Niko Korhonen

Central Bank Digital Currency & Effects on Technological Efficiency

In the European Union

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Author: Niko Korhonen
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ABSTRACT:
The purpose of the master's thesis is to resolve the potential effects on technological efficiency within the European Union area when the European Central Bank launches a Central Bank Digital Currency or Digital Euro via conducting a phenomenographic research. At the time of the research multiple central banks across the globe are planning to issue a centrally governed digital currency, with some reaching the first simulation and trial periods. So far, no Central Bank Digital Currency has been officially launched as there remains open questions about the optimal methods of implementation, timetable, technological hierarchy etc. Potential viable options have been reported by various central banks, but no decisions have yet been made. In this master's thesis the viewpoint of technological efficiency was chosen since as a viewpoint it has not been previously studied and the results should provide significant arguments in favour or against the different methods of implementation. The research results also provide important information on which efficiency- and technological efficiency metrics are appreciated and what side-effects constantly improving technological efficiency could have.

To prepare the reader for the research and interpretation of the results an extensive and thorough theory is provided. The master's thesis illuminates the concepts of central-, retail- and wholesale banks, digital currencies, cryptocurrencies, payment systems, monetary policies, historical trends in financial technology and digitalization. The research was conducted as a qualitative phenomenography research, by organizing interviews and workshops with top experts within the financial and fintech field of profession. The correspondence consisted of a prerequisite form, a two-hour intensive themed workshop, and an additional round of interviews. The interview's objective was to present open-ended questions that allowed maximum flexibility for the experts to expose their perception and experiences about the phenomenon. The interviews were recorded in transcript and video format, and later analysed. In the analysis the experiences and perceptions of the experts were identified and categorized in terms of their meaning. Out of the categories, distinct themes and views could be formed in a logical and hierarchical method to form the subjective future view of the experts.

The key findings of the research were the categories identified from the gathered materials through phenomenographic methods and the finding that what is perceived to be efficient and what is technological efficiency could be interpreted to be close to identical derived from subconscious and conscious perceptions. The categories derived from the perceptions of the experts proved to provide the crucial material for forming the future view of the research and to answer the key research questions. The main categories identified from the gathered materials were Efficiency, Technology, Probability, and Policies and Political Effects. To summarise the results, it was perceived that various attributes of technological efficiency were perceived to enhance as a result of, or as result of the following motivation and funding behind a CBDC's launch, but all the effects were not seen only as net positive.

KEYWORDS: Digital Currency, Central Bank, Technological Efficiency, Phenomenography

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TIIVISTELMÄ: Tämän Pro Gradu tutkielman tarkoituksena on tutkia, mitä mahdollisia vaikutuksia Euroopan Keskuspankin (EKP) julkaisemalla digitaalisella, keskuspankin hallinnoimalla valuutalla voi olla teknologiseen tehokkuuteen Euroopan unionin rajojen sisällä. Tutkimus on suoritettu fenomenografisin tutkimusmetodein. Tutkimuksen aloittamisen ajankohtana useat keskuspankit ympäri maailman ovat julkisesti ilmoittaneet kehittävänsä digitaalista keskuspankki valuuttaa, tarkoituksena lanseerata valuutta julkiseen käyttöön lähitulevaisuudessa. Toistaiseksi viralista digitaalisen keskuspankki valuutan lanseerausta ei ole suoritettu, joskin useita simulaatioita, sekä suljetun käyttäjäryhmän kokeiluja on tehty. Implementaatiokeino, käytettävä teknologia ja vaikuttavat tahot digitaalisen keskuspankki valuutan ympärillä ovat vielä laajalti standardoimatta, joka luo kriittisen tarpeen optimimaalisimman loppuratkaisun tutkimiselle. Yksi kriittinen aspekti selvitystyössä on tutkia eri implementaatiokeinojen vaikutuksia teknologiseen tehokkuuteen, joka on valikoitu tämän tutkimuksen näkökulmaksi. Tutkimuksen tavoitteena on selvittää mitä vaikutuksia, sekä mahdollisia sivuvaikutuksia Euroopan keskuspankin lanseeraamalla digitaalisella keskuspankki valuutalla voi olla teknologisen tehokkuuden osalta.

Tutkimus toteutettiin kvalitatiivisen fenomenografisen tutkimuksen metodein hyödyntäen erilaisia haastattelu ja kyselypohjaisia tiedonkeruumenetelmiä. Tutkimuksen osallistujiksi, eli asiantuntijoiksi valikoitui viisi finanssi, vakuutus, IT, eCommerce ja talousrikollisuuden ammattilaista. Tiedonkeruukeinoina tutkimuksessa hyödynnettiin kyselylomaketta (prerequisite form), teemahaastattelua (workshop), sekä aukkojen täydentämiseksi yksityishaastettuluita sähköisiä viestintätyökaluja hyödyntäen (additional round of interviews). Haastattelut olivat luonteeltaan mahdollisimman avoimia ja ei-ohjaavia, jotta osallistujien todellisia käsityksiä ja havaintoja voitiin luotettavasti analysoida jälkikäteen ilman vaikuttamisvaikutusta. Kaikki haastattelut tallennettiin, litteroitiin, sekä teemahaastattelun osalta videoitiin. Kerätty tieto analysoitiin huolellisesti, jonka lopputuloksena muodostettiin havainnekuva ja teemoiteltu kategorisointi keskeisimmistä havainnoista, sekä käsityksistä. Lopputuleman kategorioista jalostettiin tiivis kuvaelma (The view of the future), tulevaisuuden näkymä, joka maalaa kuvan tulevaisuudesta, jossa digitaalinen keskuspankki valuutta on otettu käyttöön, sen vaikutuksineen.

Tutkimuksen tärkeimmät tulokset muodostuivat analyysin kautta muodostetuista kategorioista, joiden perusteella tulevaisuuden kuva voitiin muodostaa ja jota kautta tutkimuksen kysymyksiin voitiin vastata. Tutkimuksen tuloksena havaittiin myös, että ns. tiedostamaton ja tiedostettu vaikutelma tehokkuudesta olivat lähes identtiset, joka korostaa tutkimustulosten luotettavuutta ja sitä, että kyseessä on tosiasiallisesti vaikutelma, mielipiteen sijaan. Tutkimustulokset osittain kompensoivat aiempaa tutkimuskenttää, mutta myös uutta relevanttia tietoa onnistuttiin luomaan, jonka perusteella keskuspankkien hallinnoimaan digitaaliseen valuuttaan liittyy myös uhkakuvia, joita aiemmista tutkimuksista ei löydetty. Tiivistetysti tutkimuksessa todettiin, että digitaalinen keskuspankki valuutta luo useita tehostavia vaikutuksia teknologiseen tehokkuuteen Euroopassa, mutta kaikki vaikutukset eivät ole kategorisesti positiivisia.

AVAINSANAT: Digital Currency, Central Bank, Technological Efficiency, Phenomenography

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1 Introduction

The subject of research in this master's thesis is Central Bank Digital Currency and how the implementation of it could most likely affect the technological efficiency within the European Union area. Numerous central banks have started planning processes relating to launching a viable centrally governed digital currency, with few even having completed the first simulation, or test periods. The exact and most optimized methods of implementation have yet been resolved and the various effects of a fully launched and implemented Central Bank Digital Currency has not yet been studied from all viewpoints, even though the ambition amongst central banks seems to be quite clear; Central Bank Digital Currencies are a question of when, not if.

In the field of financial technology and digital payments, numerous studies have been conducted linked to several statistics related to efficiency. Historical trends are usually studied quantitively for one can compare a chosen metric such as "the frequency of cash usage" before and after a revolution in the financial technology field such as the implementation of credit and debit cards. The common nominator for such described studies is that the research has been conducted after the fact. One common method to study what will be is surveys, in other terms qualitative research. Such research has been conducted related to Central Bank Digital Currencies, but so far only having a narrow scope of research, which ultimately leads to the fact that there are still many viewpoints not being researched when it comes to combining the two variables; what will be and Central Bank Digital Currencies.

The research was conducted using the method of phenomenography. The primary reason for the chosen method was that the subject that is studied has not yet materialised and cannot therefore be quantitatively studied. Therefore, the qualitative research method was seen as the most optimal method in order to achieve the most reliable results. In a phenomenographic research the key elements are perceptions, experiences and feelings of broad themes and areas of expertise. In this research a group of highly skilled experts were chosen for different information gathering events, such as forms,

interviews, and workshops. Together the experts chosen for this research have close to fifty years' worth of experience in the fields of financial technology, finance, investments, IT, eCommerce, and insurances. The materials gathered from the rounds of information gathering were carefully analysed through phenomenographic methods and categorical analysis, from which the research results could be derived from.

The research question to be answered is:

1. What are the effects on technological efficiency within the European Union area when the European Central Bank issues the Central Bank governed Digital Currency?

The answer is estimated and derived from the careful analysis of the materials gathered via methods of phenomenography such as interviews, workshops, and forms and then compared to previous studies and well-known efficiency metrics. The inspiration for the chosen metrics was derived from previous studies that could be seen in relation to, or in the same field as this research. In addition to answering the primary research question the research also aims to answer the secondary research questions of:

2. Which technological decisions would provide the most (and the least) efficiency for the European population?

3. Could the technological efficiency of a Central Bank Digital Currency have other effects for the European population?

And finally, through the answers to the underlying research questions the research aims to paint a view of the future, of which goal is to demonstrate as realistically as possible a viable scenario of the future with the Central Bank Digital Currency being launched alongside its effects and side-effects.

The different primary statistics and or attributes used in this research can be, but are not limited to, payment speed, payment reliability, payment security, accessibility, cost efficiency and technological developments and implementation options. One of the objectives for the research was to gather well-known and often used attributes of technological efficiency related to financial technology from previous studies and study how closely the attributes would align with the gathered attributes in this research. As technological efficiency can be measured through various methods, to narrow the scope of the research this master's thesis will concentrate on metrics most suited, and most reliably comparable within the European Union area. This comes from the factors that, so far, the two most extensive trials of any form of Central Bank Digital Currency have been conducted in the European Union Area (England and Sweden) and the most recent, and one could argue potentially the most influential experiment that is being assessed is the Digital Euro.

The scope determines the focus on the technological perspective to be solidly within the area of technological advancements only linked to the Central Bank Digital Currency. This results in the scope of technologies being quite broad and that many forms of technology must be mentioned in the research, even though their roles could not be significant. Therefore, technologies and matters such as cryptocurrencies and blockchain are mentioned so that the reader has a general idea of what they are, but the technologies might not be mentioned further in the research due to lack of relevance or other reasons.
In the October 2020 release "Report on a digital euro" by the European Central Bank, the technology possibilities are widely inspected but as of February 2022 the exact form of technology to be used has not been decided (ECB, 2020). It is still determined on the report that, regardless of the technology used, the fact that it is a risk-free liability of the central bank – for example makes the Central Bank Digital Currency fundamentally different from crypto-assets (ECB 2021). Statements such as this would dis-include some technologies from the scope of observation.

Once more, the purpose of the master's thesis is to conduct research on a subject that has not been yet thoroughly researched and to create valuable information for further studies and for people in legislative positions inside the European Union and European Central Bank. As stated in the "Report on a digital euro" by the European Central Bank "Issuing a digital euro would be relevant for nearly everything the Eurosystem does, and it would have pervasive effects on society as a whole " (ECB 2020).

As the importance of the correct way of implementing the digital euro or Central Bank Digital Currency is set as relevant for the whole of society, the information and findings of the master's thesis can be valued as potentially essential. Financial and technological Efficiency within and outside the European Union area is stipulated as a high priority by the European Union, and as the implementation of the Central Bank Digital Currency most likely will have an effect on it, it can be determined that the additional information provided by the master's thesis is high in value.

The goals of the master's thesis can be determined as achieved if the information gathered can be determined to be relevant for the future development of the implementation of the Central Bank Digital Currency. The way of evaluating the accuracy and relevancy of the information produced can be done by comparing the results of the master's thesis to prior studies on similar agendas. Although, the pinnacle of achievement would be to discover something that has been previously undiscovered.

As the research method chosen for this master's thesis is a qualitative form of research, phenomenographic study based on interviews and workshops of finance sector experts, and as the results vary on the subjective viewpoints of the experts, the results might vary based on either the expertise of the experts or the recency of their knowledge compared to the knowledge at the time of the previous studies. The results should produce a significant and noticeable view of the future of financial inclusion within the European Union area and the accuracy can be followed through the nearby coming years, after the potential implementation of the Central Bank Digital Currency.

2 The Theoretical Background

In order to understand the research topic and the different variables that might or might not have an effect of the research results it is vital to cover some of the most important core theories and concepts in financial technology, banking, payment infrastructures, and currencies. In addition to the latter the reader benefits from additional information about the historical trends in each subject, especially the evolution of financial technology and the foreseeable trends that pave the path for the future.

In this chapter the concepts of central, retail, and wholesale banks are briefly but adequately covered, before moving further into covering various forms of digital currencies such as the Central Bank Digital Currency, Digital Euro, and Cryptocurrencies. The underlying need for the digital euro is also discussed before going into the current European payment systems. Altogether, the concepts covered in this chapter should give the reader sufficient knowledge to advance in this research and topics such as monetary policies and the role of the central and retail banks in relation to the policies compliment the required knowledge base.

2.1 Central Bank

Central bank is an institution that manages the countries or unions monetary policies, oversees the countries or unions commercial banking system, and manages the countries or unions currency. Central banks tend to have abilities that commercial banks do not have, such as the regulatory powers to ensure the stability of the financial state and the power to supervise all the actors within the region of the central banks' governance (Oritani 2010).

A central bank also has a monopoly on the monetary policy of the region and can for example increase the monetary base if needed. Unlike the government of a developed

country that has power over fiscal policies, the central banks of developed nations are institutionally independent from political changes and influence (Oritani 2010).
The main functions of a central bank are, but are not restricted to: Monetary policy making, which means that the central bank oversees setting the official interest rates and the control of the money supply according to the global and regional monetary markets. Ensuring the governed areas financial stability through the central bank's actions, such as lending to the government and working as the banker's bank (Heakal 2020). It is said that the merchant Sir Francis Baring described the central bank as the "lender of last resort" (Baring 1797).

The central bank is also responsible for reserve management, which means managing the country's foreign-exchange, government bonds and gold reserves. The issuance of coins and notes or in other terms issuance of cash form money is among the core functions of the central bank as also the managing and supervising the means of payments and inter-banking clearing systems. The central bank also works as a regulator and supervisor of the banking industry in whole, this includes retail, business, and investment banks. In addition to the core functions the central banks are usually active in economic research, collection of statistics and advising on financial policy for the standing governments (Heakal 2020).

It can be argued that the correct functionality of central banks has so far only been achieved in the developed nations as the developing nations often suffer from internal crisis and low quality of governing. Phenomena such as hyperinflation, volatile interest rates and corruption are more common in developing nations, but there are significant indications that the establishment of central banks in developing areas in long term improve the overall monetary field (Heakal 2020). The importance of central banks according to Heakal has grown in importance in the last century, and it can be argued that the state of currency stability, low inflation and rate of employment are at least in part thanks to the central banks. (Heakal 2020).

Not all feedback of central banks activities has been positive though, after the financial crisis of 2008 and the immediate actions after the COVID-19 crisis ongoing since 2019 the most influential western central banks (ECB and FED) have also faced some critique towards the monetary policies and especially the liquidity injection decisions. For example, a consult to financial institutions William J. Dodwell wrote on his 2013 paper "Too Much Global Liquidity from Central Banks Distorts Financial Markets and Undermines Economic Growth" that the recent monetary policy can help to create new asset bubbles in the financial markets, thus a sort of reform is needed to revive the real economy and also end the period of zero interests (Dodwell 2013).

As of February 2022, the criticism made by Dodwell seems to have some ground to stand on, as the rate of inflations historical average of around 2% per annum has been subsided in the Americas, as in the European Union. The current rate of inflation being at the time of writing 7.5% in the United States of America and 5.0% in the European Union. (ECB & Trading Economics 2022).

2.1.1 Retail Banks

It is important to define the differences between retail and wholesale banking, when mapping out the different payment and money transfer methods and technologies. The importance comes from the different nature of services that the two provide, so that a full understanding of the banking spectrum is achieved and how the central bank digital currency would perform in both fields of play.

Retail banking or in other words personal banking is the banking service that provides individual consumers with banking services. Individual consumers do not include large business and large institutions, but retail banks might offer services for small and midsized businesses and entrepreneurs. Retail banking is the environment that consumers can manage their personal assets and liabilities in. Retail banks offer consumers

services such as checking and savings accounts, mortgages and other personal loans, credit cards and certificates of deposit (Majaski 2021).

Retail banks can be a part of a large commercial bank or small local community banks and retail banks usually have an n number of bank branch offices across a certain area like a country or union. In recent years as FinTech industry has developed and gained popularity there has been establishments of new types of retail banks that do not have any physical branch offices but offer the same services as the older banks (Majaski 2021).

The role of a central bank in relation to retail banks in the eyes of an individual consumer is to an act as the bank of the banks. In a simplified manner the central bank's balance sheet consists of assets and liabilities. The assets side consists of foreign assets such as US dollars in the case of European Central Bank, loans to commercial banks and securities, such as government bonds. The Liabilities side of the balance sheet consists of the currency in circulation, deposits by commercial banks to which the central bank pays interest (which can also be negative), deposits by governments and net worth (Burda 2017).

Operationally when a retail bank accepts deposits from consumers it must reserve a set amount of the deposits in cash in the retail bank's balance sheet to uphold the retail banks liquidity, in case the consumers want to withdraw their deposits. One of the retail banks core functions is to loan money to consumers and these loans can be made against the deposits made by the consumers. This process is also called a maturity transformation since deposits such as payrolls are usually short term and loans such as mortgages are usually long term (Burda 2017).

The currency in circulation and deposits by commercial banks form the money base, which is in direct control of a central bank. The deposits of the commercial banks consist of reserve requirements (or reserve ratio), and optional reserves. The structure is

important to know since it is a part of the money creation process since the retail banks create money by loans and the restriction to the money creation process is the reserve requirements. In a very simplified way when a commercial bank loans a 1,000€ the loan is executed by depositing the sum to a consumer's bank account, thus the bank has created a liability to itself and the bank has according to regulation have to have a reserve requirement to deposit to the central bank, which in this example is set as 10%, making the reserve deposit to the central bank 100€. Through this process money has been created since now the retail bank has 100€ in its assets as deposits to the central bank and the 1,000€ receivable of the loan it created (Burda 2017).

2.1.2 Wholesale Banks

Wholesale banking is the sector of banking that sells its services to large clients, which can include government agencies, large corporations, real estate developers and even other banks and financial institutions. The services sold can be for example mergers and acquisitions, currency conversions, underwriting or consulting services, in short, the types of services you would not get from retail banking sector. The two types are not entirely separate though, and many standard banks offer retail and wholesale services rather than the two sectors having entirely separate companies operating.

The reason why understanding wholesale banking in the concept of a central bank digital currency is that wholesale banking operations often also consists of borrowing and lending between institutional banks. In interbank lending and borrowing there lays significant counterparty credit and settlement risks, which the issuance of a central bank digital currency might have a positive effect on.

The potential increased efficiency to the wholesale banking sector due to a central bank digital currency is also worth studying because the wholesale banking industry is connected to a number of institutions that also have a direct relation to the financial well-being of a nation, such as government agencies and pension funds (Kagan 2020).

2.2 Digital Currencies

Digital currencies come in many forms and the central bank digital currency differs from other means of digital currencies in specific ways. In short, a digital currency is any sort of currency, money or money-like asset that is stored or exchanged in a digital form, mainly via internet. In the widely accepted terminology, digital currency is the superset that includes virtual currencies, which includes cryptocurrencies (Frankenfield 2021). These types of currencies can be used to trade physical or virtual goods and services, but some types of digital currencies can be restricted to a certain trading environment, such as an in-game currency inside a videogame (Al-Laham & Abdallat 2009).

The superset term digital currency includes all forms of digital currencies so it means that digital currencies can be regulated or unregulated. That means that even though a centrally governed central bank digital currency and a decentralized, unregulated virtual currency differ greatly, they are categorically in the same set of digital currencies. The main difference within the unregulated digital currencies, mainly virtual currencies is that to be qualified as a cryptocurrency, the technology behind the currency and the currencies ledger of transactions must be as the term suggests encrypted (Frankenfield 2021).

Cryptocurrencies are a form of digital- and virtual currency that is based on a network and is distributed across multiple computers that form a network. The structure is decentralized, and this allows the cryptocurrencies to exist outside a government or a central banks jurisdiction. The most known form of cryptocurrency is Bitcoin, which was launched in 2009 by an individual who to this day remains anonymous but is rumoured to be called Satoshi Nakamoto. Many cryptocurrencies use a technology called blockchain, which is a system of recording information in a way that makes it near impossible to corrupt the system. Blockchain can be described as a digital ledger of all transactions occurred over the network (Frankenfield 2021).

2.2.1 Central Bank Digital Currency

The Bank of England have described the central bank digital currency as electronic central bank money that can be accessed more broadly than reserves. The central bank digital currency would also have potentially much greater functionality for retail transactions than cash and it would have a separate operational structure when compared to other forms of central bank money, thus allowing to serve different core purposes. The central bank digital currency would also be interest bearing, meaning that under realistic assumptions it would have a different rate than the central bank's reserves (Ward & Rochemont 2019).

The central bank digital currency is also a form of fiat currency. Cryptocurrencies or virtual currencies are known for being decentralized whereas central bank digital currencies are centralized and regulated by a countries or unions monetary authorities, also the hypothetical central bank digital currency will most likely not need to use any type of distributed ledger technology such as blockchain, which is used for example for the cryptocurrency Bitcoin (Seth 2021).

Fiat currencies are stated as currencies that of which's value is not backed by any physical commodity, such as gold or silver. The value of any fiat currency is based on the relationship between supply and demand, monetary markets, and the stability of the issuer, which can be a central bank or a government. Most of the most important currencies today are fiat currencies, including the Euro and the US dollar (Chen 2021). The value of the US dollar was based on the commodity gold on and off again until the gold standard was suspended and finally removed in 1963 and has been a fiat currency ever since (GoldTraders 2021).

2.2.2 Digital Euro

The European Central Bank started to plan an Eurosystem digital Euro and released the opening report on the subject in October 2020. The report states that the Eurosystem's mission is to provide citizens with riskless money for their payments and to ensure the consumers unfettered access to central bank money in the digital age the ECB's Governing council decided to advance with their work on a potential issuance of a digital Euro. The report was made as an opening speech for future dialogue with the European citizens, since at the time of the writing it was too early to commit to a specific design of a digital Euro and there are multiple principles and requirements that must first be identified and fulfilled. Principles and requirements such as, accessibility, robustness, safety, efficiency, and privacy, all while ensuring the correct compliance according to relevant legislation (ECB 2020).

A Digital Euro according to the European Central Bank would still be a Euro in the same way as bank notes and coins are Euros, the form would be an electronic form of money issued by the Eurosystem, which includes the European Central Bank and national central banks. The digital Euro would be accessible to all citizens like cash money, but the idea is not to replace cash rather complement it. The Eurosystem aims to keep ensuring the access to cash for its citizens even if a digital Euro is issued. A digital Euro would ideally combine the efficiency of digital payments with the safety of central bank money meanwhile maintaining the privacy of its users since the financial incentives are absent unlike with private sector e-money, which could potentially also be governed outside the Euro area (ECB 2020).

When it comes to suggested and reported plans about the infrastructure behind the Digital Euro, the European Central Bank has not made the definitive decision yet but in summary there are two operating models for two segments of the technical and organisational approach. First of all, the segments are most likely to be separated in two, the back-end infrastructure and the End-user access solutions. For these two segments there are options of centralized and de-centralized operational models. Among many other

factors, one of the key differences between a centralized and de-centralized model is the decision to include or mis include third party providers. The decision can be made separately for each segment and is as of today up for debate. (ECB 2020).

The decision of whether the European Central Bank will issue the digital Euro was planned to be made towards the middle of 2021. But the process is ongoing, and the preparations are still under way. The last steps of the preparation phase are practical experimentation, listening to the views of the broader public and engaging with stakeholders. The requirements that must be met in short are that the overall Eurosystem's availability, safety, efficiency, and inclusiveness are to improve (ECB 2020).

2.2.3 Why is there a need for a Central Bank Digital Currency?

There are multiple reasons to why there is a rising need to issue a central bank digital currency such as, the insurance of public access to legal tender if there was to be a phasing out progress in the use of cash. If a situation where cash would not be widely available for the population, a central bank digital currency would ensure the access to legal tender. This means that as both cash and central bank digital currency would be legal forms of payment and if cash were not available, the central bank currency would also represent an equal claim to the central bank. Even though a central bank digital currency is not planned to replace cash, it would benefit the society in many other ways if the rate of the use of cash would decline. Cash is more expensive to handle and manage and is also in nature more difficult to trace. This makes cash also an effective tool in many forms of financial crime such as, money laundering, tax evasion, financing of terrorist organizations and illegal transactions. In theory the less cash in circulation and less cash transactions are made the governments and individuals could benefit from a safer form payment and increased tax earnings which could be spent more effectively on public services (Ward & Rochemont 2019).

A central bank digital currency could also significantly improve the efficiency of payment systems in whole. Given that the implementation would be made for both retail and large-value payment systems, the issuance of a central bank digital currency along with its technology would facilitate faster settlements and extend the settlement hours, because there would not be a need for any interbank communication system compatibilities. Efficiency could also be felt in the everyday transactions that would use the methods of payments tailored for a central bank digital currency whether the actors in a trade are using a point-of-sale, online or a peer-to-peer form of payment. The emphasis of the smaller everyday transactions should not be overlooked, since for example The Bank of Korea used a total of 53.7 billion Won (€ 39.9m) on coin production in 2016 alone. A widely accepted and used form of digital payment system would reduce the expenses of cash production and handling (Ward & Rochemont 2019).

Besides the economical savings in nudging towards a cashless, or at least a less-cash society, recent statistics show that the overall trend in developed countries is favouring the use of electronic payment methods and the use of cash has declined on its own (see Figure 1 - below).

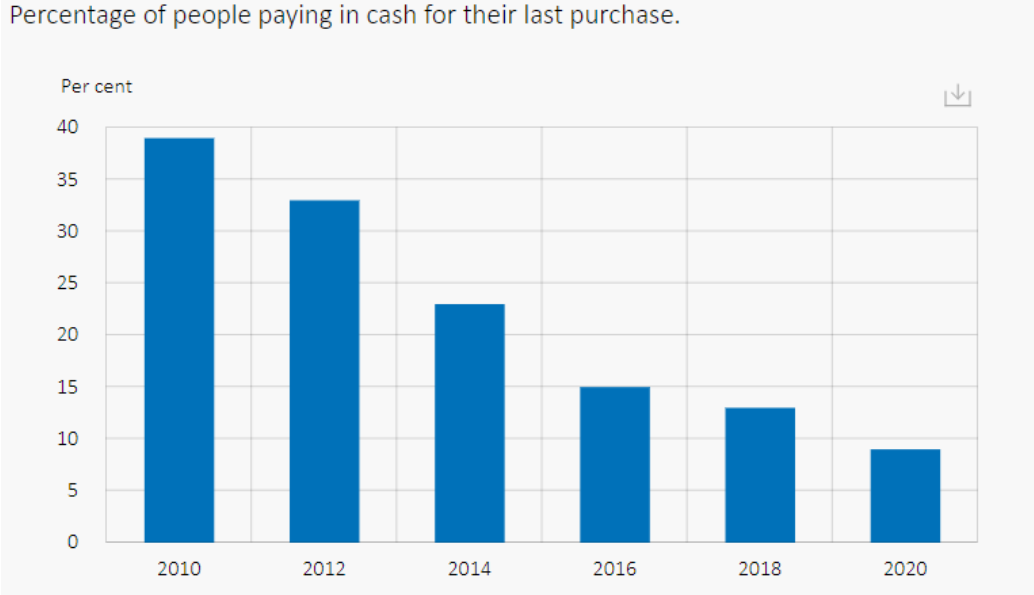


Figure 1 - % of people paying in cash… in Sweden. Riksbank 2020

In a recent survey study made by the Swedish central bank – Riksbank it was noticed that the percentage that indicates how many people in Sweden had paid their last purchase using cash had declined from 39% in the year 2010 down to 9% by the year 2020. A sturdy 30% decline within a decade. The long-term trend is estimated by the Riksbank to have been accelerated by the COVID-19 crisis and the statistics are presumed to follow the decline in trend in the year 2021 as well. According to the Riksbank, in Sweden cash is used primarily for small purchases, such as coffee and, or by older people (Riksbank 2021). The popularity of unregulated cryptocurrencies has especially risen among the younger population according to Riksbank (Riksbank 2021).

A central bank digital currency could offer a more reliable, more stable, and less volatile in value option not only for the young, but for the whole of population. As the commonness of privately issued e-money with the purpose of maximizing the issuers profits, a central bank digital currency would also minimize the social welfare costs. In a scenario where the e-money markets would be ran by the private sector and there would be a lack of fiat currency option in the e-money markets, the share of population receiving social welfare benefits from the governments would be in a disadvantaged position. Given that in their position it would be impossible or very costly to enter the e-money markets and that their socio-economical position in the society is already in a low state (Ward & Rochemont 2019).

The technological and jurisdictional advancements could also improve the efficiency of cross border payments with a central bank digital currency. A collaborative study created by the central banks of Singapore, Canada and the U.K. primarily focused on cross-border interbank payments and settlements and theorized on the potential improvements a central bank digital currency would create. In the current state the central banks rely on a Real-time gross settlement system which is the infrastructure that underpins settlements of payments. The infrastructure is described as less efficient when compared to the potential new infrastructure built around the central bank digital currency, as with the RTGS infrastructure there are cross-jurisdictional lags for the payment completions.

These and any type of lags expose the counterparts to significant credit and settlement risks (MAS 2018).

In the joint study the central banks described cross-border interbank payments and settlements using 5 separate models; The existing current state using RTGS, the expanded current state still using RTGS and three versions of models that include the existence of a central bank digital currency. The last model, which in all forms is the most challenging to launch there would be a universal W-CBDC Exchange and close to complete platform connectivity and interoperability. The last model was also theorized to be the only wholesale model that would bring significant improvements compared to the existing RTGS model. The benefits could be the improvements to the credit and settlement risks for the counterparts, anonymity, and the 24-hour availability. The study that theorized the models extensively did not yet find a clear, only positives including option. Rather, the study concluded that all the models were found to have benefits and drawbacks from the point of view of the central banks (MAS 2018).

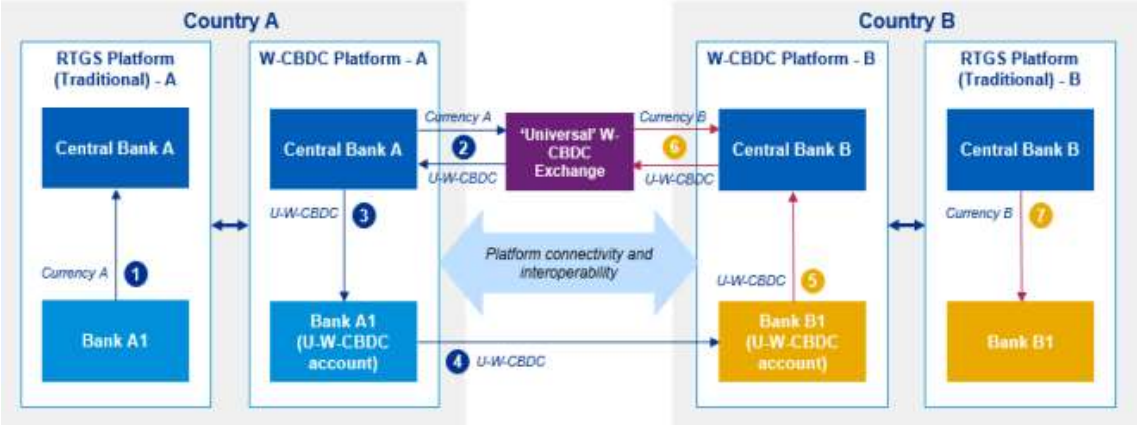


Figure 2 - The Model 3c – A single, Universal W-CBDC backed by a basket of currencies.(MAS 2018).

Until February 2022 there has been only seven non-official test launches of some form of a central bank digital currency with varying results and durations. The test launches and test periods have had different structures to them, but for now there are no commonly agreed on standards concerning governing, technology, or issuance of all central

bank digital currencies. In theory a central bank digital currency utilizes the chosen monetary technology of the country or union it is established in (Seth 2021).

2.3 What are Payment Systems & Technologies?

Different means of payments use different payment systems. Payment systems are systems that are used to settle financial transactions that transfer a monetary value between correspondents. The correspondents might include the likes of individual consumers, institutions, governments, companies and so forth. The whole of payment system includes many actors and factors such as correspondents, rules, procedures, regulations, standards, and technologies, which all together make the financial transactions a reality. Payment systems can be physical or electronic and for the sake of evaluating efficiency the focus is on the electronic systems, and even though payment systems in general are used for other than cash transfers such as equity and bond markets, the focus is on the cash transfer efficiency which would be the playing field of a central bank digital currency (Suomen Pankki 2021).

In the realm of payments, the options currently are cash payments, checks, debit card payments, credit card payments, mobile payments, and electronic bank payments and transfers (PBS 2021). Larger institutions might also use more complex and or structured payment methods, which as the result utilize one of the latter forms of payment. For example, a corporation can issue a bond, which is a dept asset, which is securitized as a tradeable asset on the markets. As the bond expires the money changes its owner via electronic bank payment (Fernando 2021).

A selection of different countries central banks has had studies made about how the current in use payment technology would work with a central bank digital currency, as well as what types of new implication could be utilised in the future to build the payment options to be even more efficient than today. The studies made by the European Central Bank, The Bank of England, and the joint study by the Singaporean, Canadian and United Kingdom’s central banks aimed to map out possibilities for everyday payment

technologies, such which people use on a daily basis when shopping for groceries or shopping online, as well as larger scale payment options such as cross-border interbank payments and transfers (ECB 2020 & MAS 2018).

So far, no central bank has decided on which technology to use for the potentially issuable central bank digital currency, for there are questions about the multifunctionality, costs and risks in each mapped method. The most recent studies have been made by the European Central Bank and the options have been narrowed down to a few. Each option has its benefits and disadvantages, and each option serves a certain payment mode better than some others. That is why it is important to map out the current payment technologies and compare them to the hypothetical, but realistic options of the future development. (ECB 2020 & MAS 2018).

When we are observing the current payment systems and technologies within the European union, it is important to make some initial distinctions. In the late 2000's a Single Euro Payments Area (SEPA) was formed, involving all the countries that are a part of the European Union plus Iceland, Norway, Liechtenstein, Monaco, and Switzerland. The 36 countries formed the SEPA in order to enhance the efficiency of bank account transfers, direct debiting, and credit/debit card payments among the countries. The main objective of the SEPA union is to elevate the cross-border payment efficiency to the same level as domestic payments. Many of the involving countries have transferred to the SEPA-payment methodology in the early 2010's. The payments are based on the ISO 20022 standard and are largely in XML format. The security aspects have also been enhanced from the FTP transfer protocol to a more modern web service and PKI-key solution (ECB 2021).

As SEPA forms the payment area in Europe, the wider scoped payment system that is used for Eurozone and non-Eurozone payments is called TARGET2 (Trans-European Automated Real-Time Gross Settlement Express Transfer System). A real-time gross settlement is described by the ECB Glossary related to the TARGET2 as "The continuous (real-

time) settlement of funds or securities transfers individually on an order-by-order basis with intraday finality (without netting).” (ECB Glossary 2021).

TARGET2 is based technically on a system called SSP or Single Shared Platform and was enhanced from the initial TARGET system. The Objectives of the TARGET2 systems are to maintain and support the stability of the Eurozone money markets and ensure the correct functioning of the Eurosystem’s monetary policies. Technically its objectives are to minimise systematic risks for payments and increase the efficiency of cross-border payments. In total the TARGET2 is the words largest payments system with over 13,000 correspondent parties, that can each be identified with a unique set of credentials including the Bank Identifier Code (BIC) and International Bank Account Number (IBAN) (ECB – What is TARGET2 – 2016).

Whereas TARGET2 is mainly the infrastructure for large volume euro payments the whole of European payment hierarchy consists of multiple payment and settlement functions that work in tandem and the main objective of the multiple methods within the hierarchy is to provide the optimal solutions for all consumer groups and to enhance the efficiency of payments when measured in time, cost and lately ESG-metrics. All in all, the hierarchy of services currently in Europe consists of TARGET2, TARGET2-Securities (TS2), and TARGET Instant Payment Settlements (TIPS) (Wegmann. A 2020). For a comprehensive diagram on how the systems work together see (Figure 3. on page 26, ECB 2020).

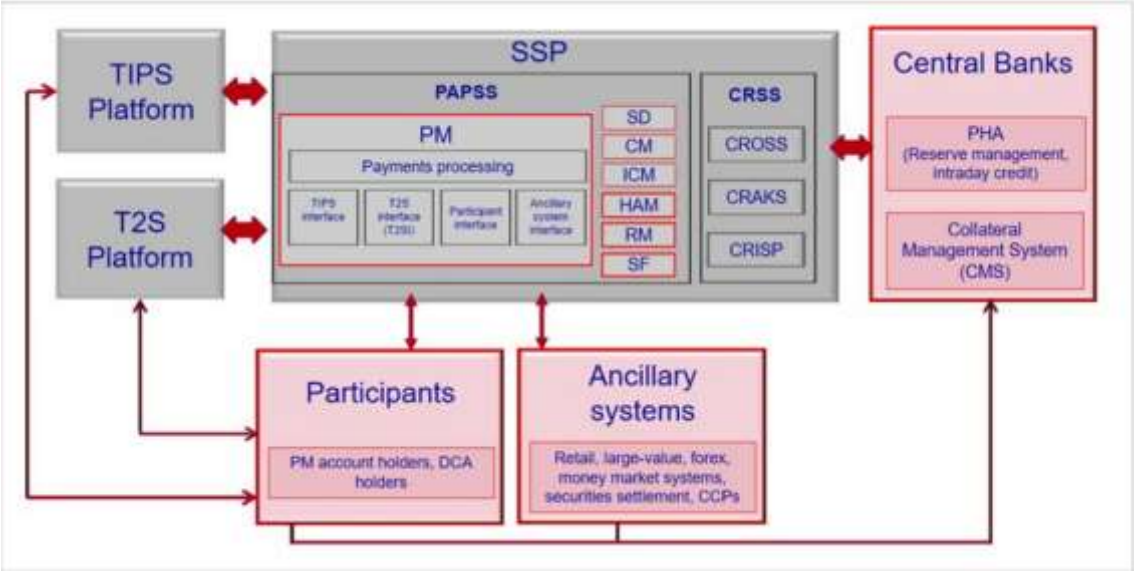


Figure 3 - TARGET2 Structure - Information Guide for Target2 users – (ECB 2020)

3 Applications of the Theory & Previous Research

Before going into the research of this Master's thesis, we are going to take a look into the most recent and relevant studies in the field of the similar subject. The topics of these recent studies vary from mapping of the financial technology history and painting the view of the future by Arner, Barberis and Buckley all the way to the book by Nicola Bilotta and Fabrizio Botti titled The (Near) Future of Central Bank Digital Currencies. I will also site another master's thesis work for it is so far the only case study about the most recent trials of Central Bank Digital Currency. The author Petteri Virtanen from the University of Jyväskylä published his Master's Thesis in 2021 about the two cases and it will provide valuable information on the subject.

It must be mentioned that even though technological efficiency statistics or effects are mentioned on these studied, none of the pieces actually concentrate or primarily focus on the aspect. Pushing the point even clearer that no research on the subject has been conducted so far.

One important definition that must be made, even though the end product of the research might be somewhat different because the research concentrates on perceptions and feelings, is the definition of technological efficiency. Technological efficiency, or in some sources technical efficiency is described by John Spacey as: "…the output produced for a unit of labour or capital". (Spacey 2017). In other words when comparing a set of products or technologies the efficiency can be defined from the amount of output metrics in relation to the number of inputs. It can be said that the maximum rate of technological efficiency is reached when the quantity of inputs are at the lowest possible rate that is able to produce a maximum of outputs (Economicshelp 2022). In the case of Central Bank Digital Currencies and technological efficiency the inputs and outputs vary and are product dependent, but at this stage it can be assumed that the inputs and outputs could include factors such as cost efficiency, where the efficiency is defined by the amount of capital required for producing the least costly output i.e., technological hierarchy.

3.1 Overview on Historical Trends in Financial Technology

In their 2016 research paper the evolution of FinTech: A new post-crisis paradigm, Douglas Arner, Janos Barberis and Ross Buckley divide the technological advancement eras of financial technology in four time periods. As for private person payments and forms of banks and deposits one could go back in history all the way to the times of the pharaohs, but in terms of financial technology the era is set to start from 1866. Although the technological advancements during those first decades of the first period of financial technology evolution were not directly linked to financial services, it is argued that the advancements were the catalyst that has made financial technology what it is today. (Arner, Barberis & Buckley 2016.)

The first era of financial technology ranges from 1866 up until 1967 as determined by Arner et al. This is the era of financial globalisation where inventions such as the telegraph, steamships and railroads broadened the financial horizon and capabilities of entrepreneurs and private citizens for the first time in human history. Alongside with the ability to move people faster, financial information could be transmitted across borders with a speed unseen before. The key events during the first decades of the era were the building of the transatlantic cable and the Fedwire, which improved the speed of money transactions tremendously. (Arner, Barberis & Buckley 2016.)

The Fedwire which in an updated form is still used today was first built in 1918. The creation of the Fedwire dramatically reduced the cost and speed of interbank settlements, especially concerning interbank lending and monetary policies. Upon its creation one of the main purposes of the Fedwire was to eliminate regional exchange rates of the US Dollar which were prominent before the Fedwire. (The Fedwire Funds Service 2014).

After the first technological leaps forward in the interbanking payments field, the 1950's brought the first advancements for private consumers and retail bank customers in the form of the credit card. Credit cards were the first invention in the modern era of financial services which enabled cash free payments for customers without relying on their

chequebooks. The first credit card was introduced by Diner's Club, closely followed by American Express company in 1958. (Arner, Barberis & Buckley 2016.)

The second era of financial technology is set to have taken place between 1967 and 2008. The spirit of the era is the transformation from analog to digital, and the era withholds the launch of the first handheld calculator and the ATM machine. These launches were just the tip of the iceberg as the next leap forwards, the establishment of NASDAQ, worlds first digital stock exchange took place in 1970's. From that it was not long until the first step, and the first surface to Central Bank Digital Currency as well, the launch of SWIFT payments, Society For Worldwide Interbank Financial Telecommunications). (Arner, Barberis & Buckley 2016.)

In the 1980's there were the first introduction to online banking and bank mainframe computers. The newfound speed and efficiency brought economic opportunities unlike ever seen before and it was not long until the world economy began thriving with the 1990's introduction of the Internet and e-commerce business models. (Arner, Barberis & Buckley 2016.) On a sidenote it can be said that the current regulation of the era was not in par with the newfound efficiency and the 1990's through the change of millennium era ended in a never-before-seen financial crash, also known as the dot com bubble. (Hayes 2019).

In the beginning of the 21st century it can be said that in the western and developed countries the banks' processes and interactions between retail and wholesale customers had reached fully digitalized state. The era as defined by Arner et al. (2016) ends with the financial crisis of 2008. (Arner, Barberis & Buckley 2016.)

Arner et al. (2016) argue that the 2008 financial crisis which due to global economies being intertwined spread globally even though the origins of the crisis were in the United States of America, developed a general distrust towards the traditional banking system among the general public. The turmoil and the aftermath of the financial crisis where

many finance sector professionals found themselves out of jobs and the public opinion being what it was, created an environment for something new, such as alternatives to traditional banks. Inventions such as smartphones, google wallet and Apple pay paved way for alternative ways of payment, and the release of the cryptocurrency Bitcoin in 2009 offered the public an alternative way of investing, paying and speculation. Alongside with the release of Bitcoin arose a boom of different cryptocurrencies, payment technologies and methods. (Arner, Barberis & Buckley 2016.)

Date	**1866 - 1967**	**1967 - 2008**	**2008 - Current**	
Era	FinTech **1.0**	FinTech **2.0**	FinTech **3.0**	FinTech **3.5**
Geography	Global / Developed	Global / Developed	Developed	Emerging / Developing
Key elements	Infrastructure / computerisation	Traditional / internet	Mobile / Start-ups / New entrants	
Shift Origin	Linkages	Digitalization	2008 financial crisis / smartphone	Last mover advantage

Figure 4 - The FinTech Eras defined by (Arner, Barberis & Buckley 2016)

3.2 Financial Technology Trends Now & In the Near Future

Moving on from the aftermaths of the financial crisis of 2008 the pace of financial technology evolution has become rapid (see Figure 4). Through the growing public distrust in the banking system and large corporations in general has caused a boom in the small FinTech industry, where new technologies and innovations are coming ever more frequently. Accelerating the development, new regulations such as PSD2 have been implemented by the European Parliament to enhance the rights of the consumers and to increase the service possibilities for the consumer. PSD2 regulation in a nutshell makes it possible for consumers to add financial APIs to their current bank services by other providers. Therefore, even small service niches can be implemented on top of the standard and in some cases outdated basic bank services. (OP 2021).

Overall, the main trend in financial technology today is digitalization. In their original paper published in the Journal of Business Economics, Peter Gomber, Jascha-Alexander Koch, and Michael Siering described the current evolutionary state of digitalization as being characterized by expanded connectivity and enhanced speed on information processing. These characteristics being implied both at the customer interface and in the back-office processes. Gomber et al. (2017) also argues on the behalf of revolutionizing the financial services towards a fundamentally new models for financial service companies. Once again painting the picture of the trend of moving away from the traditional retail banking service models (Gomber, Koch & Siering 2017).

The three also intrude a model of a Digital Finance Cube which represents the key dimensions involved in the Digital Finance today; The business functions, the technologies, and the technological concepts applied alongside the institutions concerned. The cube (see Figure 5) demonstrates the current on the surface fields that relate to all parties in the financial technology field and trickles down to the consumer level. (Gomber, Koch & Siering 2017).

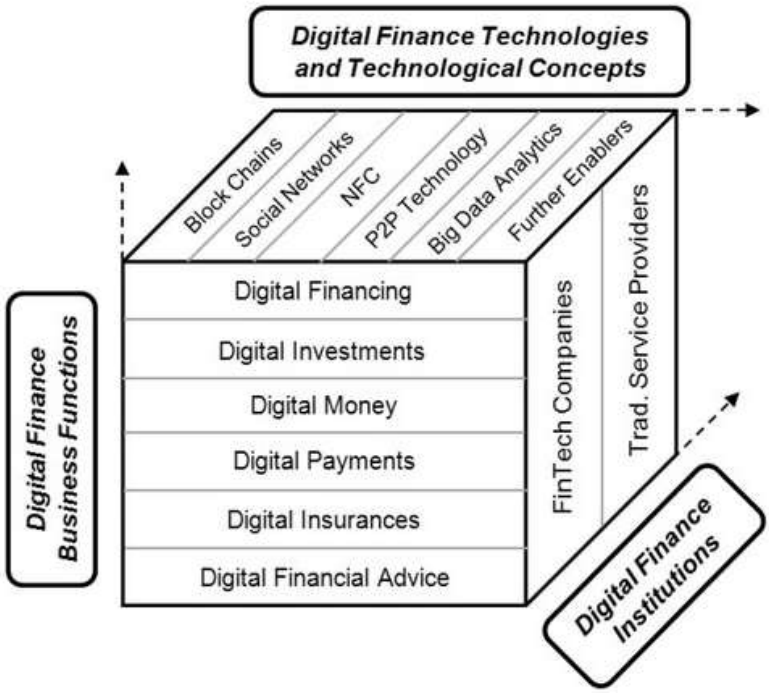


Figure 5 - The Digital Finance Cube & The Dimensions (Gomber, Koch & Siering 2017)

The current strong trends in digitalization combined with the consumers desire for alternative solutions for service providers also has affected the rate of using cash for payments in the Nordics. Mobile application used for payment transactions have become more common by the year and with applications available for the consumers such as Apple Pay, MobilePay, Vipps and Siirto, it is Norway that is currently leading the stats in less cash transactions in the retail markets with a mere 3% of retail payments being cash based in May 2021. The trend suggests that the digitalization is pushing developed western markets towards a cashless society (Norges Bank 2021).

A Study released by the Copenhagen Business School and Sweden's KTH Royal Institute of Technology went into even more detail in their estimations. The research paper commissioned by the Swedish Retail and Wholesale Council suggested that by the year range of 2025 to 2027 cash would no longer be in wide use. The paper even went further and set a specific to predict that cash will no longer be feasible for merchants as a mean of payment on March 24th, 2023. (Arvidsson, Hedman & Segendorf 2017).

With the current trends leaning towards open banking and instant payment solutions the financial sector and especially the industry of payments has become increasingly complex in a short period of time. As per usual the case is, with rapid innovation the regulation lags, that would seem to be the case currently as well. The rise of private and unregulated digital money such Ethereum, Bitcoin and stable coins such as Facebook's Diem have also created the urgency for a regulated, central bank governed form of digital money. (Engman 2021).

It is worth mentioning that approximately 97% of money is actually "produced" by the commercial banks through the day-to-day banks through the day-to-day activities such as extending loans and credits to consumers and businesses. In short how the money creation process functions are that the commercial banks provide and earn interest from a variety of loans, and as customers make deposits to the commercial bank, they simultaneously provide the banks the capital and more importantly collateral to make these

loans. In a nutshell against each 100€ deposited by the customer the commercial bank can extend 900€ of credit, thus making more money (Kagan, Anderson, & Munichello 2021). However, as Kim Engman, Senior Director at TietoEvry proclaims “even with the most stringent regulations and legislation in place, commercially generated money sitting on bank account, and their concurrent worth, will never be 100% guaranteed for account holders. Only cash comes with that guarantee as it’s a direct claim on a central bank”. Kim furthers the point by using an example of the current bank deposit regulation within the European Union; If a commercial bank was to default within the Eurozone, any amount of deposited cash on a consumer’s bank account that exceeds 100,000.00€ would be permanently lost, as the bank nor the European Central Bank are liable for that sum (Engman 2021).

To summarize the current technological trends in the financial sector seem to quite strongly push the industry towards digitalization, hence affecting the amount of cash in circulation, therefore bringing private forms of money, mostly in digital form to the markets which creates an urgency for central banks to develop a central bank digital currency to fulfil the sole purpose of a central bank as described in the earlier chapter as to ensure the financial stability, stable prices an safe an efficient payments.

3.3 Experiments with Central Bank Digital Currency in Sweden

In February 2020 the Sweden’s Riksbank announced it had begun a testing period for their own central bank digital currency called the e-krona. The test was to be proven successful and it was to be decided that the e-krona was to come into circulation, the uses for the currency could be to simulate day-to-day retail banking activities such as payments, deposits, and withdrawals from a digital wallet such as a mobile phone application. (Reuters 2020). According to the Riksbank “The aim of the project is to show how an e-krona could be used by the general public”. (Riksbank 2020).

For Sweden the environment for a pilot is optimal compared to some other countries within Europe, since only 1% of Swedish gross domestic product existed in banknotes in

2018. The 1% share is quite unique in the developed countries, since for example the average share of gross domestic product existing in banknotes for the Eurozone in 2018 was 11%, in the United States of America the share was 8% and in Great Britain 4%. The pilot simulation was conducted in an isolated test environment developed by the consulting agency Accenture (Reuters 2020).

The e-krona technical solution in the first testing phase is a token based in a distributed network that is based on blockchain technology. Tokens differ from the current digital form of cash in the way that the e-krona tokens are uniquely identifiable. This technical implementation enables the e-krona to be created (and destroyed) only by the Riksbank and gives the e-krona similar attributes to physical cash. The functions of the e-krona have been developed to take place within a e-krona network where the important parties of the functional topology act, that would include the participants, liquidity supply and the end-users. (Riksbank 2020).

The e-krona network is based on the Corda platform developed by R3. The decentralized private network functions similarly to a blockchain network and can also be called a distributed ledger technology. The Riksbank acts as the owner of the network and can decide who joins the network, but the actions within the network are not registered to a centralized database, rather they are registered with the participants within the network that are involved in the transactions. The network works in parallel to the existing payment infrastructure where other transactions such as card payments and bank account transfers take place. The fact that the infrastructures are separate theoretically could improve the operating reliability of the payment systems, since if the other side is down the other side would still function. The money creation takes place in Riksbank's own settlement system RIX, and no money is created within the E-krona network (see figure 6). (Riksbank 2021).

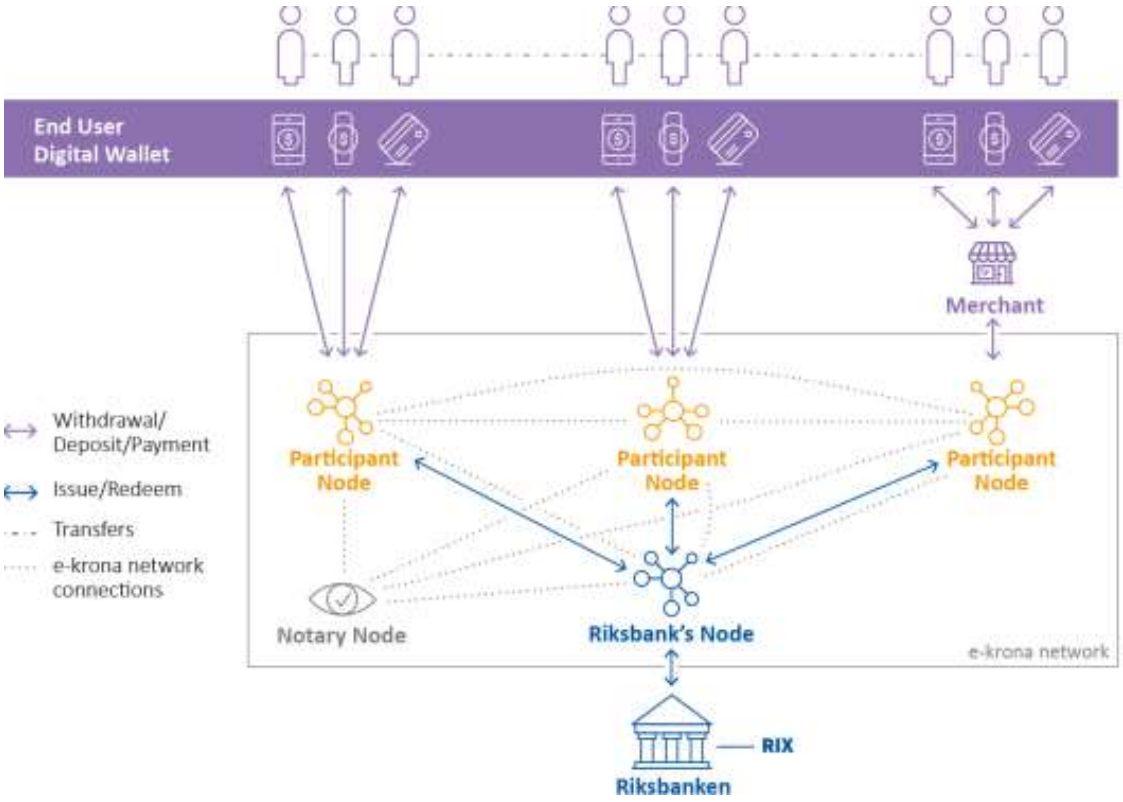


Figure 6 - The E-krona infrastructure. (Riksbank 2020).

There are however some weaknesses and question marks about the e-krona network and the money creation and destruction party RIX. In his master's thesis released in 2021, Petteri Virtanen from the University of Jyväskylä did a thorough literature review about the cases of Central Bank Digital Currency implementation concerning The Great Britain and Sweden (Virtanen 2021).

In his concluding remarks the following challenges rose about the Swedish experiment, Virtanen mentioned that in the case of launching the e-krona, the effect on commercial banks would most likely be showing as an immediate need for more employees, which in turn would have the positive effect of guaranteeing access to a reliable source of money for the general public. When it comes to the technical implementation though, Virtanen sees issues about the lone, independent operator model. He mentions that the digital currency is based on a separate infrastructure and the possibility for all payment suppliers and financial technology firms getting access to the network would

enhance the public use of the e-krona. Whereas the current situation is so that there is an oversupply of actors in the payment and retail bank markets in Sweden and it is theorised that the potential benefits of the e-krona could be lost in the competition that would ensue if private actors were not to be implemented and included in the networks of e-krona. The final conclusions that were backed up by the literature review of Virtanen state that the resources demanded, and the potential benefit gained from the current planned implementation of a Central Bank Digital Currency e-krona in Sweden does not, to the same degree accomplish the aims of expanded competitiveness and durability. In short, the amount of additional value generated compared to the resources that would need to be used would not improve the current situation in Sweden substantially enough. (Virtanen 2021).

Virtanen's conclusions are supported by the Riksbank's own piece of research titled E-krona design models: pros, cons, and trade-offs. Similar conclusions are made by the authors Armelius, Guiborg, Johansson & Schmalholz about the different proposed models such as the heightened barrier for newcomers to enter the market, the increased role that the central bank would have to take in order for the Central Bank Digital Currency to function the way it is proposed, and the effect the wholly centralized model would have on commercial banks. In their study report no design model is necessary found to be substantially better than others and even a synthetic e-krona model is pondered upon, but in conclusion the positive effects E-krona is planned to have been recognised in each design model although none of the design models came without any hiccups. (Armelius, Guiborg, Johansson & Schmalholz 2020).

3.4 Prior Research on Central Bank Digital Currencies

Central Bank Digital Currencies have been a topic in general discussion for only a brief time so compared to other relatively new topics such as cryptocurrencies, there is not that much high quality, peer reviewed studies on the subject. In this chapter the most important articles and studies concerning Central Bank Digital Currencies are reviewed. That is to give a proper general oversight into the current discussion in the scientific field

and to gain an alternative viewpoint in addition to the articles and studies conducted by actors such banks, central banks, and consultants. During the last couple of years, the journal of monetary economics has been able to produce some of the most quoted studies related to Central Bank Digital Currencies and the different aspects to it.

In their article titled designing Central Bank Digital Currency released in the journal of monetary economics, Itai Agur, Anil Ari, and Giovanni Dell'Ariccia provide mathematical calculations and proofs on how the optimal Central Bank Digital Currency would be designed. To put their work into simpler terms the study observes two potential options and the different outcomes for a Central Bank Digital Currency model: an interest-bearing currency and a non-interest-bearing currency option. The trio concludes that the most significant effects would be social and economical effects on both versions and the non-interest-bearing model would be the more optimal version. Arguing that the interest-bearing version would be more deposit like and not cash like solution, the effects would most likely be felt in the roles of retail or private banks, that are highly dependant on deposits and the collateral and funding it provides them. It was also argued though that a cash like non-interest-bearing Central Bank Digital Currency could have the effect of diminishing the amount of ATM's and result in more and more shops not accepting cash at all, which could be seen as a social effect as well. It is however concluded that the designing of Central Bank Digital Currencies is still at a laboratory phase and the search continues for the most optimal model of implementation (Agur, Ari & Dell'Ariccia 2022).

Jack Meaning, Ben Dyson, James Barker, and Emily Clayton continue similar type of research in their study Broadening Narrow Money: Monetary Policy with a Central Bank Digital Currency, but this time taking in consideration the monetary policy making potential in the formula. In their study the same type of risk concerning interest-bearing and "digital bank runs" are highlighted. Meaning et al. (2021) theorise that by introducing some restrictions through imposing fees or creating withdrawal limits the digital bank runs from retail banks could be limited or prevented, still maintaining the deposits,

therefore funding and collateral capabilities intact. It was then again also argued that if a Central Bank could hold deposits, it could create significant risk situation in times of financial crisis. As central banks hold assets such as government bonds already, adding deposits to the central banks balance sheet in a time of crisis when generally the public seeks for less riskier options to hold their assets in could increase the risk level of the central banks' balance sheet over the allowed limit. As it has been for many studies concerning Central Bank Digital Currencies also the study by Meaning et al. (2021) offers no concrete opinion on the optimal model to move forward, but some insight on how the interest-bearing and non-interest-bearing options could affect monetary policy capabilities of the central bank. Also, what seems to unite the papers is the take on the role of the retail banks (Barker, Clayton, Dyson & Meaning 2021).

In their IMF working paper "A survey of Research on Retail Central Bank Digital Currency" John Kiff and his colleagues dive deeper into the core reasons and outcomes of a Central Bank Digital Currency, especially concentrating on providing the central banks a step-by-step how-to guide for implementing a Central Bank Digital Currency. The researchers state that the motivations for a Central Bank Digital Currency vary from tackling the issue of dwindling use of cash to seeking innovative methods to expand financial inclusion, so unlike the other studies the so-called side effects on retail banks for example are not handled as much in detail. But the research does state that "A big decision is whether to outsource the running of the CBDC network to third-party cloud providers and how to manage any associated risks." Therefore, emphasising the importance of the role of the third-party service providers. This remark was made in the research especially concerning the infrastructure of the Central Bank Digital Currency. Without going too deep into detail about the unquestionably big questions like the previous researchers, the paper offers a four phased summary for the consideration of relevant stakeholders for a retail Central Bank Digital Currency implementation (Alwazir et al., 2020).

	Considerations	Description	Technical Assistance Components
1.	**Objectives**	Central bank identifies the needs and problem(s) that a retail CBDC would address, and the full array of possible (other) solutions. Central bank assesses cash and non-cash use and trends	Policy frameworks Central bank law Payments and Financial Market Infrastructures
2.	**Implementation & Infrastructure**	Central bank identifies project management approach and involves key stakeholders. Central bank assesses CBDC design features based on policy objectives (point 1) and country circumstances, including aspects of cybersecurity, user-centricity, flexibility, and financial integrity.	Central bank project management Central bank cyber-security Payments and Financial Market Infrastructures
3.	**Legal Framework**	Central bank identifies constraints posed by legal framework, including legal tender definition.	Central bank law
4.	**Governance, Organization, Risk Management**	Central bank identifies decision-making structure relevant for CBDC, organization structure (including innovation hub and/or sandbox), and operational risks (including outsourcing/cloud computing).	Central bank governance, organization, risk management, accounting. internal audit

Figure 7 - Implementation Considerations (Alwazir et al., 2020)

If we broaden the scope on observation to considering the timeliness of a Central Bank Digital Currency, Auer and others describe Central Bank Digital Currencies in their article titled “Central Bank Digital Currencies: motives, economic implications and the research frontier” as being an idea of which time has come. The main reason for the issuance of a Central Bank Digital Currency would be that it is a chance to improve payments in general through a technologically advanced version of the traditional Central Bank money, in this case FIAT-money. The opportunity of a Central Bank Digital Currency according to the paper if properly designed is that it could be the backbone of a highly efficient new digital payment system. Noticeable factor is once again that the emphasis and the if statement is directed towards the designing of the Central Bank Digital Currency, as it has been with the previous studies in the literature review. The research itself has two main points in its conclusions, the other being the already mentioned timeliness of a Central Bank Digital Currency and the fact that there is a real need for it as it would at least theoretically improve the efficiency of digital payments, data governance and

privacy standards in general. But there are also mentions about the design of the Central Bank Digital Currency and the importance of the careful assessment of the potential effects towards the private sector. For instance, the term from the previous studies interest-bearing is not mentioned, but the same meaning is delivered through the term universal store of value. To conclude the paper provides a slightly more opportunistic point of view for the topic of Central Bank Digital Currencies, but offers no alternative opinions, at least in a direct fashion (Auer et al., 2021).

Finally, as the broadest review of a study related to the Central Bank Digital Currency Ozili K Peterson published his literature review of the topic involving numerous studies about Central Bank Digital Currencies in the Journal of Money Laundering Control in January of 2022. The purpose of Peterson literature review was to discover what is or is there any sort of strong consensus about Central Bank Digital Currencies amongst the academic field at the time being. Peterson spent time reviewing around forty different studies related to the topic and in his conclusions the most important facts and findings do not drastically differ from the ones mentioned in this chapter previously. The findings are inline in terms of the positive effects, as Peterson mentions that it is expected that the status of financial inclusion, conduct of monetary policy and the efficiency of digital payments would most likely enhance. Those according to Peterson were also the main motives for the Central Bank Digital Currency from the Central Bank's perspective. But, as in the other papers Peterson spends a lot more rows of text on the cautionary signs of over optimism about the Central Bank Digital Currency and starts to highlight the found potential negative effects, one of which being the cost of credit and financial stability. Finally, the emphasis is once again set on the design and the importance of identifying what it is that is actually wanted from the Central Bank Digital Currency in the design process. And Peterson ends the review on a non-conclusive remark on the question if the Central Bank Digital Currency will yield the expected outcomes as "Only the future will tell". (Peterson 2022).

4 Choosing the Research Method

One logical solution for measuring the technological efficiency of a Central Bank Digital Currency implementation would be to perform a quantitative analysis based on a certain set of chosen metrics and for example comparing the metrics before and after the launch. After which, analyse the key differences from which final conclusions could be made. Since in the realm of Central Bank Digital Currencies no actual country or region wise public launches have yet been made qualitative research is not only justified, but also mandatory for no concrete measurables yet exist.

The main purpose for the research is to reach a as realistic as possible view of the future, generated by the analysis of interviews and discussions with the top experts of the financial technology and payments field. Therefore, the conclusions are not based on figures analytics, but on the general feel that the experts have on the research question, or more broadly the phenomenon. As this research aims to study what the experiences of the experts within the field are and to understand from the top professional minds what aspects, advantages, or disadvantages there might be, qualitative research done according to the approaches of phenomenography and categorical analysis should provide the most accurate results.

4.1 Why Qualitative Research?

The methods of research for this master's thesis can be dissected to three parts. There is the top-level methodology of qualitative research, under which lies the more accurate method of phenomenography that is used for this thesis and the final part that will be used in the analysis phase of the research which is categorisation. To add to the list under the phenomenography there is also the method of material gathering, which in the case of this thesis is interviews or expert workshops. The first question of what qualitative research is has many answers and definitions. Here are a few ways to describe it:

> *« Qualitative research is a research strategy that usually emphasizes words rather than quantification in the collection and analysis of data » (Bryman 2008).*
>
> *« Qualitative research is a process of naturalistic inquiry that seeks as in-depth understanding of social phenomena within their natural setting » (UTA 2021).*

Qualitative research in its core aims to understand and explain phenomena and to get down to the most central meaning or purpose of the phenom. It is more common for qualitative research methods to be used for humanistic sciences such as history, philosophy, and psychology, but there are no restrictions on whether qualitative research methods can or cannot be used for natural sciences such as physics, biology as well. (Alasuutari 1999).

Overall, qualitative research can be conducted in multiple different methods, of which phenomenography, the method for this master's thesis is one of. The common factor that holds for all of these methods is that the emphasis of the research is on the environment and background, the meaning and purpose and interpretation and lingo of the phenomena. In other words, the feel, or qualities (Koppa 2021).

Other characteristics to qualitative research include the fact that there rarely is any hypothesis to qualitative research. This no-hypothesis characteristic means that usually material is gathered and analysed with no presumptions or expectations by the author. Although it is necessary to acknowledge that it is almost impossible to withhold from all expectations, thus it is important present the realm of possible presumptions and expectations in the research. Hypotheses are not all together mis included from the universe of qualitative research, as one of the purposes of a qualitative research is to create or present plausible hypothesis for further quantitative research (Eskola, Suoranta 1998).

Theory as a concept is related to qualitative research in at least two common ways. A theory can be used as a mean that aids the conduction of the research or as a guideline or baseline where the goal of the research is to further enhance or develop an existing theory. A theory can also be the objective of a research, this is the most apparent when

the researcher is using inductive reasoning with the gathered material (Eskola, Suoranta 1998). In short, inductive reasoning can also be called bottom-up logic where the working method is drawing general conclusions from a set of specific observations. The goal of this way of working can be to create new theoretical knowledge (Masterclass Staff 2021).

When gathering the material for qualitative research the methods differ from quantitative research in general. The selection criteria are usually very strict and planned, since for the quality of the research and the outcome the factor that matters is not the quantity of research subjects, rather the quality of the subjects. This is a crucial step to be planned carefully by the researcher since there is a small margin for the optimal size of the subjects. The sampling should be large enough to have enough variance, but also constricted enough to be able to perform the analysis sufficiently and comprehensively. As mentioned in the previous paragraph, one of the most common methods of analysing the gathered material is trough inductive reasoning and making comparisons to the theory. Unlike in quantitative research it is uncommon for qualitative research analysis to make comparisons to any statistics. Unlike in quantitative research, in qualitative research the research question can and often changes during the course of the research, this partially due to the open-minded approach to the different phases of the research and the researcher's capability to alter the way of approach during the course of the research (Sommers 2000).

Despite the clear differences between the two research ceiling research methods, Pertti Alasuutari describes in his book "Laadullinen tutkimus 2.0" that qualitative and quantitative research methods are not the polar opposites to one another, in fact the two research methods complement each other and can be seen as being in continuation to each other. One of the most characteristic forms of quantitative research is the questionnaire, of which's results can be measured and analysed quantitatively. The former method can be used to measure the popularity of political parties or which brand of milk is most bought brand of all. The same method can also be applied to measure the feel

of a population. Just by analysing the answers of a “feel” based questionnaire does not necessarily result in the research being qualitative though, and often what is required from the top-quality qualitative research is the observation and comparisons of the results to actual measured, statistical data. In other words, the feel needs to be validated through statistics as true or false (Alasuutari 2011).

4.2 Phenomenography

The research method chosen for the master’s thesis is phenomenography. Phenomenography studies the ways in which people experience, understand, and makes concepts of a subject or the surrounding world. This means that in phenomenography the interest is not within the peoples thinking processes, observations nor the real or correct way of thinking about a phenomenon rather the interest lays solely on the experiences of the people around the studied phenomena (Järvinen & Järvinen 2000).

The birth of phenomenographic research can be traced back to the University of Göteborg where in the end of 1970’s a study about the experiences and concepts of the university students about studying was started by a group of researchers lead by the professor Ference Marton (Järvinen & Järvinen 2000). In the beginning the research methods and ways of research did not resemble the ways of how phenomenography is understood today, but it created the basis for the development of phenomenography. It was only in the 1990’s that the actual pillars and structures of phenomenography were starting to resemble the frames known today and solid theoretical foundations were formed (Niikko 2003).

Phenomenography has close relations with other research methods as well such as phenomenology and grounded theory. One concept that unifies the three methods among others is as previously mentioned inductivity, or inductive reasoning. All three methods are inductive in the way that the concepts and categories of the research are based on the materials and the common objective is to enhance and develop them as the research moves forward (Raunio 1999).

The differences, subtle as they are come from the differences in the objectives of the research and the analysing of the materials. For example, grounded theory is the only method that has the objective of creating new theory, which is not the case with phenomenography or phenomenology. In short, phenomenography concentrates in research about people's subjective concepts in the way they are formed according to the individuals understanding. And in phenomenology the research is about people's subjective experiences and the essence of the experience is formed of the common nominators of the experience (Marton 1988).

One other aspect where phenomenography differs from phenomenology is that in phenomenography the analysis of the research is done through a material-based approach, rather than theory-based approach. According to Huusko and Paloniemi in phenomenographic research the material itself forms the theory for the research, therefore no concrete, predetermined framework is needed nor used for the categorisations of the themes (Huusko & Paloniemi 2006).

According to Maarit Kalliomäki there are a number of presumptions and engagements related to phenomenography. A human being is a rational entity which aims to form perceptions on experienced phenomena by attaching events and happenings to each other and trying to explain them, therefore perceptions can be understood as processes for giving meaning (Kalliomäki 2012).

Kalliomäki also defines that there is a difference between the first reaction, the so called reflexive experience and the more thorough thought out experience, but as experiences go in phenomenography there is no clear distinction made between the two ways of experience. Language is also a factor that should be taken in consideration in phenomenography since the conceptions and experiences, and especially the way people describe them is influenced by the language of the person as well. Overall, the distinction between an individual's world and the surrounding world function in a non-dualistic way in

phenomenography. Kalliomäki states that there is only one real world which at the same time can be described as both the real world (Surrounding) and the experienced world (individuals). Therefore, the experienced part of the world is a part of the world, not the whole world (Kalliomäki 2012).

4.3 Phases of Phenomenographic Research

Phenomenographic research advances in phases where each phase has an effect to the following phase (Kalliomäki 2012). With some variations existing, this master's thesis follows the conventional four phased research method. This chapter will describe each phase of the research from a theoretical viewpoint and reflect the theoretical approach to the approach used in the master's thesis research. (see the phases in Figure 8).

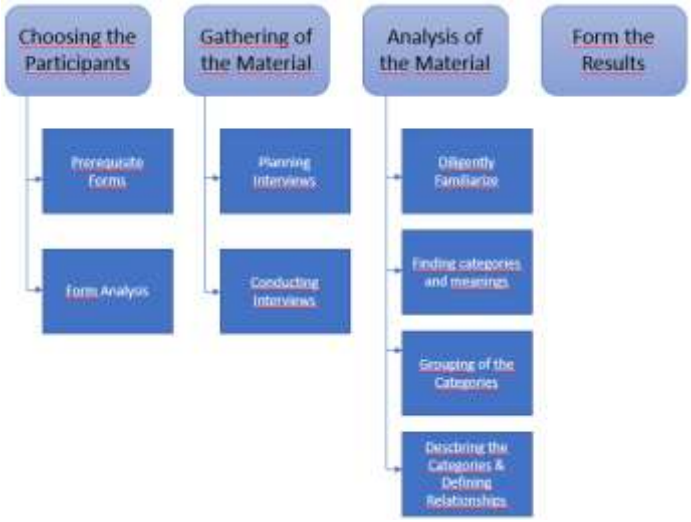


Figure 8 - The phases of the research

4.3.1 Choosing the Participants

The first two phases of the research could also be tied into one phase, since merely the choosing of the participants can be described as gathering of materials for the research (Huusko & Paloniemi 2006). This comes from the fact that usually the choosing of the participants phase include a written interview, which can also be called the filling and gathering of a perquisite form. The idea of the perquisite form is to gather the first

materials and to guide the researcher in conducting a framework for the discussions to be held in the workshops, therefore making the latter phases more efficient.

There needs to be a careful assessment of the question; how many participants is the optimal. One phenomenon that might occur when having too many participants is the saturation of the themes, thus results (Francis et al., 2010). In phenomenographic research what is meant by saturation is that the expressions and themes that the researcher picks up from the materials are similar or identical to the extent that even by gathering additional material form the same group of participants the action would not provide any significant new information for the research (Saunders et al., 2018).

Since this master's thesis category wise falls under digitalization, digital payments, and financial technology, I have decided to look for my participants in that particular field of expertise. The experts chosen to participate for this research will be introduced more thoroughly in chapter five. To avoid the saturation in a too early stage of the research two participants were also chosen outside the field of financial technology to gain a control group for the analysing of the general feel and perception around the phenomenon.

In this research the focus is on the feel of the future; what is the general understanding of the top experts in the field about the future developments in technological efficiency related to Central Bank Digital Currencies. And since the research question is rather broad and ambiguous there should not be an issue with having mostly experts as participants.

Generally, in a phenomenographic research, if the research is about sensibleness of a matter X (which could be e.g., an action such as cleaning the house) the participants would be chosen in a way where the frequency of performing the action would vary between the participants. That is because for example some tasks would lose the sensibleness if the action were repeated frequently enough. As in, taking out the trash every now and then does not bother most, but if the activity is done on a daily, or an hourly

basis the participant doing the deed could most likely feel less about it. Or as Kim and others, summarize it; as the frequency increases, the persons valuation of his/her actions and especially the sensibleness of the actions can be warped (Kim et al., 2005).

In this first phase of the research the participants were provided with a prerequisite form that contains twenty-five (25) questions around the background and competence of the participants, and the subject of the thesis. The meaning behind the prerequisite form is to first of all provide the author a chance to not include a participant to the study to avoid saturation and to gain the first set of material for the research, from which the theme interviews can be formed. As Francis and others state, even in a select group of ten participants there is probably going to be saturation (Francis et al., 2010).

4.3.2 Gathering of the Material

The gathering of the material in phenomenographic research is not an action performed only once. It can be said that the gathering of the material is a repeatable process during which the researcher should conduct continuous analysis. The analysis conducted by the researcher in this phase also has an effect on the latter phases of the research, because the interpretation of the material gathered at any point is also not a one-time act. To summarise this phase in short, it is impossible to separate gathering of the material from analysis in phenomenographic research because the two are intertwined (Niikko 2003, 32; Marton & Booth 1997, 129).

In general, as Kalliomäki has defined it the material gathered for a phenomenographic research can include different types of written material such as transcripts of an interview or surveys etc. When analysing the materials, the researcher is absolutely obliged to be able to self-reflect and keep an open mindedness about the perceptions and prejudices he/she might have and not let those affect the analysis process (Kalliomäki 2012). In the case of this master's thesis the gathering of the materials started with the prerequisite forms, from which the process of planning the interviews started.

Interviews are one of the most common and popularly used methods for gathering material in phenomenographic research (Eskola & Suoranta 2008, 85). When it comes to realm of interviews, there are at least three known main categories. The one where the researcher can interpret more than just the verbal output of the interviewee, and arguably the most influential form of interview is the face-to-face interview. This form of interview is more up close and personal than the other forms of interview, which are the online interview performed in Microsoft teams for example or the written interview, where there cannot practically be any correspondence and reactionary interaction (Tuomi & Sarajärvi 2018, 85).

When planning the interview, it is important for the researcher to choose the correct way of conducting the interview in a way that it serves the purpose of the research in the best possible way. There are multiple categories when it comes to types of interviews, but they can mostly be derived from three main types of interviews: The unstructured interview, the semi-structured interview, and the structured interview. Within these categories sub-types can exist such as theme interview or telephone interview (Fauvelle 2020).

The structured interview in other terms known as the form interview is one of the most used types of interviews (Hirsijärvi & Hurme 2008, 44). The purpose of this interview type is for the researcher to get the answers to the questions in the desired order. This type of interview is more common in quantitative research, but it can also be utilised in qualitative research in the way of setting a baseline for further interviews or to start categorising the answers (Tuomi & Sarajärvi 2018, 87). This is also the chosen type for the prerequisite form used in this master's thesis, for it provides material to form the workshop interviews.

The semi-structured interview type can be described as a hybrid between the structured and unstructured interview. The key characteristics are that in the interview the researcher does not have a specific order for the questions and the questions themselves

can be quite vague or even just bullet points. A subtype of this interview type, the theme interview was also the type chosen for this master's thesis. The important factors in the theme interview for the researcher are that even though there might not be a set list of questions, the researcher should make sure that all the prepared themes are handled (Fauvelle 2020). The generally accepted reason for the use of theme interview is to serve the purpose of the research, instead of first conducting the interview and then trying to figure out what to research (Eskola, Lätti & Vastamäki 2018, 28).

The unstructured interview is the most open form of the interview types. The unstructured interview is also known as the open interview, informal interview, and non-directed interview (Hirsijärvi et al., 2009, 86). The unstructured interview is the closest form of interviews to a conversation as the researcher does not have a planned frame for the interview. One of the key characteristics of an unstructured interview is that it is usually recorded in order to better analyse the main points and themes afterwards (Eskola et al., 2018, 28). The unstructured interview is mostly used in psychology and folklore studies as the format does not fit well for other study types (Hirsijärvi et al., 2009, 210).

In this master's thesis the chosen forms of gathering the material are the prerequisite form in the choosing the participants phase, and then a semi-structured theme interview in the gathering of the material phase. After the conducted theme interviews, otherwise in this master's thesis also known as the workshop, the analysis phase of the gathered materials started.

4.3.3 Categorical Analysis

In the analysis phase of a research conducted in the methods of phenomenography most often there are four phases. The core and where the analysis process starts, is from the materials that the researcher has so far gathered (Uljens 1989). The materials usually are in written form and can consist of transcripts of an interview or a workshop that can have been conducted as one on one, theme based or as a group interview,

documentaries, surveys, essays or in some cases even drawings or notes (Kalliomäki 2012). The material is handled as complete, whole entity instead of cherry picking interesting or seemingly interesting viewpoints from the materials. This way the researchers can aim to seek and systemize ways of thinking and feeling that can be described as shared and socially significant (Kallimäki 2012).

The first step in the analysis phase is for the researcher to diligently familiarize him or herself with the gathered material. This means that the materials are often read and re-read multiple times in order to get an overall understanding what was said, at what point and why. This process is also very useful for the researcher in order to get an overall view of the research and start forming the initial draft for the analysis. When interpreting the materials, the researcher should look for larger categories or themes of thinking instead of single words or sentences, this is because the interest should be focused on the background perceptions and ideas behind the answers of the participants (Kalliomäki 2012).

As the analysis process progresses the researcher starts to form the themes and ideas into categories. The core of the analysis in this phase is to identify different variations of ideas and themes and accurately identify them. This means that the researcher might need read sentences and paragraphs multiple times in order to differentiate the meanings behind two similar sentences (Kalliomäki 2012). In the final phase of the categorical analysis the categories are depicted on an abstract level and the relations between the categories should be clearly defined (Niikko 2003, 36-37). This means that in order for the categorical analysis and formation of the categories to be accurate, there should not be any overlapping definitions between the categories. One way to form the definitions of the categories is to describe the unique characteristics of each category and present a quote from the materials gathered to represent a certain category. This way the categories are explained to the reader in more than one way and the example, in this case the quote emphasises the differences between the different categories (Kalliomäki 2012). The last phase of forming the categories is usually scrutinized until the very last

bit, where the status of the most clear and narrow descriptions of the participants feels can be described and categorised accurately (Entwistle 1997, 21).

4.3.4 Forming the Results

The results of a phenomenographic research can be described as an outcome space around a phenomenon. The outcome space is finally formed out of rigorous analysis and categorisation of the gathered materials and by the logical connections made out of the relationships between the categories (Marton & Booth 1997, 136). It has been argued that there can be a countless number of possibilities for the outcome space produced, but in reality, the possibilities are finite because the outcome depends on the context, communications, forms of the questions and viewpoint of the research that the interpretation is based on (Uljes 1989, 45).

The outcome space in a phenomenographic research can have three different types of categorisation methods: horizontal categorisation, vertical categorisation, and hierarchical categorisation (Uljens 1989, 47). In the vertical categorisation the categories are ranked from top to bottom, based on the importance, commonality, and time. In the horizontal categorisation all the categories are the same valued and equal, with the differences between the categories coming from the content of the categories. And in the hierarchical categorisation the categories are unequal among each other, and they are ranked based on their theoretical value and broadness (Huusko & Paloniemi 2006, 169). In this master's thesis the horizontal categorisation was used.

In a simplified manner it can be said the results of a phenomenographic research is the as accurate as possible categories that have been formed by the researcher during the analysis phase. The categories and the outcome space should be able to answer the research questions as they are. The variance of the results and the altering credibility of the results in the sense of reliability and validity is quite wide in phenomenography since there are no clear guidelines on conducting a phenomenographic research, but more about the reliability and validity will be discussed in chapter seven.

5 The Research Implementation

In this chapter the whole workflow and phases of the research are covered on a level of depth that describes what was done during each phase (see Figure 9). This chapter however will not go as deep in to analysing the findings as chapter six. There are two chapters named as analysis chapters, but in these sections only the way of analysis is described and the more in-depth analysis in the form of presenting the results will be gone over in chapter six. As mentioned in the previous chapter describing the various workflow possibilities of a phenomenographic research, there are more than one way to conduct the research.

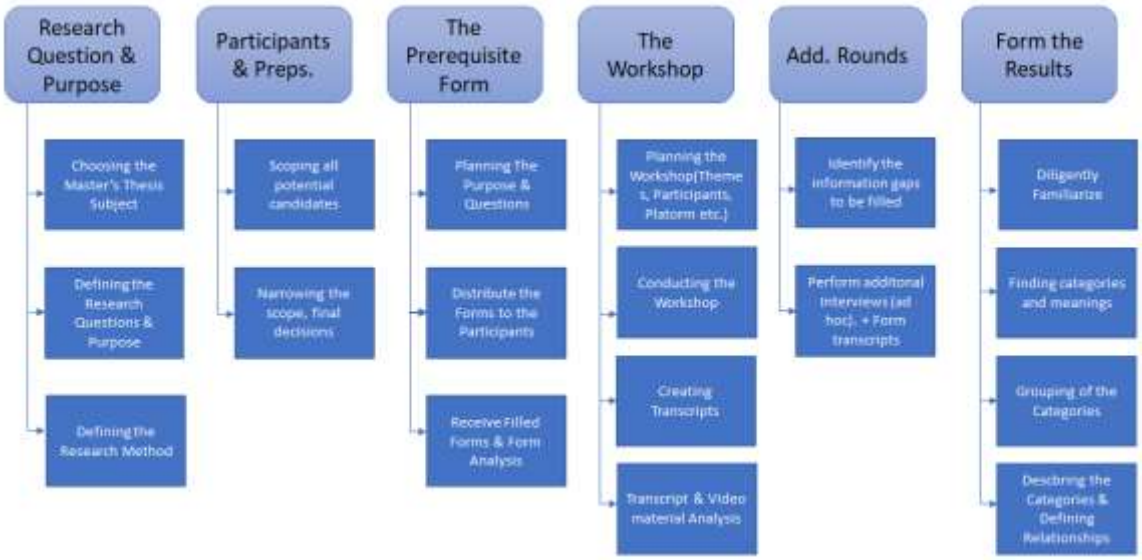


Figure 9 - The Research Implementation Workflow

This is also the reason why it is in the authors opinion mandatory to detail the phases of the research, starting from the preparations, describing even the smallest details along the way and being diligent to the general idea behind the spirit of phenomenography which directs the researcher to develop the research and potentially change the approach angle when deemed necessary.

The research in question is the authors first attempt at phenomenography and thus rigorous studying of the research method and works conducted using phenomenography was the first phase before even beginning to formalize and visualize the research in question here. The general idea of what the author wanted to research was present since day one, but the idea to conduct research using phenomenography materialized during the conversations with the master's thesis curator.

To reach the answer to the question, what would be the optimal research method to answer this research question two methods were weighed. Phenomenography being the chosen method and futurology being left out as the not as optimal research method. It was decided that phenomenography would suffice as to provide exactly the right tools and the format to conduct the research optimally and within the limits of a master's thesis, and that the essence of phenomenography which is to study the perceptions and feelings of the participants around a certain phenomenon is exactly what is wanted from this research. As described in the chapter four about the research method, phenomenography serves a certain, very specific purpose and after careful and thorough analysis it was established that the purpose of the research method and the purpose of this research were perfectly aligned.

5.1 Research Question & Purpose

As mentioned in the introduction to this master's thesis the research question on a broad level is:

1 What are the effects on technological efficiency within the European Union area when the European Central Bank issues the Central Bank governed Digital Currency?

Since the digital Euro or any Central Bank Digital Currency has not been officially launched so far, the answer will be pursued through phenomenographic research and category analysis. The main level research question should also be divided to comprehend other factors besides technological effects and efficiency, because the goal of the

research is to paint a view of the future that has a Central Bank Digital Currency issued and the effects most likely will not be restricted to only technological efficiency. That is why side-effects and by-product effects of effects on technological efficiency will be included in the view of the future. The second level research questions are:

2. Which technological decisions would provide the most (and the least) efficiency for the European population?

3. Could the technological efficiency of a Central Bank Digital Currency have other effects for the European population?

And the output that should answer the research questions is the outcome space generated by the analysis of the gathered materials that in the end will provide a view of the future according to the expert's perceptions on Central Bank Digital Currency focused on the European Union area. Therefore, it can be argued that the actual research question could be: "How does the future look like, after the issuing of a Central Bank Digital Currency in Europe".

The predetermined metrics for measuring efficiency were chosen to be payment reliability, payment speed, cross-border payment speed, computing power need, cost efficiency, and energy efficiency. It is important to recognize though, the essence of phenomenography in this case and accept that phenomenographic research advances in stages and as Maarit Kalliomäki mentions "each phase of the research has an effect on the future selections" (Kalliomäki 2012).

Keeping this in mind it is completely plausible that the metrics will change, since the objective is to answer the research question through the perceptions of the experts and according to what the experts think are the attributes related to the word's efficiency and technological efficiency.

It is also likely that alternative directions for the research will be discovered when analysing the gathered materials and interviewing the experts, but the sole objective is to study and analyse what do the experts of the field think the future of financial technology and digital payments looks like after the launch of a central bank digital currency and what are the concrete effects on technological efficiency.

It must also be mentioned that for the sake of a naturally flowing conversation and knowing the technological competence of the experts it is unlikely but not impossible that the conversation will move towards handling engineering level concepts, such as talking about the actual technological components of hardware or detailed protocols. But if the research should naturally flow in that direction the author will not resist the direction.

The purpose of the research is to provide valuable information for the reader and more importantly for the developers of any Central Bank Digital Currency. The field of research is relatively fresh since the concept and possibilities of a Central Bank Digital Currency keeps evolving with time and along the constant technological development.

The subject has previously been researched mostly in the fashion of what hopes, requirements and demands different entities have of a Central Bank Digital Currency, but so far, no such study or survey has been made where the questions are open, and non-leading and the focus is solely on the honest feelings and perceptions of the answerers. This sort of research should reveal the honest emotions and perceptions of the people involved and should provide more unbiased results than research conducted by the European Central Bank (ECB – Questionnaire on a digital euro 2021).

Since the research method is phenomenography and of the key characteristics of the interviews conducted according to the method is openness and non-leading forms of questions, all the hopes, probability estimates, fears, challenges, opportunities, and so forth should appear naturally and unforced in the interviews. That alone provides valuable information to anyone linked or working with central bank digital currencies, since

no such research where the “answers” that are provided are gathered in an unforced and undirected fashion exist at the moment, and that is one of the main justifications for this research.

5.2 Participants & Preparations

With the research question and the purpose of the research defined the next problem to solve was to find the right participants for the research. The participants would have to have some baseline knowledge about the subject for the subject cannot subjectively be considered to be an everyday talking point, of which the common person would necessarily have sufficient knowledge of. Since the author of the master’s thesis has been working in the financial sector for around 8 years and made contacts within the industry, the task of finding people knowledgeable was not a major hurdle. But what had to be considered was the variety of the participants still, for if the participants were to be chosen only from positions focusing only on FX or digitalization, there laid a risk of over saturation in the answers the participants could or would provide. That’s why a brief, undocumented elimination round was done to ensure that all sorts of professional areas and viewpoints within the financial and IT industry were covered, or sufficiently covered in a way that there would be no apparent holes in the reliability and validity of the research findings.

In total twelve (12) potential candidates were considered as a final participant to the study, out of which five (5) were chosen as the final participants. The choices were made on the basis that, even though more than five participants had sufficient knowledge about the subject; Central Bank Digital Currencies, Fintech and digital payments, there was an oversupply of candidates with similar professional background and current professional position. That is why the final selection pinpointed in the five (5) participants, for each of the participants had diverse professional background in the general area that suits the subject of the research and none of the participants were working in similar professions at the time of the research. (see Table 1).

Table 1 - The Final Participants, Gender and Professional Background

Participant	Gender	Professional Background
A1	m	Insurances
B2	m	Digital Payments
C3	m	Anti-Money Laundering
D4	m	E-Commerce
F5	m	IT

After the final participants were chosen a written document of consent was signed between the author and the participants stating the consent of the participants to allow the use of anonymised personal information such as age, gender, professional background, and competency to be used in the writing of the master's thesis and conduction of the research. In addition to the basic information, the consent agreement also allowed the use of all materials gathered in the interview sessions, workshops and any written interview forms that were to be used in the master's thesis. The planning and communication with the participants in first phases were done via Microsoft Teams and WhatsApp applications.

To briefly introduce the background of the participants, starting from here called as "the experts". Expert A1 has a master's in economics degree and has close to ten years' worth of working experience within different areas of the financial and Insurances sectors within the European Union. Expert B2 has a bachelor's degree in financing and is currently finishing his master's degree studies. Expert B2 has a thorough senior level work experience within the financial field in mobile and digital payments. Expert C3 has a master's degree in international business administration and is currently working in a senior position among the field of Anti-Money Laundering. Expert C3 also has a noticeable professional background in corporate banking in the financial sector. Expert D4 has bachelor's degree in e-commerce and is currently working in a senior position in an e-commerce company. Expert D4 has entrepreneurial background as well as working in developing payment options for online stores. Expert F5 has a bachelor's degree in information technology and has a long history in entrepreneurship and working in the IT field

as a software engineer. Expert F5's expertise lies on the technical and IT side of the subject.

5.3 The Prerequisite Form

With the final participants chosen the method of using a prerequisite form was chosen by the researcher. As Tuomi and Sarajärvi mentions, the written form of interview is a non-corresponsive form of interviewing (Tuomi & Sarajärvi 2018, 85), and that is why the prerequisite form was not the only form of interview. The prerequisite form was conducted and chosen to be used to get an initial starting point to the research and more importantly to start performing the first analysis rounds from which the conducting of the theme interviews or workshops could be done.

The idea of the prerequisite form followed the guidelines of phenomenography in the way the questions were asked, meaning that the questions were all open questions and the researcher made sure that no leading or own perceptions could be determined from the questions. Because there was no correspondence, the prerequisite form had with it a set of instructions to make sure the participants would not for example start to google or search answers to any questions. By this the researcher wanted to make sure that the answers would be 100% the experts own perceptions and ideas, rather than someone else's. The Instructions were as follows:

> *« Please answer the questions based on your current experience and impression, try to avoid using google or other search engines for outside opinions. The answers should reflect your thinking, not someone else's. »*
>
> *« Note that the size of the answer fields is not static, please feel free to write as long or short answers as you please. »*
>
> *« Please note that some questions are about CBDC in general, whereas some questions are about digital Euro. »*
>
> *« Try to be thoughtful and even speculative in your answers, in the final thesis work all answers are anonymous. This is not a test; it should represent the flow of your mind as filter free as possible. » (Prerequisite Form : Instructions).*

The prerequisite form consisted of twenty-five questions out of which questions 1- 3 focused on the expert and the experts background. Although the background of each expert was previously somewhat known to the researcher, it was vital to have the information in written form for the latter analysis of the material. Through the first questions the educational and professional background as well as a self-estimation of the competence of the experts on financial technology and digital payments was achieved. This theme would be continued later in the interviews, for it could provide validity and reliability points for the final analysis of the future view created in the research.

Questions 4 – 8 focused on the usage of and habits of usage concerning digital payment methods and financial technology of the experts. The objective for these questions was to fish for the perceptions on technological advancements and the level of improvement or lack of improvement that the experts felt through their own use of digital payments within the last 10 or so years. The way the questions were set did not direct the experts to any direction, rather allowed to experts to answer as broadly or narrowly as they wished on how and how often and which methods of digital payments do they use.

Questions 9 – 11 focused on the feel around historical trends and developments in the financial technology field that the experts have and for the case of the research most importantly question 9 asked the experts to define efficiency in their own words. This was important for the purpose of the research was not to provide the experts a definition of efficiency, but rather to have the experts express what efficiency is to them in the field of financial technology and digital payments. The following questions also aimed to take a grasp on the feelings of the experts on efficiency in the way that would elaborate is efficiency always good, could be it be negative, or are there cases where efficiency could be considered neutral. Although it must be mentioned that these concepts rose only at the analysis phase.

Questions 12 – 14 focused broadly on the general perceptions that the experts have concerning central bank digital currencies and digital euro, as well as cryptocurrencies and stable coins. The aim of the questions and why there was a separate question for each form of digital currency in the prerequisite form was to try and see if the exerts felt there were similarities and differences between the different digital entities. The answers after analysis could provide useful talking points for the theme interview/workshop to follow.

Questions 15 – 18 focused particularly on the digital euro through different viewpoints such as Efficiency, Opportunities, Challenges, Threats, Data, Privacy and Technology. Although it must be mentioned that the viewpoints mentioned, were not given to the experts, rather the researcher wished that the experts would ponder on these aspects when answering. For example, question 15 asks the experts “In your opinion, describe the optimal digital currency for Europe?”. If the expert is thorough in his/her answer, all the viewpoints could be present and observable for the researcher.

The same viewpoint type of focus was applied for questions 19 – 24 concerning central bank digital currencies in general with the view directed to the future. By the statement that the questions were directed to the future what is meant, is that the questions asked for estimates, predictions of what entities could be affected, what kind of demographics could be affected and how, what kind of technological effects might take in place and how could the future look like when compared to the current situation. In the questions the researcher carefully avoided directing the questions to any single type of an answer and kept the possibility open for the future to not necessarily be more efficient and/or positive. The answers proofed to be surprisingly diverse since the experts were given the chance to define efficiency in their own terms.

The experts were given 10 days to answer the prerequisite form and all the experts managed to submit the filled-out form in time. After the filled-out forms were returned to the researcher the workshop Microsoft Teams session was scheduled for the 20th of

December at 17:15. That timetable would leave the researcher a little over a week to get familiar with the first set of gathered material and start recognizing the first initial themes and potential categories.

During the analysis of the prerequisite forms the first meanings and the potential categories started to surface. Perceptions and concepts around themes such as attributes of efficiency, probabilities, challenges, opportunities, and personal usage were some of the most easily noticeable themes. As mentioned earlier there were five experts that answered the questions on the prerequisite form.

In the analysis of the prerequisite forms all the answers from every expert were gathered in to one document to have all five answers under the same question to ease the analysis and the recognition of themes in the answers. A word cloud was also generated to get a simple overview on which words were used most often, in other terms called a word analysis, which is not the main direction or method of analysis for this thesis (see Figure 10). Nevertheless, this strategy was chosen as a mean to create extra depth and to identify some top or subcategories.

Figure 10 - The word cloud of the prerequisite forms (Created in Atlas.ti 22)

The objective for the analysis at this stage is to find similarities and differences in the gathered material and recognize the underlying perceptions and themes in the material. As mentioned earlier the themes in this case do not consist of just one word or a separate idea but rather the broader opinion or feeling behind one or multiple answers, that the researcher is tasked with to identify. Based on these broader perceptions and feelings the first theories can also be formed and then further refined.

5.4 The Workshop

The Interview or in other terms the workshop was held on December the 20th at 17:15 via Microsoft Teams application with each participant having their webcam on for observing facial signals. The interview was conducted in a semi-structured fashion and as described by Fauvelle and stated in the earlier chapter: The key characteristic of a semi-structured interview is that the themes have been prechosen and written down in for example bullet points, but the conversation itself is mostly open formed and does not necessarily follow a tightly planned order (Fauvelle 2020). It was also in the case of this theme interview, that some talking points that had been derived from the prerequisite forms were written down and it was essential that all talking points were to be handled, but the order was not predetermined.

There were three main themes chosen for the workshop that would either concentrate on deepening the answers on the prerequisite form or then aiming to gather information not available via the prerequisite forms. The first theme concentrated on the Personal and General usage of digital payments and financial technology, the second theme concentrated on the evolution and the feel around the evolution of financial technology, and the last theme concentrated on the future of financial technology, efficiency (as determined by the experts) and probabilities. The themes and some supporting questions had been written down on a Microsoft Word document that was only visible for the author.

The participants for the workshop were Expert A1, B2 and C3. D4 and F5 were not included for according to the initial discussions and the prerequisite form the answers provided by them starting to show signs of saturation before the end of the answer form. The author also estimated that via Microsoft Teams the optimal number of participants should not be over three to be able to have an open, freely flowing conversation instead of having separate monologues.

The workshop was recorded using the recording feature of Microsoft Teams and the mp4. file of the recording was saved from the SharePoint cloud on to the author's hard drive right after the session had ended. The total runtime of the recording was 1 hour 54 minutes and 15 seconds. The workshop was held in English to ease the transcription process for which a speech to text/subtitle generator application was used. The transcriptions were inspected and corrected by the author and the workshop resulted in a transcript document consisting of 36 pages, 13,701 words and 69,028 characters including fillers such as: uhm, oh, hmm.

The analysis of the workshop materials consisted of listening to the recording multiple times, while proofreading and writing the transcripts and making sure that the possible errors made by the subtitle generating application were corrected. After the final corrections of the transcript, the transcript was read and analysed carefully while simultaneously picking out perceptions, sentences and correspondences that were related to the initial themes from the prerequisite form or made into new previously non recognized themes.

The discussion around the first theme of personal and general usage of digital payments and financial technology held the purpose of getting a grasp without directly asking of the perception of the experts on the historical advancements and development of the two subjects. This was vital in order to get an honest opinion on which developments previously had been experienced as the most significant ones and to have the experts openly name the most significant attributes of development or efficiency in their

personal use. The conversation also touched on the subjects of security and handled different payment and transaction forms starting from cash, credit/debit cards and ending in various forms of digital transaction methods such as mobile payments, bank transfers and wearable payments.

The other motivations for the first theme of the workshop were to grasp the feelings and conceptions of the expert's own usage and see how the expert's proportion themselves to the general population in terms of usage, efficiency, and user experience level. Naturally it goes without saying that the experts represented the more qualified section of the user base based on their own valuation.

In the second theme of the workshop the discussion hovered around the subject of development of financial technology and digital payments and the first mentions of centralized digital currencies were made. This section of the workshop was particularly useful since the researcher had little role to play in curating the discussions, since the experts held long conversations about the different aspects and possibilities and outcomes of the future developments. Such factors as risks, side-effects, opportunities, alternatives, and more were discussed and interestingly the conversation also took a side path to mapping out the different types of outcomes of the future depending on the technological implementation choices for a Digital Euro. This provided important material for the results of the research since it was established that the technological implementation and the inclusiveness of the development will have a significant effect on the future view.

The conversation in the workshop effortlessly progressed into the final theme which solely concentrated not only on the future of financial technology and digital payments and the efficiency attributes but also the future of Central Bank Digital Currency. Some key factors that would in the expert's opinion determine the path and the outcome were identified and for good measure there was no noticeable saturation in the opinions. The workshop ended with discussions on probability and likeliness where the experts had

different opinions on factors such as timeframe, likeliness, and confidence behind the answers.

During the discussions in the workshop, it also became apparent that the effects of a Central Bank Digital Currency were not all directly linked to technological efficiency even though that is the main research question in the master's thesis. Therefore, through the conversation held in the workshop and through the vigorous analysis of the gathered material it was obvious that effects other than the technological ones must also be mentioned in the results of the research. The reasoning behind the realisation is that such phenomena were recognized in the workshop where the Central Bank Digital Currency has an effect on technological efficiency attribute "X" and then the effect on attribute "X" has further effect on non-technological efficiency attribute "Y", in such a concrete way that it cannot be mis included from the overall formed view of the future since the effect is high in significance.

One example of the train of effects as mentioned in the previous paragraph was spotted from a conversation between expert A1 and expert B2, when pondering on the technological hierarchy choices for the European Central Bank concerning the Digital Euro. To provide a background for the conversation, there was talks about whether the European Central Bank would include third party service providers from the payment infrastructure of the digital Euro, in somewhat similar fashion that Riksbank had done with the E-Krona. Therefore, it was interesting to observe the effects of both ways of implementation, with and without the third-party service providers assistance.

The experts were quite certain that efficiency and technology wise it would be a much better option for the European Central Bank to include third party service providers as it would not only have a positive effect on technological efficiency but also it would have other beneficial effects such as the likely increase in jobs available, more diversified risks for system failures among others. But when discussing about the possibility of

centralising the technology of payment infrastructure only for the European Central Bank the experts had many concerns:

> *Expert A1: « …why would they want to keep it just by themselves? Okay, well it does give control over the amount of money in circulation, and you can let's say limit the payment transactions to different areas… so it's (control) very valuable in that regard »*

The conversation progressed in finding motives and effects in the case of European Central Bank having full control of the Digital Euro infrastructure and what other effects besides technological ones that scenario could have and it resulted into multiple viable and interesting theories such as effects on credit expansion, monetary policy, grey economy, and political power. Therefore, some of these theories must be included in the final analysis and results of the research as they are a part of the view of the future and can be considered as by-products of an effect for technological efficiency.

5.5 Additional Round of Interviews

Due to the diversity of the discussions held in the initial workshop and due to the fact that there might be alternative views of the future possible to be created out of the experts' perceptions, it was found vital to further pursue some of the themes and concepts that rose from the analysis of the prerequisite forms and workshop transcripts. Therefore, an additional round of interviews was held, this time one on one with the expert and the researcher.

The one-on-one small-scale interviews were held also held using Microsoft Teams software and in the case of expert C3 a WhatsApp video call, which could not at the time of the interview be recorded, so only a summarized transcript could be created out of the call. The decision to have an additional round of interviews was also made because some of the themes that were recognized in the workshops did not particularly appear in the prerequisite form materials and therefore the researcher thought it would be beneficial for the research to also interview the experts D4 and F5 for those themes.

In the additional interviews the focus was more on the topics of technological implementation and the role of the private sector in the administration of the currencies and the payment infrastructure, as well as some topics concerning monetary policies and political effects. Out the previously mentioned topics the latter was one of which's appearance in the initial discussions was not anticipated by the researcher but quickly recognized as a vital piece of the outcome space. Concerning the technological and infrastructure topics it was found important to interview the expert F5 since expert F5 had significantly the most experience in information technology and programming.

The additional round provided valuable information to fill some of the gaps and answer some of the questions that remained open until this point of the research, and it was also found that including the two experts that did not attend the workshop provided important additional perceptions for the generation of the research results and the vies of the future.

To summarize, the material gathering consisted of three separate phases which were: the prerequisite form that included all five experts, the workshop/interview which included three experts valued to provide the most significant results based on their diversity of expertise, and the additional round of interviews. The three rounds took place within a timespan of two months, using mostly Microsoft Teams and WhatsApp applications, and produced somewhat 35 pages of material in Microsoft Word and Six hours of recorded materials in mp4 format. For later analysis on the research results the three sessions were named as: PF, WI, and AI as the table below demonstrates (see Table 2).

Table 2 - The Material Gathering and Participants

Participants / Experts	Prerequisite Forms (PF)	Workshop/Theme Interview (WI)	Additonal Round of interviews (AI)
A1	Participated	Participated	Participated
B2	Participated	Participated	Did Not Participate
C3	Participated	Participated	Did Not Participate
D4	Participated	Did Not Participate	Participated
F5	Participated	Did Not Participate	Participated

6 The Research Results

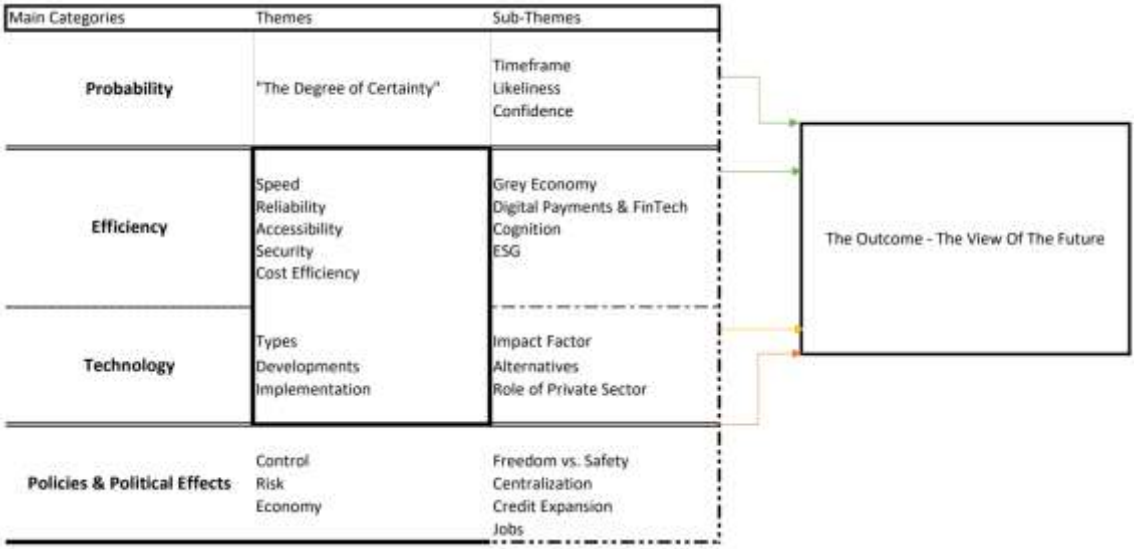
In this chapter the results of the research are represented, keeping in mind that the results for this research include not only the categories and relationships identified from the gathered materials during the analysis process, but also the outcome space (see Table 3) which in the case of this research is also named “The View of the Future”. Both of these results are to answer the research questions. In the analysis phase four distinct main categories were recognized that all include a set of sub-categories and have relationships with one another. To form the categories the emphasis was made on not only focusing on individual experiences of the participants, but rather the collective perceptions and feelings around identified phenomena. As mentioned earlier the material gathering process was three legged including the prerequisite forms, workshop interviews and the additional round of interviews, so some phenomena have been revisited and some mentioned once in all of the rounds combined.

The first sub-chapters of the research results chapter will focus on the main categories and will utilize direct and indirect quotes from the gathered materials to emphasize and justify the validity of the categories. The quotes that are used in all sub-chapters will also include markings that indicate by which expert and during which session the remark was made. These first sub-chapters are the ones that aim to answer the main research question of what the effects on technological efficiency could be from, and around the issuing of a Central Bank Digital Currency in the European Union area. The structure of the sub-chapters aim to build a comprehensive understanding of the experts’ perceptions while describing the relationships between the different categories, starting with describing the identified tool “Degree of certainty” before moving to the definition of efficiency, and moving forwards to the perceived effects on technological efficiency.

The first of the last two sub-chapters of the research results chapter aim to answer the secondary research questions which ask; which technological decisions would provide the most and least efficiency and if there are any other significant side-effects other than the ones that effect technological efficiency, what are they. The final sub-chapter of the

two is focused on directly painting the view of the future. The View of the future is the collective phenomenographic result of the research and it demonstrates what the view of the future is going to be like according to the perceptions of the experts when focusing on the subjects and categories under observation in this research. It is to be noted that not all perceptions of the experts were unanimous, so the view of the future is a product that includes the most likely aspects that have been described with the highest level of confidence. It is to be noted that the View of the future is a narrowed down summary of the most likely scenario according to the perceptions of the experts involved in the research, and the broader universe with alternative end results is described in the chapters before the view of the future chapter.

Table 3 - The Outcome Space/Main Categories



6.1 Central Bank Digital Currency & Effects on Technological Efficiency

In the forthcoming the chapter the research results about the main technological effects on efficiency related to Central Bank Digital Currency will be reviewed. The structure of the chapter will follow the outcome space presented in the table 3 above, starting with the probability category and ending the policies and political effects which offers a suitable transition to chapter 6.2. that handles the side-effects.

6.1.1 Degree of Certainty

As an additional tool for the whole of the research results, in the analysis process a factor called; a degree of certainty was identified. The degree of certainty was derived from the quotes, comments, and facial expressions of the experts. On certain topics the comments of the experts included adverbs such as maybe, perhaps, could, and might, whereas other comments were more direct. A clear difference between comments was recognized even though the comments identified as high in the degree of certainty might have not included words such as certainly, for sure, etc. The level of certainty could be sensed through the comments or "between the lines", and from the non-flinching facial expressions of the experts. Therefore, as an additional aid for the researcher when analysing the certainty of perceptions and feelings, the careful analysis of terminology and physical language offered assistance.

The degree of certainty was identified to have different values, although a simple "zero to one hundred" scale was not implemented. The degree of certainty could be deducted as mentioned earlier from the words chosen, body language and the pace or quickness of the answer. Therefore, the degrees of certainty of a perception or estimation could range from: guessing and educated guessing to valid deduction and further to almost certain statement. The degree of certainty was not assessed much further than that, but through the analysis of the gathered material it can be concluded that what effects the degree of certainty is the base experience and the sum of experience of multiple areas of expertise and the overall predictability of a future scenario and the timeframe of how far into the future are the perceptions or estimations directed to.

6.1.2 What is Efficiency

It must be established that in order to start answering the research question of the master's thesis "What are the effects on technological efficiency within the European Union area when the European Central Bank issues the Central Bank governed Digital Currency?" it needed to be well defined what the research participants, the experts think

efficiency and technological efficiency is. Then and only then can the comparisons be made to the dictionary definitions of efficiency and technological efficiency and review the potential effects that a centrally governed digital currency could have within the European union area.

So, one of the first perceptions that needed to be grasped from the experts was that how do the experts see efficiency? What efficiency actually is according to the experts, what attributes do the experts link with efficiency and what is the overall feeling of efficiency. Is efficiency always positive or could it also be neutral or even negative, and does technological advancements always enhance efficiency. The answers to these questions were sought with indirect questions when surveying about the background of the experts and their own personal usage of digital payments and financial technology, as well as a natural result of the progression of the discussion towards the topics of efficiency and technology.

As mentioned in the chapter 3 Applications of the theory, efficiency is measured by the ratio of useful output to input. Efficiency as a phenomenon as it was experienced by the experts quite strongly was linked to attributes concerning ease of use when it came to technological and financial aspects. Throughout the conversations concerning personal usage of financial technology and digital payments as well as the historical trends in personal usage, the most recognised themes were tightly linked to the same attributes and perceptions around the direct answers to the question; what efficiency is. That would emphasise the finding that the subconscious perceptions of technological efficiency were relatively identical to the conscious perceptions of efficiency. The dictionary definition criteria for efficiency would also be fulfilled in many of the perceptions of the experts, stating that the figurative output would improve as a result of the input of which there would be required less of in the future. The phenomenon applies for both the subconscious, and conscious perceptions of efficiency of the experts. Both were close to the Merriam-Webster definition of efficiency:

> *"Essential Meaning of efficiency: the ability to do something or produce something without wasting materials, time, or energy: the quality or degree of being efficient. Because of her efficiency, we got all the work done in a few hours.*
> *The factory was operating at peak efficiency." (Merriam-Webster 2022).*

Subconscious attributes linked to efficiency rose from the discussions around the personal usage of digital payments and financial technology, and one phenomenon that was common for all the experts was the habit of using less cash now compared to how much cash was used a decade ago. The phenomenon turned out to be a useful comparison in order to ponder what attributes in efficiency are appreciated and how the increase of efficiency changes the behaviour of the consumers. This theme that rose from the cash usage also provided a looking glass into the technological advancements and developments concerning payment technology.

> *« I use cash very rarely. Mobile Payments and card payments have increased drastically. Foreign payments are easier to make straight from the bank account or by using different payment providers. No need to make bill payments from payment machines or by using cash at the teller » (Expert C3 – PF)*

> *« Before the P2P payment were done only using cash and now only using mobile payments. Today, I also use digital payment methods (Google Pay or Garmin Pay) in in-store payments, whereas before it was cash or card transaction. » (Expert B2 – PF)*

The reasons behind the changes in personal usage can be linked directly to the amount or rate of efficiency in the payment processes felt. Therefore, as a result of the queries around personal usage and the background it can be confidently stated that attributes such as: ease of use, speed and accessibility can be linked to efficiency and the effect of increased efficiency in payment methods and technological capabilities can be interpreted to result in increases of usage and the amount positiveness felt.

The recognised cases when the usage diverts back to cash, in other words less efficient methods of payments were all the types of scenarios where more sophisticated digital methods were not available. These types of cases were mostly when traveling abroad to

a region that does not have the same level of coverage in digital platform availability than in Finland, or if a service provider does not accept any other form of payment other than cash, though those types of cases were recognised to be diminishing in occurrences. This would also indicate that accessibility is a sub-category of efficiency when it comes digital payments, and therefore digital currencies and the technology. It can be interpreted that the better the accessibility, the more efficient the payments are, and the effect on the ease of use is positive.

> *« …for example, there was this one place last month(in Germany) and they were demanding me to buy something for worth 18 euros until they accept card which is ridiculous in my opinion but you know that's their business » (Expert A1 – WI)*

> *« …when I go to Kosovo there are no payment terminals, so you always have to use cash. and we can say that it is a developing country, so the infrastructure for paying digitally is very bad, so basically cash is the only way » (Expert C3 – WI)*

The discussion around the personal usage and changes in personal usage was rounded up around the perceptions of quality of enhanced efficiency and development in general. At this stage it was well established that efficiency as defined by the experts at least effected the personal usage of the experts and in theory, the public in general. It was also found that generally the more efficient the payment method possibilities are, the more positive the overall experience around a payment, transaction or happening is. All this emphasises the quality “ease of use” which as a concept surfaced numerous times when discussing about efficiency. Efficiency was also observed from all angles to define whether there could be any net neutral or negative aspects efficiency. The discussion naturally progressed in how the experts would define efficiency consciously and what is their perception of efficiency.

> *« ...Speed, ease, safety and traceability. Traceability means that personal financial management is easier compared to e.g. cash payments. Actually, there’s no things that I depreciate in the development of digital payments. » (Expert B2 – PF)*

> *« The easiness of making transactions and payments nearly from everywhere and with several different means. Cost effective, time effective and easiness to make payments/transactions in a secure manner. I believe efficiency to be a good thing for most of the people who are capable of absorbing new technologies and are capable of using them properly. »(Expert C3 – PF)*

Speed and cost efficiency were identified among others as key factors that increase the positiveness felt by the experts when it comes to overall feeling something is efficient. When comparing the speed of transactions, a decade ago versus currently the difference was noticeable even when it comes to domestic bank account transfers. It was also noted that even though the speed efficiency of transactions has improved, yet still not all transactions today are instantaneous, for example cross border payments and some interbank transactions that occur around the weekends. In the corporate and institution level the observation was made that the likely future increase in speed efficiency is likely to reduce the amount factoring services needed for large companies and is also likely to improve the liquidity of companies, since the share of receivables not received should be decreased due to the pace of transactions. The experts were quite unanimous about the perception that the speed of transactions could very well improve alongside the issuing of a Central Bank Digital Currency, due to technological simplification and thus efficiency.

> *« Overall, digital payments are already very fast and reliable in general. Something CBDC could bring to the equation is that maybe the ledger of transactions on a waitlist to be processed could disappear and all transactions could happen immediately. »(Expert A1 – PF)*

In general, the overall perception among the experts was in a nutshell that being efficient and efficiency in general is a net positive when it comes technological advancements and the benefit of their own personal usage and the usage of the public in general. There was a feel that when payments, settlements and clearances become faster, more reliable and more cost efficient there are more benefactors to the positive developments than there are those who do not benefit of the progress, but it must be mentioned that not all felt that all progress in improved efficiency is only positive.

6.1.3 Perceptions on Accessibility, Security & Cognition

As expert C3 mentioned (quote p. 78) the efficiency benefits those who are capable of absorbing new technologies, and as also mentioned earlier by C3; the accessibility of the required technology to run the modern, more efficient forms of payments is not at the same level in all regions, even within the European Union area. It was also discussed that how does security link to efficiency and even though technically and technology wise it was found that the modern, more efficient methods are more secure than cash when it comes to occurrences such as storing cash, transferring cash and the odd chance of robbery:

> *« cash payments are safe within the payment, but after that it's not necessarily so safe. The hardware store of my fathers was robbed… so it(cash) is definitely not the safer option for the company… it's also quite expensive to store the cash and to put it to the bank and to have somebody to pick the cash »(Expert A1 – WI)*

It can also be said that the enhanced efficiency with attributes such as ease of use and accessibility can also act as security risk when it comes to fraud, scams, and phishing, but in those cases as previously mentioned the technology itself is more secure and usually the weakest link was felt to be the person being scammed. Therefore, the conclusions would be that efficiency in the case of security creates more opportunities for the malicious actors when compared to cash for example, especially within the act of transactions and payments. That aspect along with the previously mentioned factors help to define that efficiency, even though generally perceived to be a net positive, is not necessarily only positive and that there are aspects that fall under negative effects.

> *« The issue of not understanding how digital payment services work often puts people at risk of being victims of fraud. There are plenty of scams on the internet and people give way too often passwords for bank identification, card's pin codes and other sensitive information to the wrong sites/thiefs. Also not understanding different investment scams is a huge problem in nowadays Finnish society. The fact of digital payments being efficient enables funds to move extremely fast internationally, which then makes it harder to trace the funds and to catch the criminals. In addition, several people do not lose just their own money, but often also take*

quick loans which nowadays can be accepted and the funds are available within hours. Thus, it sometimes feels that technology has advanced too fast for certain groups of population. It is probably not the fault of technology, but rather the education of the population. »(Expert C3 – PF)

Despite the recognition of increased efficiency having effects on the security, overall the perception of the experts pointed towards suggesting that more modern, more efficient solutions offer better state of security technology wise. Especially when observing security throughout the entire lifespan of a transaction and storage of a unit of currency. Another important aspect that was felt increased security in the more efficient methods was the traceability of assets, which was felt is next non-existent in cash for example. It was also perceived that the launch of a Central Bank Digital Currency should act as a factor that further develops the security of digital payment and holding methods. It was seen that the funding behind the development and the motivation to create the most secure digital option for the largest possible demographic are two major factors that would improve the technological efficiency, security wise in the near future.

Among the discussions the phenomenon of spending tendencies and frequencies rose as well, and it was recognised by most of the experts that if a payment method is efficient in the terms that it is easy to use and fast to make the actual transaction, it could have an effect on the spending of the people. First the phenomenon was recognised in the personal usage of the experts when describing for example monthly reoccurring payments and entertainment spending. And when the question was broadened to the level of the public in general some psychological effects of spending in general were made which supported the hypothesis that spending, and overspending is easier when the psychological pain experienced because of spending is shorter in time.

« if you're for example night out or something then if it's only cash that is accepted then probably I wouldn't buy another drink if I don't have cash and it's it requires me to go to ATM and come back so probably these cases»(Expert C3 – WI)

« spending money does have a mental effect. it's a short, like a small amount of pain or mental pain that occurs to people when they are paying or they are using money so basically the less they have to think about it it's certainly easier to spend when you don't have to think about it that much. let's say we buy something online

> *and we're also going to have to confirm the card payment by logging into mobile bank, so if it was just a one click you have your card there saved already and you just click. that's it, it's mentally easier to spend money if you don't have to think about it » (Expert A1 – WI)*

Therefore, it can be argued that increased efficiency as defined by the experts could potentially increase spending in general and whether that effect is interpreted as positive, or negative is up to the angle of inspection. On the other hand, it might have a negative effect in the way that it might cause overspending, meaning that people could spend over their budget, but it could also mean increased revenues for companies in general which then again could have positive effects for the owners, employees, and shareholders of the companies. Either it was found that with efficiency even though the technological security is most likely improved, the cognitive effects efficiency brings can alter from improving to deteriorating through hackability and lower experienced pain of using money.

To summarize, the perspectives around efficiency attributes such as speed, reliability, accessibility, security, cost, and general ease of use were recognized as the key factors and metrics when it comes to efficiency. Interesting observation about the metrics is that all the metrics are quantitative and non-qualitative, except the ease of use. A general observation about the perceptions of efficiency is that it was felt that just by improving each of the metrics, it would not necessarily improve the overall positivity of perceptions around efficiency, rather almost each metric had its up-and downside effects while improving efficiency. It was also noted that not all of the potential improvements of efficiency occurred due to the development of technology and that there were other factors that would improve efficiency, such as cost efficiency which although made possible with efficient technology and the development of technology, also is made possible due to other factors such as avoidance of monopolies and having fair competition status in the markets.

So, the effect that all experts were unanimous about is the assumption that the speed of transactions will improve due to the issuing of a central bank digital currency within

the European Union area. The arguments for why there is a unanimous assumption for the speed to be improved were diverse. While others argued that the overall technological trends would drive the development towards even faster and faster transactions, some argued that the centralization and the fact that there would be less actors performing settlements and clearances could be the main driver for the speed in the future. None of the experts felt like there could be a decline in speed when it comes to technological efficiency but as mentioned before, there are other factors that may be caused because of the improvements in speed that can be interpreted to increase some negative aspects such as risks and security.

> *« In the future, I assume that the payments/transactions will be even faster as they are now. Most likely immediate, even across the globe. In this way the funds will move from one to another immediately, and they are further exposable. Companies will have their receivables faster, thus may probably need less financial liquidity from the traditional banks. » (Expert C3 – PF)*

> *« Payments will be made more and more in real-time »(Expert B2 – PF)*

> *« In the future, I think there will be a very centralized system around a few CBDCs that are issued by the most significant central banks in the world. The payments will be instant and mostly done via wearables when paying in person and via instant online payments when paying online. »(Expert A1 – PF)*

This perception of the experts can be seen to be directly in line with the historical trends in financial technology as mentioned in the third chapter. As demonstrated in the research by Arner, Barberis & Buckley one of the key elements of improvement in the history of financial technology development has been the increasement of the speed of transactions, which according to them was exponentially accelerated through digitalization of payment infrastructures. The expert's perception indicates that there is a strong belief that the development will lead to the same direction, although given the fact that the experts feel that the speed is already at a very high and efficient rate the development can not be judged to be as drastic as the founding of the Fedwire was for example.

6.1.4 The Method of Implementation & Effect on Certainty

As mentioned earlier the degree of certainty is a tool created in the analysis process to assist in identifying subtle differences in perceptions. The initial use for the tool was to assist in the creation of the "The Future View", but it can be used for assistance in case-by-case examples as well: The other technological efficiency metrics that were identified through the analysis of the gathered materials were not necessarily as conclusively affected by the issuance of a Central Bank Digital Currency. Reliability as a metric for example was identified from the materials as a metric that is assumed to improve due to the improvements to the other metrics identified, but the term itself "reliability" would not surface in the gathered materials often. The belief and perception that the reliability of the technology and therefore technological efficiency would improve due the issuance of a Central Bank Digital Currency can still be recognised from between the lines, by interpretation and analysis of the degree of certainty. But it was also recognised that once the discussions progressed towards defining the technological aspects and especially the methods of implementation and the technology chosen, the degree of certainty dropped. This is demonstrated in the comment versus comment example below:

> *« Instant cross-border transactions, transparency and efficiency in payments. The funds would be immediately available in any country and in any payment method. » (Expert C3 – PF)*

Notice the certainty and straight forwardness in the quote by expert C3 and the lack of adverbs describing uncertainty, when commenting on the more certain factor speed. And then compare that to the quote by expert A1 when discussing about the potential technology for the Central Bank Digital Currency:

> *« It <u>probably</u> should be something similar to Ethereum which is proof of stake, which is a lot more let's say user friendly in that regard. So, something like that <u>maybe</u> but <u>I guess</u> they know their stuff there so they can detect themselves… <u>I bet</u>… » (Expert A1 – WI)*

The accessibility of payment options and the digital currency was deemed to improve due to advancements in technological efficiency. One of the factors that would affect the accessibility was the perception that the technological trend of having more technology available for cheaper cost would continue and that unification of infrastructures around a currency would encourage financial technology companies to consolidate efforts in development around a more concentrated area. The degree of certainty in this particular perception cannot be interpreted as certain as the development of speed for example, since as mentioned earlier when the discussions progressed to technology, there were more uncertainties about the outcomes due to possible policies and decisions to include the private or third-party sector in the development processes by the European Central Bank. Therefore, creating the assumption that the overall perception leaned towards a feeling that the more centralization there would be concerning technological development, the less technological innovation and efficiency could potentially happen, or at least it could affect the rate of development in a negative fashion.

This was a significant finding, since the failure of the first e-Krona trial period was due to high rate of centralization of operations, and the mis including of third-party actors, as mentioned in the chapter 3.3 Experiments with Central Bank. There was also a noticeable difference identified from the materials concerning accessibility between the perceptions of what could be, and what should be. Whereas the general feeling was identified that the accessibility should improve and include as many people as possible, it was also theorized that whether that is the goal behind a Central Bank Digital Currency or not. In short, it can be concluded that if the central banks should decide to include the third-party providers within the development process of the technological infrastructure the combination of agility and capability of the broad knowledge and experience base of the central bank and private companies combined could improve accessibility through technological efficiency through the higher rate of technological development and transparency in the processes.

« it really depends on how they decide to go about it in the end, but like I guess ideally it would be very accessible everywhere, even if there's no electricity or internet»(Expert A1 – WI)

« Personally, one of the most important issues for future payments and financial technology advancement is to make it available to as many people as possible in the developing countries where the banking system is not available for poor people. Maybe it could be that centralized digital Confidential currency would enhance the availability for a larger audience to have access to banking/payment solutions. »(Expert C3 – PF)

« there are capabilities within the third party providers that cb(Central Bank) for themselves don't offer »(Expert B2 – WI)

An aspect that rose in the discussions multiple times was the security aspects around a Central Bank Digital Currency. In this sense security was discussed and looked at from multiple angles. As mentioned, before it was established that the technological security behind a Central Bank Digital Currency is most likely going to be top of the line in the realm of security options that currently is available and that there would most likely be a strong incentive to continuously develop the security during the whole lifespan of the Digital Currency.

There were strong links and relationships found between the aspects of security, implementation, technology, and side-effects concerning policies and politics. In that sense the area of security could be handled under multiple headlines and chapters. To summarize these relationships, it was found that the same idea applies to security as well as for accessibility in terms of that the rate of effectiveness is depended on the including of third-party providers and in addition to that, the motivation behind the decision to include or not include the third-party providers could be political.

Overall, there was a perception among the experts that if the implementation of a Digital Euro, a Central Bank Digital Currency for Europe would be done with a model where each Euro is unique, with an identifier code that enables perfect traceability, it would tremendously improve the general security for the public, and for the governments.

The public in general would benefit from being able to track the euros misplaced in transactions made to wrong recipients for example, and governments could trace each step of each euro in the cash flows of corporations, which would help to fight against money laundering, grey economy. The governments could also better oversee the compliance of financial sanctions.

It was felt that if the governing of the technology and administration of the Central Bank Digital Currency would be centralized for the Central Banks alone, there could be less transparency and there could be a negative effect on financial freedom for the price of improved security. Including the third-party providers could produce a better view of the future in terms of transparency, but the assumption of diminished financial freedom and loss of anonymity was apparent in every implementation. Security was one of the attributes of which by improving was felt might have a overall net neutral, or negative effective due to the side-effects brought by the improvements in security compared to the status quo.

> *« I think the advances will be more on security, monetary policy and anti-money laundering and sanctions enforcement. Overall, the future will likely lead to more centralization of payment processing and financial technology. This will function well for the consumer, but it will come at the cost of privacy and financial freedom. » (Expert A1 – PF)*

> *« The main concerns are based on the private information shared during the transactions and payments. How much private information there would be available for different parties (payment providers) and how they can be secured that nobody misuses them. » (Expert C3 – PF)*

> *« commercial banks i think have a very important role. When we think of trust, bank is basically an institution that we trust that they handle our money and they're safe there, so if it would shift to central bank I would feel it's not that safe, maybe. Even though that it's kind of the same thing but i think mentally it would be quite difficult to have that shift » (Expert B2 – WI).*

6.1.5 Technology & Third-Party Service Providers

When analysing the gathered materials, a category concerning technology and technological possibilities became apparent quite quickly. The perceptions around technology can be divided in two segments of which the first one describes the perceptions of the experts on how the technology will or might develop during the near future that also includes a Central Bank Digital Currency, and the second segment concentrates on the possibilities of technological choices made for the Central Bank Digital Currency. There was a strong relationship between the perceptions that predicted the technological development and the research question of what the effects of a Central Bank Digital Currency on technological efficiency are. It could be described as a classic, which came first the hen or the egg situation, where the effects are depended on the technological choices made according to the experts.

The setting described in the previous paragraph made it so that the aspects concerning technology were arguably more speculative than the perceived effects on expert chosen efficiency metrics for example. That argument is emphasised when carefully assessing the estimates of technological developments, for the guestimates can not be directly linked to the issuance of a Central Bank Digital Currency, rather the natural development of technology and estimated continuation to historical trends. It can be said with confidence though that some attributes can be linked to Central Bank Digital Currency as well, such as speed and cost efficiency, but they can also be seen as by-products that could manifest despite the issuance of any digital currencies.

The estimated development of technologies varied from upgrades to current technology to whole new set of methods of technology that are currently used for other purposes but estimated being able to be implemented for the purpose of usage for digital currencies. There was a strong consensus on the perception that the technology of the future, not dependent on the technological choices of the central banks would consist mostly of wearables and mobile phones. The possibility of biometrics to be used for usage of digital currencies was also accepted with slight hesitance. The topic of biometrics rose

naturally while discussing security and security threats of current on potential future technology, and one key factor for biometrics was that the hackability was deemed lower in risk than for the current technologies in use. Therefore, it can also be argued that one of the effects for technological efficiency could surface through the potentially more secure usage of biometrics in the field of financial technology and enablement of digital transactions.

> *« Like we can already see in futuristic movies: we have implants that allow us to pay for everything and everywhere on the world. Identification is not done through your face, fingerprint or eyes anymore but through something that is even more unique (DNA?) And is not hackable. » (Expert D4 – PF)*

> *« The ecosystem of softwares and hardwares solutions are quite advanced nowadays so basically the digital EUR could be adapted in the existing ones. There are constantly upcoming new ways of making payments, but the main issue is also the security. Mobile phones are one of the most important ones, since nearly everyone has one of them. » (Expert C3 – PF)*

When comparing the technologies used for finance purposes today it was the perception of many that for example blockchain technology that is currently used in retail banks as a ledger for transferring and storing shares of stock for housing is not a likely choice for the basis of a functioning digital currency. The experts had the perception that blockchain technology does not meet the requirements in speed efficiency, cost efficiency, nor ecological or ESG efficiency. On the other the one expert felt the solution could be similar to another cryptocurrency Ethereum, arguing that proof-of-stake method used by the cryptocurrency is faster than blockchain and requires much less computational power and work needed. Other experts still argued that the computational effort required when scaling for the European Union would surpass the current mechanisms of producing, storing, and shipping of cash Euros in CO2 emissions, making it also less efficient on ESG basis. Even after the thorough discussion about the technological possibilities to be implemented for a Central Bank Digital Currency the overall feel leaned towards suggesting that an implementation of a mix between current technological hierarchies by the third sector providers such as VISA & MasterCard and the current

hierarchies already in the use of the central bank would be the optimal choice going forward with the issuance of the digital currency, but there was also discussions about the motivations behind the choice as mentioned was the case with security and centralization as well.

> *« I think there are, right now, some cryptocurrencies that are bad and good for efficiency. Bitcoin and Ethereum being some that are bad for efficiency since they are very slow and cost a lot of fees. But there's projects like IOTA, Ripple or Cardano (fast, almost no fees, decentralized) which are right now under development and could change the way we use payment solutions. » (Expert D4 – PF)*

> *« I guess visa and mastercard are already facilitating payments like blockchain payments within the networks so it's not like it would be a big transition for them to make it work for something else than a central bank digital currency. But I could definitely say that bitcoin is not efficient, or quick or even cheap or at all resource friendly. So yeah it's not going to be something based on the blockchain. From the things that we have now it's probably something similar to ethereum which is proof of stake which is a lot more let's say user friendly in that regard » (Expert A1 – WI)*

As earlier described in the second chapter it is mentioned in the European Central Banks report for the Digital Euro that there is a possibility to choose between a centralized and a de-centralized back-end infrastructure and the End-user access solution. This would suggest that in reality there is also a chance that most of the Digital Euro infrastructure and services are produced centrally. The perception of the experts which was identified from many discussions around different subjects was that the solutions should be as decentralized as possible if the highest rate of efficiency is the goal and to avoid other negative impacts on a political level.

6.1.6 Perceptions on Timelines

The accelerating digitalization of financial sector and therefore the technology concerning financial sector as mentioned in the chapter 3.2. can be estimated to be on the same lines with the perceptions of the experts. It could be argued that the experts might even have a more ambitious feeling of the future and especially the technological development of financial technology than Gomber, Koch & Siering had on their research about

the evolution of FinTech. Also, the prediction made by Arvidsson, Hedman & Segendorf in their research paper commissioned by the Swedish Retail and Wholesale Council about the timeline when cash would no longer be widely used is subconsciously accepted and perceived by most of the experts as well, although some deemed the timeline to be a bit longer. The paper that was mentioned in the chapter 3.2. detailed that cash would no longer be widely used between 2025 and 2027, and that cash would not be a feasible method for payment for merchants as early as March 2023. The latter date is a bit too early according to the Experts feelings on the timelines, but for the role of cash the predictions are clearly on the same lines.

> *«...yeah, I think overall probably within five years in Europe. maybe like okay the Chinese are already doing it, and the swedes are already pushing ahead as well so yeah, i would say that probably within five years here » (Expert C3 – WI)*

> *« probably they would need a transition period like we had for example when we transferred from the small national currencies to Euro. so yeah it's probably going to start within five years in here or maybe a bit later»(Expert A1 – WI)*

> *« ...my initial thinking was that it would have been earliest in the early 2030s because in Europe there are a lot of differences between the countries and the countries payment infrastructures. But it has a lot of effect; how are we gonna deal with the cash... The new digital currency could be even faster but from what I've understood my answer would be in the early 2030s » (Expert B2 – WI)*

6.2 The Side-Effects of Central Bank Digital Currency

During the discussions with the experts and while analysing the gathered materials it was identified that the issuing of a Central Bank Digital Currency in the European Union area would have other effects than just the effects on technological efficiency. Even though the effects were not directly in scope for the research, some of them were deemed critical enough to be worth mentioning in the research results. These side-effects as I named them offer valuable alternative and further research options for others and they will be mentioned in the last chapter as well. Some of the side-effects have already been mentioned in the main research results chapter but are expanded in this

chapter. The quantity of side-effects was identified to increase in correlation to the rate of centralization of the administration of the digital currency, meaning that the more centralized the administration of the currency and payment infrastructure is, the more side-effects it is likely to cause. Therefore, the side-effects described in this chapter are caused by the maximum rate of centralization and the reader can have the assumption for the entire chapter that the administration of the Central Bank Digital Currency for Europe is entirely under the European Central Bank.

One of the themes around the side-effects was the theme of control and motivations behind the need for control. There was a strong perception that the more control there would be for the digital currency the more control there would be to control financial crime. In the scenario where each Euro is traceable and unique, money laundering and sanction breaching would be next to impossible and the central banks power to manage monetary policies would be immensely improved. There was also a feeling that could be best described as fear which suggested that in this scenario the consumer would have no financial freedom nor privacy since each step of each transaction could be traced. All of these effects would accentuate if physical cash currencies were to be removed from circulation over time, being that currently cash is the only form of payment that can be called near private.

> *« The payments will be secure but not private. Laundering money will be very difficult or next to impossible as will be breaching sanctions. Overall, the future will likely lead to more centralization of payment processing and financial technology. This will function well for the consumer, but it will come at the cost of privacy and financial freedom. « (Expert A1 – PF)*

> *« thinking in the sense of privacy nowadays the only payment method is cash which really guarantees privacy » (Expert B2 – WI)*

The most significant side-effects identified from the gathered materials concerned the effects on the economy and especially areas such as the credit expansion and the money creation process, the price of money or the interest rates, and the effects on employment. These side-effects in relation to the overall size of the gathered materials pool was

surprisingly large, and as a sidenote would most likely be a the most beneficial topic of further research. As mentioned in the chapter two of the thesis over 90% of the money created within European Union area is done by the commercial banks by granting a variety of loans to the customers, made possible due to the customers deposits and the collateral for the deposits. The experts had the feeling that with a more centralized solution there would be direct effect for the price of money or the interest rates through credit expansion. Given that the money creation power and money holding would be more and more concentrated to the central bank, a question was made that asked who would want to have deposits in commercial banks anymore? Another estimated contradiction was that if the power to mint new digital and unique Euros or create more money would be the sole responsibility of the central bank, how could the digital currency system would still allow the commercial banks to lend out money, since the lending process as standard creates more money. This contradiction would suggest that it would be realistically impossible to concentrate all functions of digital currency to the central bank as such, or then given that the commercial banks would still have the possibility to lend out money there would need to be a collaborated system where the commercial banks are the entity lending the money, but the central bank is the one minting the Euros.

> *« ...how would that work like does the central bank become the sole issuer of money ? This is a big question to me and like, shall we keep it as is and the commercial banks can still have the ability to expand credit which is something like i would perceive to be easier if they can mint euros as well but like, i don't know how that would work if it's going to be all digital and every euro that's issued is unique » (Expert A1 – WI)*

This brings forth other questions concerning credit expansion and monetary policy management. In theory if the previously described situation would stand and the central bank would have the total control of minting new Euros and therefore credit expansion. It would also mean that the central banks could control the credit cycles, meaning that if it would be recognized by the central bank that the credit cycle and expansion of credit is getting out of hand it could theoretically limit the credit expanded in the system, thus preventing overheating of the economy and or inflation, which as mentioned in chapter

two is one of the tasks of a central bank. Overall, the perceptions concerning monetary policies were diverse, because although it was identified that the central banks could be more efficient in governing monetary policies with more power, it was still perceived to be a net negative option because of the impacts on commercial banks and furthermore for the economy.

The side effects for the economy were perceived to manifest more through the effects on interest rates than the power over monetary policy. The discussion progressed to the topic of consumers holding accounts and where they would be located. As mentioned in the chapter about the digital Euro, there is a possibility of having a wallet, which would act as a holding account at the central bank, and this was seen to have negative effects on the economy. There was a mutual concern amongst the experts that if the consumers would have a holding account at the central bank, then how would the commercial banks get their funding, since at the moment the commercial banks are getting the bulk of their funding from the cheap deposits by the consumers. This dilemma was perceived to be crucial since it was theorised that if there is no difference in the yield between having deposits in the central- or the commercial bank, and on top of that if there is no risk of having deposits at the central bank, why would the consumers have their deposits at a commercial bank. From this train of thought the natural continuum was perceived to be that the commercial banks would have to offer interest rates for the deposits of the consumers, a phenomenon that has not been in effect since Euro crisis of 2008-2011. This was perceived impossible to occur without having the simultaneous effect on the cost of funding and credit available so the effect of providing interest for the deposits would cause there to be an increase in the banks margins of lending, therefore transferring the cost of the deposits for the bank to the consumers, which would also include corporations and potentially governments.

The last side effect that was seen as a possibility in the most centralised model relates to the other side effects mentioned in this chapter as it was also seen that if the private sector being the third-party providers would be excluded from the digital currency

system, it would have a drastic effect on the employment level within the European Union. Retail and wholesale banks are major employers and given the situation described earlier where the consumers have a possibility of holding their deposits at the central banks with less of a risk than in commercial banks it would probably cause the public move their assets to the less riskier option, therefore stripping the commercial banks of their source of funding, therefore causing such financial effects for the commercial banks that reducing staff would be required in order to try and cope with the situation.

> *« let's say you take out your mortgage… if they're going to have to pay for the deposits I don't think they're going to offer margins of let's say 0.3 or 0.5, that's just not going to happen" (Expert A1 – WI)*

> *« if you start disrupting the private sector by putting it all in to the central bank system, it's going to incur a large cost to the economy when it comes to like jobs » (Expert B2 – WI)*

For the conclusion to the side effects chapter it must be mentioned that unlike the perceived effects on technological efficiency as researched in the main section of the research results, the degree of certainty in the side effects chapter is not on the same level, and the experts had the shared experience that the side effects were more speculative because all of the side effects were dependent on the technological implementation of the Central Bank Digital Currency and especially the decision on how centralized the digital currency system is going to be. Yet this chapter proofs that there is a significant difference in the effects and side effects that potentially will occur based on those decisions and that functions as a justification and importance for the side effects chapter and the reason for why it was worth mentioning these side effects as well.

6.3 The View of the Future

To conclude the research results this chapter aims to summarize the most likely scenario and the view of the future according to the perceptions of the experts involved in this research. To aid the reader the perceptions, outcomes and probabilities have been set on an X-Y scale for a one-glimpse overall view. (See figure 11).

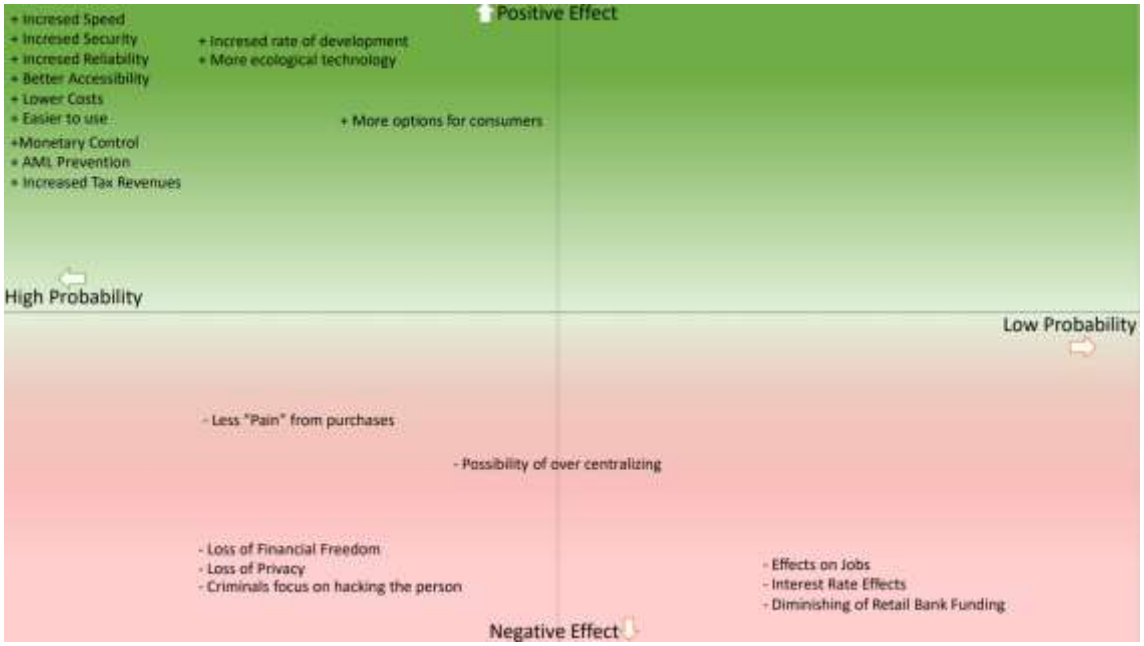


Figure 11 - Simplified View of The Future

The View of the Future is not only intended to be a novelty for the reader, but it is also the objective of this chapter to answer the question; what about it? Meaning that in this chapter the answers provided by the view of the Future are also distinctly directed to relevant parties who based on the research results of this study and previous studies would most clearly benefit from this newfound information.

As it was clear from the research results, some effects were more certain and non-dependant on the implementation decisions concerning the digital currency system than other effects. Therefore, the view of the future follows as closely as possible the middle ground that is evaluated based on the degree of certainty and therefore probability. As it was identified from the material analysis, the more immediate effects proved to be the most reliable to predict in terms of the degree of certainty in the perceptions and therefore, the more immediate effects are the ones that most concretely form the view of the future.

It is estimated that it is more likely than not that the central bank digital currency will be issued, and the consensus was that the launch would take place within the next five to

seven years. It was estimated that the technological capability would be already available for the launch of the central bank digital currency, but the people and the differences between the technological infrastructures within the European nations would require a transitional period to finalise the implementation. It was estimated that the transitional period would involve the digital currencies being used alongside cash and eventually overtime the whole Eurosystem would migrate towards a fully digitalized system. This information should be vital for the decision makers and designers of the Central Banks, as it also supported by previous studies on the topic.

The most likely and preferred option for the digital currency system and hierarchy was felt to be a combination and collaboration between the third-party service providers and the central banks. Enabling the public in general and the institutions the widest possible range of technologies and applications to choose from. It was also felt that the more inclusive the designing of the digital currency system is and the more possibilities to provide solutions after the launch there would be for private companies, the more it would accelerate the rate of technological development in general. This should for example mean that third-party actors could already start planning processes in terms of enhancing the readiness to participate in such architecture designing process if the Central Banks should contact the known actors in the field. Even though the process is most likely multi-year and multi-phased, agility should benefit the third-party actors in more ways than financially.

The key effects on technological efficiency were felt to be related to the speed of payments and transactions, the security and reliability of the payments, transactions, and holdings, and the accessibility to the services through a multitude of possibilities of technological implementations to choose from. The historical trends of increasing the speed of payments were seen to continue to improve due to technological advancements and the further knitting together of the European financial area, making for example cross border payments instant in the near future. The historical trends also supported the perceptions of the anticipated improvements concerning payment security for the public in

general. It was also felt that the overall security would improve due to the effects of technological efficiency through the traceability of Euros that would enable near perfect prevention of money laundering and sanction breaching. This factor should be one of the utmost of importance when designing the balance between security of the Central Bank Digital Currency and the potential effects for financial privacy. The concern between the shift in the two factors among the experts should provide insight and direction for security professionals in a way that alternatives that also enable anonymity should be observed.

The central bank digital currency was felt to be a motivator for pursuing improvements to technological efficiency through developments of more and more efficient solutions concerning financial technology and the infrastructures behind the digital currency. It was felt that the funding and motivation behind creating the digital currency would create new technologies for the public in general as well as institutions, therefore improving the efficiency of the technology in relation to the status quo. It was felt that after the launch of the digital currency more and more options for making payments and transactions would surface including wearable technology and even technology dependent on biometrics. In the fields of security and technology this finding should also raise interest in terms of further study about how willing people are in linking their financials to such identification methods as biometrics.

To summarize, the effects on technological efficiency due to the launch of a central bank digital currency within the European union were almost unanimously perceived to cause an incline in efficiency, when talking purely about technology. The identified effects that could be categorised as neutral or negative were all deemed to be caused by the improvements in efficiency thus providing the other important talking point of the research, that is being efficient a good thing. This research would argue that the question must be observed as a totality and reviewed by the sum of positives and negatives, and the results would indicate that the effects on technological efficiency and the improvement of the efficiency can be perceived as a net positive. These findings should provide

absolutely vital information for multiple parties in direct involvement in designing and designing the implementation of a Central Bank Digital Currency as well as providing a valuable insight for third-party actors into what look forward to and potentially what to lobby for within the allowed limitations in order to push the designing in a favourable direction for the third-party actors as well. Naturally, given that the process is transparent, and the decisions and options are available for the general public. The view of the future offers valid expectations, concerns, and hopes of the experts in the field, and upon close inspection the reflections are inline with the more general public and other experts in the field of academia, and subjectively it can be argued that the information provided in this research should be valuable for multiple relevant actors.

7 Discussion

The research questions answer proofed to be ambiguous in the sense that the confidence of the different outcomes varied depending on the category. While some categorical effects were felt to be almost certain, other categories provided more questions and more alternatives for the view of the future. Especially estimating the technological implementations and the involvement of third-party service providers proofed to be a crossroad from which the future could take multiple routes, each providing a various type of effects on the technological efficiency as well as other factors. This research concentrated and studied the perceptions of the experts involved and it was seen that the choice of which to go from the fictional crossroad will be a decision of the European Central Bank, which in the premises of this research is not viable to be accurately estimated. It can be concluded that the researched answered the core research question sufficiently and remarkably the research provided more topics for further research than estimated.

7.1 Key Findings

The key findings of the research can be interpreted to be the categories identified from the gathered materials through phenomenographic methods and the finding that what is perceived to be efficient and what is technological efficiency could be interpreted to be close to identical derived from subconscious and conscious perceptions. The categories derived from the perceptions of the experts proved to provide the crucial material for forming the future view of the research and to answer the key research questions. Through the identified categories it could be mapped out that what does the experts in the field of finance and technology see as the possible outcomes when it comes to the European Central Bank launching the first Central Bank Digital Currency. The topic raised enthusiasm as well as concerns towards the future and provided material for further research purposes.

One of the most significant findings of the research was the correlation found between subconscious and conscious definitions of efficiency when it comes to financial technology, digital payments and behavioural justifications that link the two together. Therefore, it could be concluded that the dictionary definition of efficiency did not only match the perceptions of the experts directly enquired but also with what the experts felt as to be efficient. Through those findings the latter discoveries of the research analysis became more validated and provable. The categories identified can be described as hierarchical meaning that other categories are more significant in importance, and in the case of this research probability than others. Another aspect about constantly improving efficiency that the research indicated was that the experts perceived that not all efficiency is necessarily net-positive and that efficiency in itself can have negative aspects to it. As it was previously mentioned in the chapter applications of theory, Arner et al. (2016) argued that the rate of growth in efficiency could very well have had a significant role in the 90's dotcom bubble and the intertwining of global economies through rapid digitalisation was an element in the financial crisis of 2008 (Arner, Barberis & Buckley 2016.) These two factors although not directly correlated can be found to emphasise the same point.

Through this emphasised definition of technological efficiency, the research found the attributes or metrics of efficiency that the experts most confidently perceived would improve as a result of launching a Central Digital Bank Currency in the European Union area. The most significant attributes that were felt most likely to improve were speed, accessibility, reliability, cost efficiency, and security. The mentioned attributes and the effects on technological efficiency could be thoroughly justified and the perceptions of the experts were supported by the theory and the applications of the theory previously mentioned in the research paper. This can be linked with the Gomber, Koch & Siering study where the authors stated that the key characteristics of the current trend of evolution in digitalization are enhanced speed on information processing (Gomber, Koch & Siering 2017). These identical attributes of efficiency that were expected to improve were also mentioned in other previous studies such as the study by Auer and his colleagues in their paper "Central Bank Digital Currencies: motives, economic implications and the research

frontier" which was mentioned in chapter 3.4. Where Auer and his colleagues argued among many other predictions about the improvements on efficiency that "CBDC could be the backbone of a highly efficient new digital payment system". (Auer et al., 2021). This trend was recognized and supported by the perceptions of the experts in this study as well.

Another finding that was supported by previous studies was the shared perception of the European Union area slowly but surely moving towards being a cashless society. The timeframe on this finding was found to be the only aspect that had some variance among the experts' perceptions, but as the study by Norges Bank conducted in 2021 stated "the trend suggest that digitalization is pushing developed western markets towards a cashless society" (Norges Bank 2021), the claim is steadily backed by the findings of this research. Related to the diminishing use of cash, when it comes to monetary policing and the effects, or in this research's case the side-effects the claim made by Ward & Rochement is also backed by the findings, on how less cash in circulation and more monetary power concentrated on the central bank could have the effect of increased tax earnings (Ward & Rochemont 2019). One of the perceptions about a cashless society and European Union that did not match the previous studios was the estimation on the timeline, when cash would be ridden of circulation. Arvidsson et al. (2017), presented a bold statement that cash would not be appropriate mean of payment on March 24th 2023, whereas the experts felt that the date is a bit further away. (Arvidsson, Hedman & Segendorf 2017). All together though, the claim that the Central Bank Digital Currency is a very current topic also in terms of materialisation was also supported by the Auer et al., (2021) research paper, where they mentioned that the time for a Central Bank Digital Currency is now, although giving emphasis on the meaning that the designing should start now (Auer et al., 2021). This claim is very much supported by the perceptions of the experts.

Other attributes were seen likely to improve in efficiency as well but there was a robust consensus on the dependency in the choice of implementation of the Central Bank Digital Currency and the chosen role for the third-party service providers. This finding was

also seen as vital in numerous other previous studies in the field such as the study by Agur, Ari & Dell'Ariccia and Barker, Clayton, Dyson & Meaning that were mentioned in the chapter 3.4. The questions around the implementation models and the involvement of the third-party service providers proofed to have a significant role in providing answers to the research questions and on some aspects, it provided follow up questions that should be further studied. The exact similar point about the importance of the implementation model was also presented by Petteri Virtanen in his master's thesis and by Riksbank themselves in their paper about E-Krona design models (Virtanen 2021, Riksbank 2021).

As discussed in the side-effects of a Central Bank Digital Currency chapter the role of the third-party actors and the motivations of the Central Bank could have very distinct and drastic effects on such factors as the funding and deposits of retail banks, interest rates, housing markets, bank runs, jobs, and even in the placement of ATM machines. These topics that rose from in the research results were found from nearly each scientific, peer reviewed paper which were published in a scientific journal and are clearly aligned. These topics and therefore the importance of proper design of the Central Bank Digital Currency were especially emphasised in the Barker, Clayton, Dyson & Meaning paper, Agur, Ari & Dell'Ariccia paper, and especially in the Alwazir et al. (2020) authored paper where they argued that there is "A big decision is whether to outsource the running of the CBDC network to third-party cloud providers and how to manage any associated risks." (Alwazir et al., 2020). The interesting finding was that even though many of the previous studies were titled something different, as with this research most of them still ended up raising these topics as the most important ones, really emphasising the claim that the even though factors such as efficiency are seen to improve the real concerns are linked to economic effects and the other effects described here.

Lastly, what can be described as most significant piece of new information are the nuances around the phenomenon of efficiency. The perceptions of the experts revealed some, in lack of a better word worries that have not previously appeared on research

about Central Bank Digital Currencies. Given the fact that the perceptions are of those who can be described as senior level experts in the field of financial technology and digital payments the worries should not be taken lightly, vice versa they should provide an abundant ground for further research and valuation for the design model and technological implementation model choosing. This was also one of the most emphasised factors according to previous studies and the finding was apparent in quantitative studies as well as other qualitative survey studies such as the one by Alwazir and his colleagues. (Alwazir et al., 2020).

To summarise the key findings of this research and how they compare to the findings of previous studies the results mostly support the consensus viewpoint, but with the clear difference on having a wider scope when it comes to the realm of effects and observation of both positive and negative effects as well as effects and side-effects. The perfect observation points for comparing the findings of this research to previous studies on the topic could be made by analysing the findings of Ozili K Peterson's recent (January 2022) literature review study on Central Bank Digital Currencies. Peterson's findings support the previous paragraphs' claim about the findings of this research being mostly in line with the previous studies in the field and what Peterson also concluded in his study's last words were that the design and the role of the third-party actors were seen as a key element. Also, his conclusions about the effects on the technological efficiency were inline with the findings of this research (Peterson 2022).

The research provided some previously undiscovered or at least previously publicly undiscovered information that can be utilised by the people in charge of making decisions related to Central Bank Digital Currencies and other stakeholders. The information is also useful for anyone directly or non-directly influenced by the decisions related to Central Bank Digital Currency and its implementation models. In either case the new information can be put in practical use, by considering the presented potential effects in the legislative decision making or by means of voting.

7.2 The Assessment of Reliability and Validity

The most conclusive findings of the study were produced by qualitative methods of phenomenography and through expert interviews. The experts involved in the study have between them over five decades of relevant expertise from the finance and digital payment sector. The amount of experience among the experts solidifies the reliability of the major findings of the study and the fact that one of the experts has had hands on development experience in creating, launching, and promoting modern mobile payment solutions in northern European regions emphasises the direct knowledge of the required field in this study.

The materials for the analysis in this research were gathered using multiple methods of interviewing such as, prerequisite form and additional round of interviews which were structured, and the workshop interview which was semi- to non-structured. An aspect that solidifies the reliability and validity of the results of the analysis, therefore the result of the research is the fact that the perceptions of the experts were also sought out using methods that aimed to grasp the subconscious feelings of the experts. The fact that the identified subconscious perceptions matched the conscious perceptions gathered through more direct questions emphasises the fact that the studied matter in the study was in fact the broader perceptions of the experts rather than merely opinions.

In the scientific community phenomenographic research is under constant scrutiny about its reliability and validity. That is because the findings mostly rely on the participants describing the phenomenon and it could be that the participants have perspectives that differ more or less from reality, or what is assumed to be. In the case of this research the emphasis on the participants was more on the quantity of expertise, not on the quantity of experts. It must be concluded that there being five participants to the research has a factor in affecting the reliability and validity of the research, even though phenomena such as saturation and homogeneity did not appear in the research process nor the gathered materials and there was a satisfactory amount of diversity in the perceptions throughout the research. But it must be mentioned that one argument against

the reliability and validity of this research could be directed towards the quantity of participants.

Chris John Cope described the scientific problems concerning the reliability and validity of phenomenographic research in his article in Qualitative Research Journal back in 2004 as “Ensuring the rigour of qualitative research has been a contentious and unresolved issue. A trend over time has been for the gradual demise of the scientific terms and concepts of validity and reliability” (Cope 2004). The comment in itself criticises the reliability and validity of qualitative research in general and it is worth mentioning that in general qualitative research results might be harder to justify against conclusions of quantitative research. As a counter to Copes’ argument, it could be argued that the reliability and validity of the research should be compared to another qualitative research.

Thus, a conclusion could be made that the reliability and validity of this research should not be assessed based on how accurately the experts have predicted the future development of technological efficiency in the era of a Central Bank Digital Currency when it unfolds. But rather based on the question is the future view realistic and consistent with the results of previous studies and does the theories of previous studies in the field support the theory of the future created in this research. The relevance and importance of the study comes through the value of the findings in using the newfound information when further planning the implementation of the Central Bank Digital Currency.

7.3 Limitations and Further Research

The study was conducted with the involvement of five experts of the finance field of profession. Even though there is no questioning of the expertise of the experts, it must be mentioned that the experts involved were also almost entirely from Finnish finance and technology sectors, which although can be rated as one of the most advanced markets in digital banking options globally, still holds the fact that geographically the participants were not as diverse as the studied effect area for example. The fact might have an overly optimistic effect on the future view, for the experts involved have limited

experience of technological state of finance sector in other European countries or developing countries.

As mentioned before further research should be done about the technological implementation options and alternatives for the Digital Euro concerning hierarchy and the involvement of the third-party providers versus wholly centralised model. Such research has already been done to some extent when assessing the different possibilities related to E-Krona (E-krona design models: pros, cons, and trade-offs - Riksbank 2021). The effects could be observed not only from the technological point of view but an alternative viewpoint or even a subject of an entirely new research could be found from the effects on employment levels, monetary policies, and interest rates and economy. The workshops conducted in this research for example included highly intellectual and interesting discussions concerning deposits, interest on deposits, credit expansion, reference rates and overall, the "cost of money". All of the previously mentioned topics would provide a suitable subject for a master's thesis study.

If given a similar topic than in this master's thesis, if the future research would be based on the theorised technology to be used in the implementation of the Central Bank Digital Currency one could then perform a cross review of the multiple research projects to provide the most accurate vision, or the view of the future. All together the European Central Bank has defined three possibilities for the technological approach for the European version of the Central Bank Digital Currency and based on the discussions with the experts the technology chosen has significant effects on the future view. Overall, the subject in hand has enough perspectives and possibilities for multiple master's thesis and further research is surely high in demand, publicly and privately.

References

Agur, I., Anil, A., & Dell'Ariccia, G. (2022). Designing central bank digital currencies. *Voume 125, 2022, Pages 62-79, ISSN 0304 3932,* https://doi.org/10.1016/j.jmoneco.2021.05.002.

Alwazir, J., Kiff, J., Davidovic, S., Farias, A., Khan, A., Khiaonarong, T., Malaika, M., Monroe, H., Sugimoto, N., Tourpe, H., & Zhou, P. (2020). A Survey of Research on Retail Central Bank Digital Currency. *International Monetary Fund SSRN Electronic Journal. 10.2139/ssrn.3639760.* DOI: https://doi.org/10.5089/9781513547787.001

Alasuutari, P. (2011). *Laadullinen tutkimus 2.0* Tampere: Vastapaino.

Alasuutari, P. (1999). *Laadullinen tutkimus* (3. uudistettu paino ed.) Tampere: Vastapaino.

Al-Laham, M., Al-Tarwneh, H., & Abdallat, N. (2009). Development of electronic money and its impact on the central bank role and monetary policy. *Issues in Informing Science & Information Technology Education, 6*, 339-349. doi:10.28945/1063

Armelius, H., Guibourg, G., Johansson, S., & Schmalholz, J. (2020, Apr 1,). E-krona design models: Pros, cons and trade-offs. *Sveriges Riksbank Economic Review,* 80. Retrieved from https://search.proquest.com/docview/2522177058

Arner D. W. (2016a). FinTech: Evolution and regulation. Retrieved 05-10-2021 from https://law.unimelb.edu.au/__data/assets/pdf_file/0011/1978256/D-Arner-FinTech-Evolution-Melbourne-June-2016.pdf

Arner, D. W., Barberis, J., & Buckley, R. P. (2016). The evolution of fintech: A new post-crisis paradigm? *Georgetown Journal of International Law, 47*(4), 1271. Retrieved 05-10-2021 from https://www.researchgate.net/publication/313365410_The_Evolution_of_Fintech_A_New_Post-Crisis_Paradigm

Arvidsson, N., Hedman, J., & Segendorf, B. (2017). Cashless society: When will merchants stop accepting cash in sweden - A research model. *Enterprise applications,*

markets and services in the finance industry (pp. 105-113). Cham: Springer International Publishing. doi:10.1007/978-3-319-52764-2_8 Retrieved 26-10-2021 from http://link.springer.com/10.1007/978-3-319-52764-2_8

Auer, R., Frost, J., Gambacorta, L., Monnet, C., Rice, T., & Shin, H. (2021) Central Bank Digital Currencies: Motives, Economic Implications and the Research Frontier (September 22, 2021). *Annual Review of Economics, Forthcoming*, SSRN: https://ssrn.com/abstract=3922836 or http://dx.doi.org/10.2139/ssrn.3922836

Bryman Adam. (2008). *Social research methods* (3rd edition ed.) OUP Oxford.

Burda Michael, & Wyploz Charles. (2017). *Macroeconomics* Oxford University Press.

Cope, C. (2004). Ensuring validity and reliability in phenomenographic research using the analytical framework of a structure of awareness. *Qualitative Research Journal, 4*(2), 5-18. Retrieved 05-01-2022 from https://search.informit.org/documentSummary;dn=133094720910488;res=IELHSS

Dodwell, W. J. (2013) Too much global liquidity from central banks distorts financial markets and undermines economic growth. *SSRN Electronic Journal,* doi:10.2139/ssrn.2408174 Retrieved 20-04-2021 from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2408174

ECB-PUBLIC. (2020). *Information guide for TARGET2 users .* ().ECB. Retrieved 17-11-2021 from https://www.ecb.europa.eu/paym/target/target2/profuse/nov_2020/shared/pdf/Information_Guide_for_TARGET2_users_v14.0.pdf

EconomicsHelp. (2022) Technical efficiency definition. Retrieved 17-01-2022 from https://www.economicshelp.org/blog/glossary/technical-efficiency/

Engman, K. (2021). Bye-bye cash. why central banks are pushing digital currencies. Retrieved 17-01-2021 from https://www.tietoevry.com/en/blog/2021/08/why-central-banks-are-pushing-digital-currencies/

Entwistle, N. (1997). Introduction: Phenomenography in higher education. *Higher Education Research and Development, 16*(2), 127-134. doi:10.1080/0729436970160202

Eskola, J, & Suoranta, J. (1998). *Johdatus laadulliseen tutkimukseen*. (2. painos): Tampere: Vastapaino.

Eskola, J., & Suoranta, J. (2008). *Johdatus laadulliseen tutkimukseen*. (8. painos) Tampere: Osuuskunta Vastapaino.

Eskola, J., & Lätti, J., Vastamäki, J. (2018) *Teemahaastattelu: Lyhyt selviytymisopas.* Ikkunoita tutkimusmetodeihin 1 : Metodin valinta ja aineistonkeruu : virikkeitä aloittelevalle tutkijalle. Jyväskylä: PS-Kustannus.

European Central Bank. (2021a). *Questionnaire on a digital euro.* (). https://www.ecb.europa.eu/euro/shared/files/Questionnaire_on_a_digital_euro.pdf: European Central Bank - Eurosystem. Retrieved 27.12.2021 from https://www.ecb.europa.eu/euro/shared/files/Questionnaire_on_a_digital_euro.pdf

European Central Bank. (2021b). Single euro payments area (SEPA). Retrieved 17-11-2021 from https://www.ecb.europa.eu/paym/integration/retail/sepa/html/index.en.html

Fauvelle, L. (2020). *Qualitative Research: 3 Types of Interviews*. Retrieved 08-12-2021 from https://www.intotheminds.com/blog/en/qualitative-research-3-types-of-interview/

Fernando, J. (2021). Bonds. Retrieved 23-04.2021 from https://www.investopedia.com/terms/b/bond.asp

Finansiell infrastruktur- Norges Bank. (2021). ().Norges Bank. Retrieved 26-10-2021 from http://hdl.handle.net/11250/2756190

Francis, J., Johnston, M., Robertson, C., Glidewell, L., Entwistle, V., Eccles, M. P., & Grimshaw, J. M. (2010). *What is an adequate sample size? operationalising data*

saturation for theory-based interview studies Routledge. Psychology & Health, 25(10), 1229-1245. https://doi:10.1080/08870440903194015

Frankenfield, J (2021). Cryptocurrency. Retrieved 22-04-2021 from https://www.investopedia.com/terms/c/cryptocurrency.asp

Fulton, C. (2020). Sweden starts testing world's first central bank digital currency. Retrieved 03-11-2021 from https://www.reuters.com/article/us-cenbank-digital-sweden-idUSKBN20E26G

Gold Traders. (2021). Is the U.S. dollar backed by gold? Retrieved 20-04-2021 from https://www.gold-traders.co.uk/gold-information/is-the-us-dollar-backed-by-gold.asp

Gomber, P., Koch, J., & Siering, M. (2017). Digital finance and FinTech: Current research and future research directions. *Zeitschrift Für Betriebswirtschaft, 87*(5), 537-580. doi:10.1007/s11573-017-0852-x

Hammersley, M. (2013). *What is qualitative research?* (1st ed.). London: Bloomsbury Publishing Plc. doi:10.5040/9781849666084

Hayes, A. (2019). DotCom bubble. Retrieved 05-10-2021 from https://www.investopedia.com/terms/d/dotcom-bubble.asp

Hirsijärvi, S,. & Hurme, H. (2008). *Tutkimushaastettelu.* Teemahaastattelun teoria ja käytäntö. Publisher: Gaudeamus.

Hirsijärvi, S,. Remes, P,. & Sajavaara, P. (2009). *Tutki ja kirjoita*. Publisher: Helsinki: Tammi.

Huusko, M,. & Paloniemi S. (2006). *Fenomenografia laadullisena tutkimussuuntauksena kasvatustieteissä* Jyväskylä: Koulutuksen tutkimuslaitos 2006.

Chen, J. (2021). Fiat money. Retrieved 20-04-2021 from https://www.investopedia.com/terms/f/fiatmoney.asp

Johannes, M. (2021). Evolution of fintech. Retrieved 05-10-2021 from https://www.e-zigurat.com/innovation-school/blog/evolution-of-fintech/

Järvinen, P., & Järvinen, A. (2000). *Tutkimustyön metodeista.* Julkaisija Tampere: Opinpajan kirja.

Kagan, J., Anderson, S., & Munichello, K. (2021). Commercial bank. Retrieved 21-01-2022 from https://www.investopedia.com/terms/c/commercialbank.asp

Kagan, J. (2020). Wholesale banking. Retrieved from https://www.investopedia.com/terms/w/wholesalebanking.asp

Kalliomäki, M. (2012). Fenomenografia laadullisena tutkimussuuntauksena. Retrieved 29-11-2021 from http://hanna.vilkka.fi/wp-content/uploads/2011/12/Maarit-Kalliom%C3%A4ki-fenomenografia.pdf

Kim, S. S., Malhotra, N. K., & Narasimhan, S. (2005). Research note--two competing perspectives on automatic use: A theoretical and empirical comparison. *Information Systems Research, 16*(4), 418-432. doi:10.1287/isre.1050.0070

KOPPA Jyväskylän Yliopisto. (2021). Laadullinen tutkimus. Retrieved 28-10-2021 from https://koppa.jyu.fi/avoimet/hum/menetelmapolkuja/menetelmapolku/tutkimusstrategiat/laadullinen-tutkimus

Majaski, C. (2021). Retail banking. Retrieved 26-04-2021 from https://www.investopedia.com/terms/r/retailbanking.asp

Marton, F. (1988). Phenomenography: A research approach to investigating different understandings of reality. *Qualitative research in education* (pp. 150-170) Routledge. doi:10.4324/9780203645994-17 Retrieved from https://www.taylorfrancis.com/books/9780203645994/chapters/10.4324/9780203645994-17

Marton, F., & Booth, S. (1997). Learning and Awareness. Published by: Routledge Member of the Taylor and Francis Group.

MAS. (2018). The bank of canada, bank of england and monetary authority of singapore share assessment on emerging opportunities for digital transformation in cross-border payments. *Singapore Government News* Retrieved 22-04-2021 from https://www.mas.gov.sg/-/media/MAS/ProjectUbin/Cross-Border-Interbank-Payments-and-Settlements.pdf

MasterClass Staff. (2021*). What is inductive reasoning?* learn the definition of inductive reasoning with examples, plus 6 types of inductive reasoning. Retrieved 23-11-2021 from https://www.masterclass.com/articles/what-is-inductive-reasoning

Meaning, J., Dyson, B., Barker, J., & Clayton, E. (2021). Broadening Narrow Money: Monetary Policy with a Central Bank Digital Currency. *International Journal of Central Banking, June 2021, 68th Issue,* Retrieved from https://www.ijcb.org/journal/ijcb21q2a1.pdf

Merriam-Webster. (2022). *Efficiency.* Retrieved 15-01-2022 from https://www.merriam-webster.com/dictionary/efficiency

Bech, M., & Garratt, R. (2017). *Central bank cryptocurrencies.* ().BIS Quarterly Review. Retrieved 20-04-2021 from https://www.bis.org/publ/qtrpdf/r_qt1709f.pdf

Niikko, A. (2003). *Fenomenografia kasvatustieteellisessä tutkimuksessa.* Kasvatustieteiden tiedekunnan tutkimuksia / Joensuun yliopisto, ISSN 0781-2329 Julkaisija: Joensuun yliopisto 2003.

Oritani, Y. (2010). *Public governance of central banks: An approach from new institutional economics.* (). Retrieved 20-04-2021 from http://econpapers.repec.org/paper/bisbiswps/299.htm

Osuuspankki, O. P. (2021). *Psd2*. Retrieved 26-10-2021 from https://www.op.fi/henkiloasiakkaat/paivittaiset/maksaminen/psd2

PBS - Practical Business Skills. (2021*). Payment options*. Retrieved 23-04-2021 from https://www.practicalbusinessskills.com/managing-a-business/financial-management/payment-options

Peterson, O. (2022) Central Bank Digital Currency Research Around the World: A Review of Literature (January 5, 2022). *Journal of Money Laundering Control*, Forthcoming , Available at SSRN: https://ssrn.com/abstract=4001852

Raunio, K. (1999). *Positivismi ja ihmistiede : Sosiaalitutkimuksen perustat ja käytännöt* Helsinki: Gaudeamus 1999.

Heakal, R. (2020). *What central banks do*. Retrieved 20-04-2021 from https://www.investopedia.com/articles/03/050703.asp

Riksbank. (2021). *Riksbank graph.* Retrieved 23-04-2021 from https://www.riksbank.se/en-gb/payments--cash/payments-in-sweden/payments-in-sweden-2020/1.-the-payment-market-is-being-digitalised/cash-is-losing-ground/

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., . . . Jinks, C. (2017). Saturation in qualitative research: Exploring its conceptualization and operationalization. *Quality & Quantity, 52*(4), 1893-1907. doi:10.1007/s11135-017-0574-8

Seth, S. (2021). *Central bank digital currency (CBDC)*. Retrieved 20-04-2021 from https://www.investopedia.com/terms/c/central-bank-digital-currency-cbdc.asp

Sommers, S. (2000). *Ei se laatu vaan se määrä*. Retrieved 23-11-2021 from https://yli-oppilaslehti.fi/2000/12/ei-se-laatu-vaan-se-maara/

Spacey, J. (2017). *What is technical efficiency?* Retrieved 17-01-2022 from https://simplicable.com/new/technical-efficiency

Suomen Pankki. (2021). *Payment systems*. Retrieved 26-04-2021 from https://www.suomenpankki.fi/en/money-and-payments/payment-systems/

Riksbank. (2020). *The Riksbank ‘s E-krona pilot*. Retrieved 03-11-2021 from https://www.riksbank.se/globalassets/media/rapporter/e-krona/2019/the-riksbanks-e-krona-pilot.pdf

SVERIGES RIKSBANK. (2021). *E-krona pilot phase 1.* ().SVERIGES RIKSBANK. Retrieved 03-11-2021 from https://www.riksbank.se/globalassets/media/rapporter/e-krona/2021/e-krona-pilot-phase-1.pdf

The Fedwire® Funds Service. (2014). *Assessment of compliance with the core principles for systemically important payment systems.* (). Retrieved 05-10-2021 from https://www.federalreserve.gov/paymentsystems/files/fed-funds_coreprinciples.pdf

Tuomi, J., & Sarajärvi, A. (2018). *Laadullinen tutkimus ja sisällönanalyysi.* Kustannus-osakeyhtiö Tammi.

Uljens, M. (1989). *Fenomenografi - Teori, forskning, praktik*. Lund: Studentlitteratur.

UTA (University of Texas Arlignton). (2021). *What is qualitative research?* Retrieved 11-11-2021 from https://libguides.uta.edu/quantitative_and_qualitative_re-search/qual

Ward, O., & Rochemont, S. (2019). *Understanding Central Bank Digital Currencies (CBDC)*. – An addendum to "A Cashless Society- Benefits, Risks and Issues (Interim Paper). Retrieved 01-10-2021 from https://www.researchgate.net/publica-tion/338792619_Understanding_Central_Bank_Digital_Currencies_CBDC

Wegmann, A. (2020). *SEPA vs TARGET2: How are they related*? Retrieved 01-10-2021 from https://www.cpg.de/en/sepa-vs-target2-how-are-they-related/

Appendix

As appendix the Prerequisite Form in its totality:

Central Bank Digital Currency & Effects on Technological Efficiency

Instructions:

- Please answer the questions based on your current experience and impression, try to avoid using google or other search engines for outside opinions. The answers should reflect your thinking, not someone else's.

- Note that the size of the answer fields is not static, please feel free to write as long or short answers as you please.

- Please note that some questions are about CBDC in general, whereas some questions are about digital Euro.

Name:

Question 1: Describe your educational and professional background, as well as your current profession.

a:

Question 2: How would you estimate your competence (and/or experience) in the field of Digital Payments?

a:

Question 3: How would you estimate your competence (and/or experience) in the field of Financial Technology?

a:

Question 4: What forms of digital transactions/payments do you use monthly, please describe the use and the service?

a:

Question 5: How often do you use each form of digital transaction/payment per month? (Scale: Numerous times per day – Less than once a month)

a:

Question 6: Are there any differences in the ways you use digital transactions/payments between your personal use and your professional use? if yes, why? (Skip if not applicable)

a:

Question 7: Describe the ways in which your digital payment habits have changed in the last ten (10) years. Have they?

a:

Question 8: Comparing your use of payment(digital/non-digital) services now and then, what developments do you appreciate the most, why? Are there any developments you depreciate?

a:

Question 9: How would you define efficiency in the field of Financial Technology & Digital Payments? Is being efficient good, bad, neutral or something in between?

a:

Question 10: Looking back on the historical trends in financial technology, what or which events have had the biggest impact on efficiency in your opinion (positive or negative)? (If you have professional experience, please elaborate from that perspective as well).

a:

Question 11: What developments would you like to see in the future related to digital payments and financial technology?

a:

Question 12: What is your general perception and feel about a Centralized Digital Currency?

a:

Question 13: What is your general perception and feel about a Digital Euro (CBDC in EU)?

a:

Question 14: How would you compare a Digital Euro and CBDC's to stablecoins and crypto assets?

a:

Question 15: In your opinion, describe the optimal digital currency for Europe? (what qualities would it have, which technology would be used, what would be the purpose of the currency (the reason for it), how and by whom would it be used etc.)

a:

Question 16: Based on your current understanding, how does your "optimal digital currency" differ from what you think the digital Euro is going to be? Why?

a:

Question 17: What services, functionalities or use cases do you think are feasible and should be considered when developing a digital euro? Why?

a:

Question 18: Which software and hardware solutions (e.g. mobile phones, computers, smartcards, wearables) could be adapted for a digital euro? How & Why?

a:

Question 19: Which developments/advancements do you think a launch of a Central Bank Digital Currency could bring in the future for the field of digital payments and financial technology?

a:

Question 20: Which effects of the launch of a Central Bank Digital Currency would be the most significant for the private consumer ("retail CBDC")?

a:

Question 21: In your opinion, what are the main challenges and risks related to a Central Bank Digital Currency before and after launch?

a:

Question 22: What are your thoughts on the safety and security of a Central Bank Digital Currency? What should be considered?

a:

Question 23: What kind of effects would you estimate a Central Bank Digital Currency could have on the efficiency of digital payments? if any.

a:

Question 24: What kind of effects would you estimate a Central Bank Digital Currency could have on the efficiency of financial technology? if any.

a:

Question 25: In general: Paint a view of the future (thoughts and predictions) for the future of financial technology and digital payments?

a: