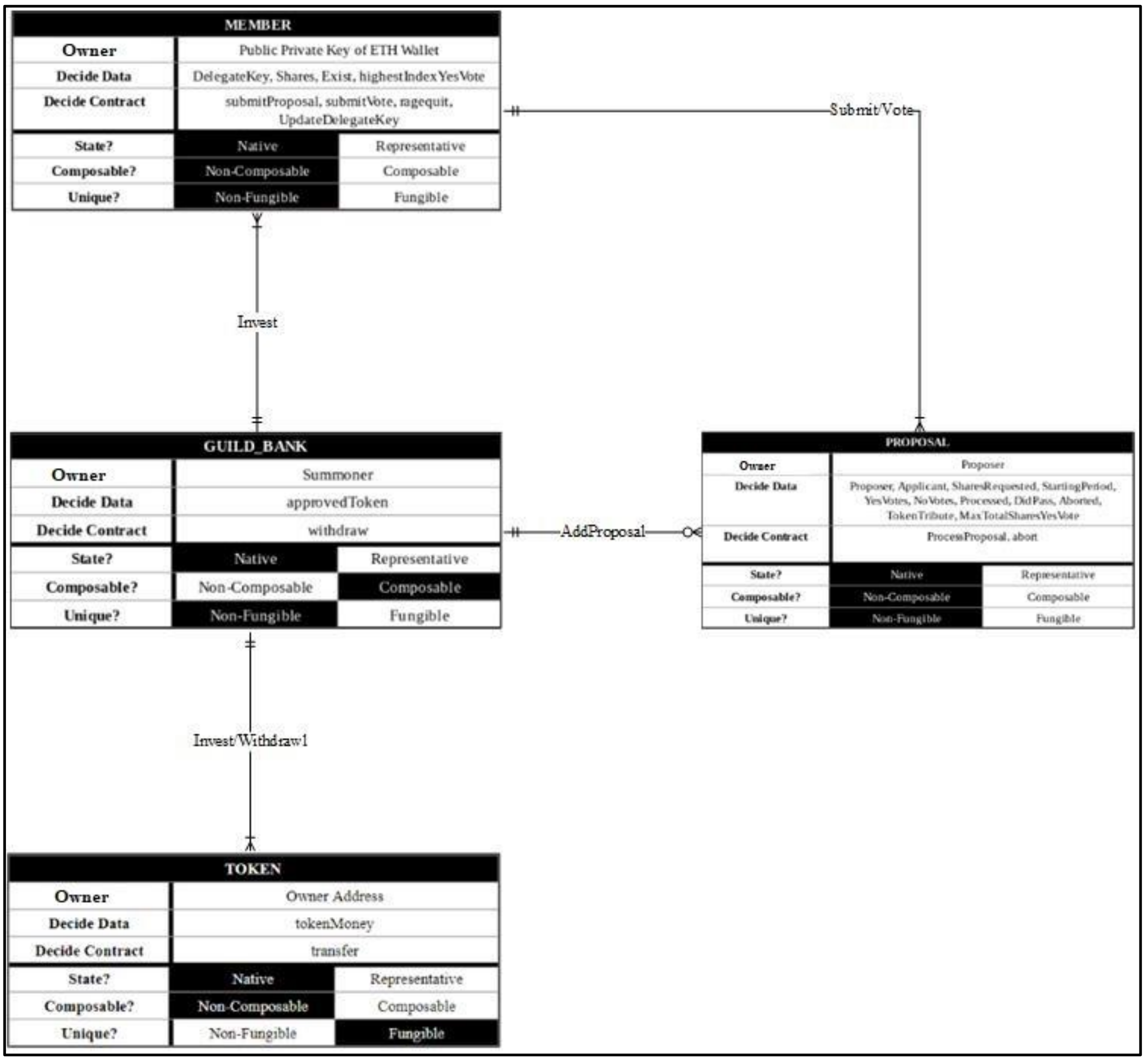

Figure 6-1: Digital Asset Framework applied to the MolochDAO system

This figure illustrates the relationship between different actors in a decentralised autonomous fund (DAO). It shows how members (called 'MEMBER') invest money into a fund (called 'GUILD_BANK'). In return for investing, they are given a certain quantity of shares (called 'TOKENS'). Once a member has joined the pool they can then get to vote (called submitting a 'PROPOSAL') on which type of investments they would like the fund to invest in. For instance, Amazon, Facebook or Google shares, might be the agreement. This figure maps out relationships between entities (digital assets) within a distributed system and consequently portrays both the data and the structural characteristics of each asset. This is useful for developers and business analysts to understand the relationship between different assets on a distributed system, how they interact at the data level while also demonstrating what the system looks like at a high level. One would take the template and put in all the data characteristics (owner, data and contract) which follow a similar convention to entity-relationship diagrams. Then the structural fields are decided by asking the following three questions: Is the asset fungible or non-fungible? Is the asset native or representative? Is it composable or non-composable?

6.1.3. System Level Modelling

This section utilises the framework to model digital assets and decentralised applications according to their properties. It does this by building upon the existing tools seen in entity-relationship diagrams by enhancing modelling conventions to make it applicable to decentralised applications. By using this model, the decentralised characteristics of an asset are illustrated in a more intuitive way. It also empowers developers and analysts to see the characteristics of an asset and how they work at a system level.

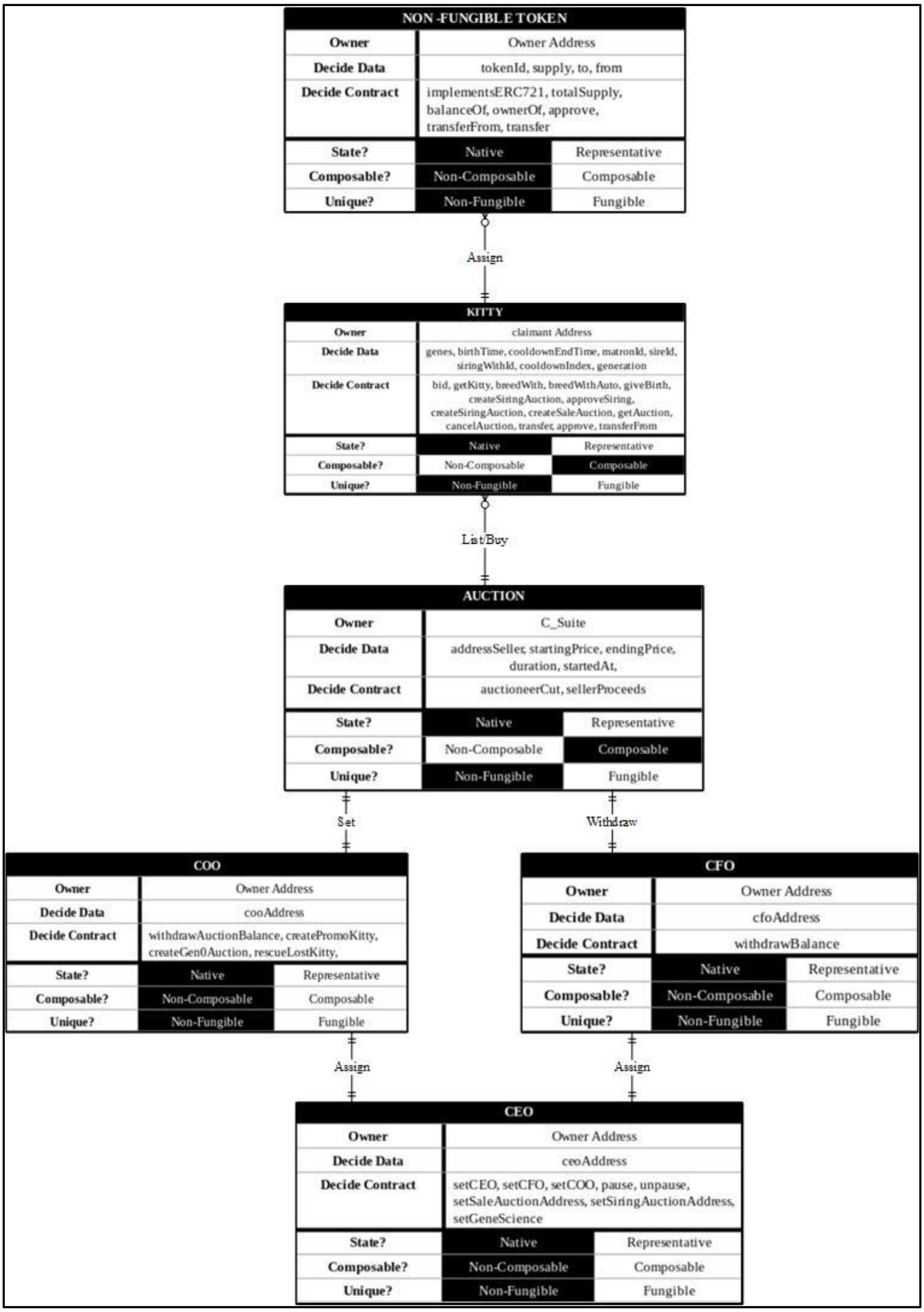

Figure 6-2: Digital Asset Framework applied to Cryptokitties.

The ‘AUCTION’ is the holding account (equivalent to a bank account in the previous example) for tokens (called ‘NON-FUNGIBLE TOKENS’ which contain all the transactional data relating to the CryptoKitty, which allows tokens to be bought or sold). ‘KITTY’ is the data link to the underlying token (for example, attributes of the cat, colour, pregnant or not, age) with the governance of the DAO being done by the executives of the distributed ledger system known as the ‘COO’, ‘CFO’ and the ‘CEO’. The modelling above as it applies to CryptoKitties allows developers and business analysts to map out relationships between entities (digital assets) within a distributed system and helps them to understand both the structural and data characteristic of each asset within the system. To replicate the system as portrayed in the figure above, one would take the template and put in all the data characteristics (owner, data and contract) for a system of their choosing which follow a similar convention to entity-relationship diagrams. Then the structural fields are decided by asking the same questions as the previous example: Is the asset fungible or non-fungible? Is the asset native or representative? Is it composable or non-composable?

6.1.4. Discussion of Framework Application

As illustrated in figure 6-2, using the framework highlights several insights that may be of interest to a business analyst or developer. All assets in the CryptoKitty system are native meaning the system is located within a distributed ledger system and there is no need for external systems integration from an input-perspective. Both ‘AUCTION’ and ‘KITTY’ assets are composable, the former due to its inherent nature acting as a holding account for tokens in the system and the latter as a data link to the underlying token itself. The CryptoKitty system introduces a ‘C_Suite’ concept whereby governance of the DAO is controlled by a few executive accounts. The ‘CFO’ being in control of financial transactions, the ‘COO’ being in control of operational procedures and ‘CEO’ in charge of assigning each of these roles. This governance structure poses different risks to that of the previous MolochDAO example from figure 6-2, where a compromised ‘summoner’ account is a risk factor, in CryptoKitties misaligned incentives between the ‘C_SUITE’ and users may lead to centralisation problems like those of a conventional organisation.

6.1.5. Framework Validation

DAO's which appeared in the literature were chosen, and each was taken individually, and the proposed conceptual framework was used to model the digital assets outlined in each of the organisation's systems. Firstly, the organisation's whitepaper was read to understand the business problem behind the system and to conceptualise the architecture of the system. In some cases, system diagrams were provided but no uniform standard was found across the set and none which solely focused on the digital assets of the system. Next, the relevant GitHub repositories for both the MolochDAO and CryptoKitties DAO's were reviewed to identify assets and populate an instantiation for each one. We were able to use the digital asset definition developed in chapter 2 of this thesis to identify the digital assets in the repositories. They each had three criteria as per the definition: a 1) data object; 2) implemented using distributed ledger technology (DLT), and 3) which can be assigned an owner. DLT implementation is guaranteed through the organisation selection process, as a DAO is inherently encoded upon a blockchain, as per the definition (Chohan (2017, p. 1). This leaves two criteria (ownership and a data object) to identify a digital asset. The process for identifying these two criteria for digital assets involved examining the official development documentation. The official development documentation was in 'Solidity', a programming language used to develop Ethereum applications(Buterin, 2019). Data structures can be identified with the word 'struct'. The second criterion, ownership, is more varied and there are indicators which can be used to help identify it. Modifiers that restrict access to functions can hint at assets in the system. For example, a modifier 'onlyAdmin' implies there is an admin asset within the system. References to an 'ownable' library can also be used to satisfy these criteria. Finally, a reference to an 'address' data type can reference an ownership wallet from within the data structure itself.

To populate each of the six fields of the framework, as seen in figure 2.5 below, a review was conducted of relevant GitHub repositories for the DAO's in question. The ownership field is outlined as mentioned above through references to modifiers, libraries, and address data types. The data field can be filled out with each of the data fields composing the 'struct' data type. The contract field refers to the functions which are labelled 'function' from within a contract. To assign each function to an asset it must be further studied to determine its output. To clarify, when a function interacts with a specific data object or type that function can then be assigned to the related asset. The state of an asset can be established with the use of an oracle. An oracle is any such system that exposes external data for on-chain use(Adler, 2018). When there is an indication of oracle-use the asset is ‘representative’ but when an asset is wholly instantiated in a distributed ledger environment, it is ‘native’. Fungibility can be indicated through various token standards: ERC20 for fungible and ERC721 for non-fungible. Composability can be established by using inheritance, an object-oriented programming technique where a class is defined in terms of one or more other classes (Snyder, 1986). Another novel composability concept illustrated in Ethereum is a ‘payable’ modifier attached to a function that refers to a function that accepts an additional parameter for an amount of Ether. This, in turn, implies the function and its related object is or can be composed of a token itself without the implementation of traditional inheritance.

6.2. Fictional Press Release

Financial Times

Sunday, 24th June 2029

Dawn of a New Financial Era

By ROBIN REED

From the turn of the century people have lost trust in the financial systems. Ever since the global recession in 2008 most people viewed financial intermediaries as the enemy, but little did we know the release of Bitcoin in 2009 would be absolutely crucial in breaking this cycle. Now, people are heavily invested in blockchain, both figuratively and literally.

It's safe to say there has been a complete disruption in the financial industry in the last decade. Incumbents no longer hold all the cards when it comes to custody solutions either. Most native digital assets are stored in an on-platform custodial feature. There's still a market there for physical, representative assets but this makes up only a fraction of what they previously held.

Traditional exchanges, as I'm sure you're aware, have come and gone. We now have one decentralised exchange fulfilling the needs for all parties involved. Its open 24 hours, 7 days a week which has eliminated any geographical restrictions. Due to the DLT based configuration of this exchange and its use of smart contracts, the functions of clearance and settlement are performed on-platform and instantaneously, which is far superior to the 3-5 days it took a decade ago. Regulators have the right to view all transactions conducted on these exchanges to ensure compliance. No party (except regulators) is able to infer details about a transaction they're not counterparty to.

People now fuel the multi-trillion dollar cryptocurrency market by using them through their phone, to pay for everyday items such as food and transport, where small discounts are given for using specific cryptocurrencies with specific companies. Most digital payments are conducted using the ECBs new, and the first ever central bank digital currency EURCOIN which is only accepted in EU countries. Looking to the future, it looks like financial incumbents will endure a period of significant disintermediation, individuals are now in the driving seat. The larger players in the ecosystem are struggling to create value for their customers - with all this innovation happening around them it's only a matter of time before they adopt, buy or die.

Self-securitisation is a new phenomenon which allows almost any individual with access to a tokenisation platform such as the Polymath or Harbor to securitise and tokenise their own assets. Customers who previously only had access to money through loans are now able to issue their own equity in various parts of their life: career, hobbies, etc. In addition to this, Security Token Offerings (STO) have become the new IPOs, with companies using the cost-effective benefits of blockchain technology and smart contracts to take their companies public. This has encouraged many SMEs to go public due to the unique opportunity afforded by STOs not previously possible through IPOs.

Reuters

The fact that all transaction data is automatically saved to the distributed ledger, blockchain based business intelligence and analytics software are more capable of generating useful insights than ever. That means that a trader can achieve a level of knowledge, transparency and insight around the behaviours of exchanges, miners and other traders that was impossible to accumulate in the traditional asset environment. This has also lead to the open source code initiative breaking into the world of financial industry in a big way. People are able to build their own infrastructure to manage their investments. There's a new type of fund manager emerging with billions under management all controlling it from their bedroom with their laptop. This begs the question: what are the next steps in this industry, and what are the digital asset products of the future?

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