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Potential efficiency of digital signatures to Finnish SMEs

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Abstract

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This study was conducted based on the needs of the commissioning company, Tieto Oyj. The company's interest was to get a better view of the benefits of digital signatures to Finnish SME's provided in a scenario such as its done in Estonia. The research objective was to estimate if digital signatures would bring efficiency to the operations of Finnish SMEs.

In order to provide the information to answer for the question of Tieto Oyj, the literature review and qualitative research method were used. The lietrature review purposedly clarified the digital signature's definition, the current working model, its benefits, drawbacks and legislations in Estonia and Finland.

The qualitative research method was applied to gain practical knowledge about features of the current working digital signature model in Estonia and analyze the empirical benefits to Estonian companies before learning Finnish SME's point of view toward digital products. The researcher focused on interviewing five (5) selected Estonian companies and six (6) Finnish construction and real estate SMEs for practical acknowledgement. The data collected by interviews, skype calls, emails and face to face meetings was applied to the situation of the commissioning company. Lastly, the researcher did cost analysis in order to value if the digital signatures would save more budget to Finnish SMEs compared to issue handwritten signatures.

The outcome of the research is included in this report in words and tables as well as in recording tapes. Although the research results proved the positive effects of digital signatures to individuals, they were taken from several (11 in total) interviews in Estonia and Finland. The reality should be still fluctuative and flexible. The representatives of the commissioning company are still recommended to make re-evaluations about significance as well as efficiency of digital signatures to Finnish SMEs.

Keywords
SME, cost analysis, efficiency

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1 Introduction

Doing business online is currently playing a very important role in globalization. However it crucially requires trust and confidentiality because business partners can not communicate directly face to face with each other. To enrich the diversity of business life, it was important to issue some devices that allow the identity online. As a result of it, digital signature system was created to satisfy the needs of many online business counterparts.

Digital signature allows you to sign documents electronically without using paper documents or acquire for face to face meetings. It allows the data transfered from one computer to another one with fully protection and reliability (Digital signature, eesti.ee, 2013). As investigated, individuals and businesses have caught up with many significant benefits after applying the system to their operation. Therefore, many European countries have been trying to issue digital signature system including Finland, but still Estonia is considered as the most advanced country with the most efficient and reliabe working digital signature system under the control of government (Herlihy 2013).

With the purpose to create the revolution for the online business throughout Finland, the commissioning company of this thesis (Tieto Oyj) would like to understand the benefits of such model as Estonian one to Finland. In this thesis, the author focuses on dicussing Estonian digital signature framework and forecasts if the same system would bring efficiency to Finnish SMEs.

This research is part of TARU project (Taloushallinnon Runkoverkko, TARU) financed by the Finnish Funding Agency for Innovation (Tekes). This is a two-year project from 2014 to 2015 owned by Administer Oy, Taitoa Oy, Tieto Oyj and Tikon Oy. The project concentrates on digitalization and automation of financial administration with the expectations to provide better financial administration and management services for Finnish SMEs and municipalities. The commissioning company of this thesis, Tieto Oyj, is responsible for B2B intergration and public

sector (Interoperable Financial Administration, 2014.). HAAGA-HELIA University of Applied Sciences was chosen as the partner to join and produce new ideas for the project in addition to Aalto University and other business companies operating in Finland.

Since digital signature, especially specializing in digital signature system in Estonia is still a very new and perpective topic without many available books for literature review, the author mainly relied on internet sources like Estonian technology webpage or the digital society of Estonia and articles for the research process beside a few academic books for cost benefit analysis and market research.

1.1 Background of the study

In an article published by Estonia world (Estonia World, 2013.), Prime minister, Asip, talked about the efficiency of digital signatures to Estonia.

> Saving time also helps save money. In Estonia, we save time worth a total of two percent of the annual gross domestic product (GDP) by using digital signatures – this is equivalent to saving one week of working time per person.
> (Estonian Prime Minister, Andrus Asip, Estonia World, 2013)

Estonian people are very proud of their system thanks to enormous benefits it has brought to their life. According to the article named "The Small and Medium-sized enterprises" published by yrittajat (Yrittajat, 2013) there were total 322 183 companies in Finland in 2012 and 99,8% of them are SMEs. While European Business Register (Estonia, European Business Register) published that there were only around 170 000 enterprises in Estonia in 2013. As a result of that, the number of companies in Finland doubles the amount of Estonia. With more companies operating in Finland, the country would save a huge amount of money thanks to digital signature system as Andrus discussed about Estonian situation. Moreover, Andrus (Estonia World, 2013) also analyzed the total amount with up to 4 500 Finnish companies in Estonia and 3 500 Estonian companies in Finland and effective

influences for two countries to communicate to each other digitally. The successful research would enable the commissioning company to find out the possibilities for digital signature in Finland.

The benefits of this study will add value to the effectiveness of the commissioning company's project and contribute to the further decisions about digital signature in Finland in the future. It was essential for the commissioning company to understand about the benefits and disadvantages of digital signatures in Estonia. Studying about Finnish customer's expectations toward digital products and Finnish legislation for lectronic signatures are paramount to the success. The prospected outcome of this research would enable the commissionning company to assess digital signature's efficiency, understand the market for the same model and benchmark the current situations of digital signature popularity in Finland in order to later conduct more specified research related to the topic.

I myself will also be acknowledged a lot from the findings of this research. For my professional work and study, this research will add value to my reputation and applications in job searching which requires practical knowledge with research skills and analytical skills, hopefully increasing the likelihood of getting envolved in the same projects in the near future. Moreover, this research will enhance my academic knowledge by conducting an empirical research on a national level scale which strengthens my time management and decision making skills among the diversity of choices.

1.2 Research objectives

The objective of this study is to learn about the current digital signature working model in Estonia and its future perspectives in Finland. To conlude the main content of this research, the title of this thesis has been defined as the following one:

" **Potential efficiency of digital signatures to Finnish SMEs".**

Table 1. Research questions

IQ 1 How does Estonian digital signature system work in practice?
IQ 2 What are benefits and drawbacks to Estonian companies in practice?
IQ 3 Which methods do Finnish SMEs use to create signatures and what are their expectations toward digitally signing?
IQ 4 Would digital signature bring cost efficiency for Finnish SMEs?

The first step of the study is to search, acquire, read and gather all the literature about digital signature from internet sources, books and journals to sum up all the main findings for the theory part. The second step is to understand about digital signature current working model with its benefits and drawbacks by conducting interviews with five Estonian companies. The next step is to interview six Finnish companies to understand about capacity of working with contracts and online transactions within Finnish companies and clarify their expectations when creating signatures online. Data collected from literature review and from interviews with companies is used to do cost analysis to estimate the efficiency of using digital signatures. Finally, the results collected are applied to make the final research report with the most accurate key findings for the commissioning company. The complete final results are introduced and published to the commissioning company for evaluation and further research. Table 1 below provides the research questions of the study and in the attachment 1, you can find the overlay matrix which explains the theoritical framework, key words and the outcome for each investigative question.

The final outcome of the research is:

- The current working model of Estonian digital signature description.
- The sucess reasons of Estonia
- Benefits and drawbacks of digital signatures to Estonian companies
- Legislation acts about digital signatures in Finland and Estonia

- Methods Finnish SMEs used to create signatures.
- Expectations of Finnish customers toward digital products
- Efficiency tools analysis results

In order to get deeper understandings about digital signatures, qualitative research was chosen and interviews with Estonian and Finnish companies were the main sources of the empirical data to get practical point of view about the use of digital signatures and customers's expectations toward digital products.

1.3 Research scope

Considering the limitations placed on this research, it has been deemed to cover the entire phenomenon of digital signature, its related features, customers's expectations for digital products as well as cost analysis between digital signatures and handwritten signatures. The components of these phenomenon have been drawn and linked to each other to fully support the analysis and satisfy the needs of the commissioning company (Tieto Oyj). The theoritical framework included in Chapter 2, 3, 4 and 5 will provide the knowledge for the phenomenon mentioned above.

Further limitations have been put on the number of companies chosen for the interviews. The author was required to specially concentrate on only Finnish SMEs operating on construction and real estate fields. They are known to have been working a lot with contracts, bills and other kinds of documents. Specifically focusing on 6 construction and real estate SMEs enables the researcher to analyze exactly how often companies in the field has been working with contracts, bills and inquiries and how much papers they have been spending for paper documents. The results collected are valuable for the cost analysis part of the research. Furthermore, by reducing the business fields of interviewed companies, the researcher manages to have better insights of each company's operation and produce empirical knowledge from the interviews. In addition to Finnish companies, 5 Estonian companies were chosen for the interviews. The author was assigned to conduct interviews with 6 companies that have been using digital signature system so far, however the

interviewees did not seem to bring new perspectives, the author came to the decision to select 5 companies to finish up the interviews.

The research was limited to a time frame spanning approximately 8 months. The commissioning time was at 31st March 2014, the commissioning company in coordination with the researcher set the time frame and agreed for the complete time by the end of December 2014.

1.4 Introduction of the commissioning company

Tieto Oyj is the commissioning company for this thesis. They set up the objectives for this research and utilise of the results of this research for their benefits.

Tieto Oyj is set up in 1968 under the name as Tietotehdas Oyj. Nowadays it is considered as the largest Nordic IT service company operating in over 20 countries worldwide, with the head office located in Helsinki, Finland. Tieto Oyj operates in the IT development industry and employs in excess of over 16 000 personnel worldwide. They provide full life cycle services to both private and public sectors and product development services in the field of communication and embedded technology (IFA, 2014). At the end of 2013, Tieto Oyj reported annual sales of 1 607 million euros (Tieto Oyj, 2014).

The rapid growth as the results of acquisitions, mergers and strategic alliances during the years of 90s enhanced the fame and popularity of Tieto Oyj in Finland and worldwide. Up to now, Tieto Oyj has provided IT services and products to many Finnish companies. Since 1970s, the customer base of the company went up and generating the sales increases which opened up the perspective future for Tieto Oyj to be the leader in IT provider in both Finland and Europe (wikipedia, 2014).

1.5 Key concepts

This study withholds these main key concepts which lay the foundation for the theoretical framework: **SMEs, cost analysis and efficiency.** These concepts will be mentioned in the following chapters. All of these key concepts are explained below which help the readers to easily follow the contents of the research.

SME stands for small and medium-sized enterprises defined by EU law. The main factors that determine a company as a SME or not are the number of employees involved in the business and the turnover or the balance sheet in total. The amount of employees in SMEs should not exceed 250 people and the total balance sheet reaches to 43 million euro as its peak (European Commission, 2014).

Cost analysis: or Cost-benefit analysis (CBA) is a method that is used to evaluate the performance of operations for a business. Cost analysis is often used with the purpose to point out the unique features of an option among many so that it is easier for people to choose the best approach. Cost analysis is used to evaluate the labour, time and cost savings (Braun & Tietz 2014).

Efficiency is the efforts in making out of the best use for a company's resources. By maximising the outputs and minimize the production costs would enable an enterprise become efficient in their operation. Efficiency is considered as the effective tool to bring competitiveness to the company on global business (BBC, 2014). In this research, efficiency is used to evaluate if digital signatures would bring cost-savings or time-savings to Finnish SMEs.

2 Digital signature

This chapter covers the most important features about the digital signature system. It starts with the definition of digital signature and then opens up with new ideas about its benefits with drawbacks. This chapter is just talking about digital signature in general, not the used model in Estonia currently. The author expects to give the overall knowledge about the system in advance to make it easier for readers to follow.

2.1 Digital signatures.

A digital signature enables the users to electronically sign the online documents without using any paper form as in the past thanks to the use of certificates issued by trusted providers under the legal control of government (Eesti, 2013). A digital signature is easily transportable and can be used for any kind of online documents such as electronic tax fillings and company registration portal (e-estonia.com).

In order to create signatures online, it is important for signers to issue the certificates. The certificates can be used for identity and digitally signing. They can be issued by governmental offices or private providers which are reached to the requirements of legislations. A reliable certificate should satisfy the legal requirements such as the information about certification-issuing authority and identification information of the signer. It would acknowledge people about the validity of the signatures and identification of the signers if needed. A complete certificate also encloses "public key" and "private key" to enable signers to create signatures online (Eesti, 2013). Public key and private key is key pair belonging to public key infrastructure. This key pair enables the forwarding data process of digital signature system (Estonian information system authority, 2012).

Figure 1 explains how digital signature system works to transfer signatures electronically from the sender to receiver through their own working computers. In this picture, Mike was trying to send his signature online to Bubba.

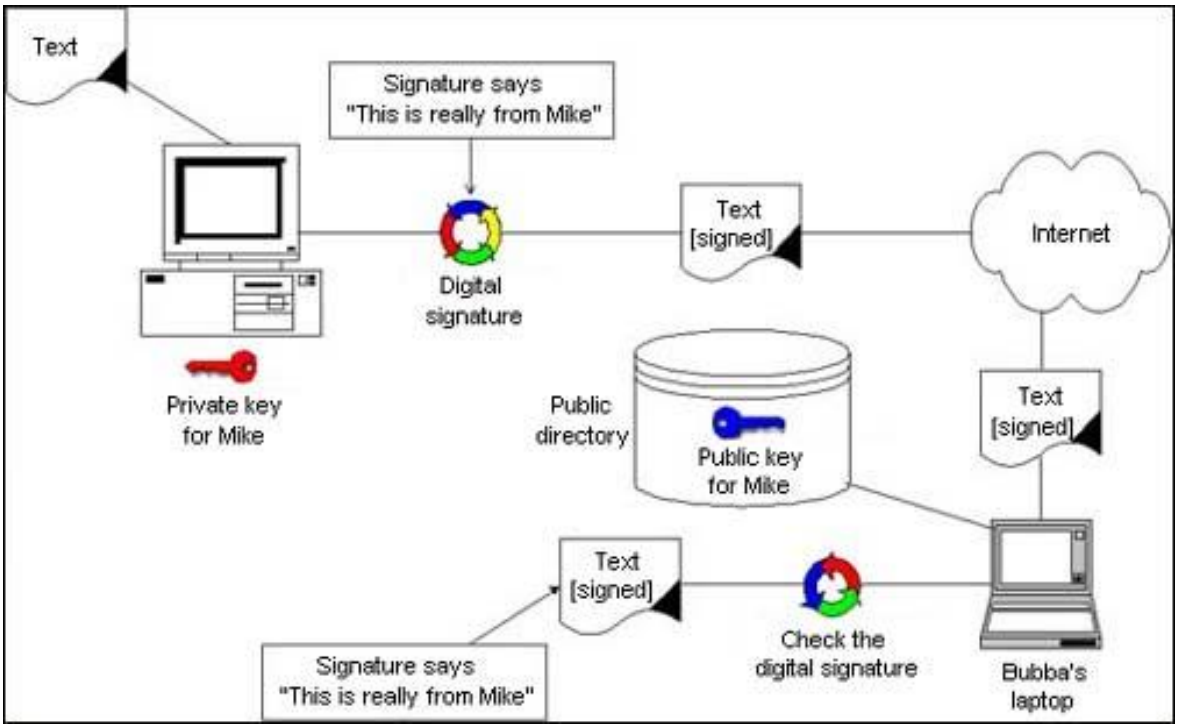

Figure 1. How digital signature system works. (Lera Blog, 2014)

Mike and Bubba were far away and unable to meet in person to conduct handwritten signatures so they chose digital signature system to finish up their business deal online. The exact steps are described in the following paragraphs.

The first step:

The first step is considered as the preparation step. In order to start digitally signing, Bubba and Mike are required to have software for signing online and certificates which are used for both identity and electronically signing. There are "public key" and "private key" issued on the certificates they own. Public key is one type of key that is publicly accessible to anyone while private key belongs to the only use of its user (Comodo, 2014) People should not let private key lost that would cause negative influences to the signatures created. The person who got the lost private key would be eligible to use it to encrypt the faked signatures digitally. Mike is required to encrypt the data with Bubba's public key (Comodo, 2014)

The second step:

The next step is to start signing electronic documents. Mike clicks "sign" button on the screen after he tries to log into the signing database or applications and sends the documents with his signature to Bubba computer. When the signed documents reach to Bubba's computer, Bubba uses the private key to get accessed to the received signature and he is the only one to verify signature received. Even if any change in the future would be impossible (Comodo, 2014).

Figure 2 is an example of how digital signatures look like before being sent by the signers as well as the brief guide how to make signatures.

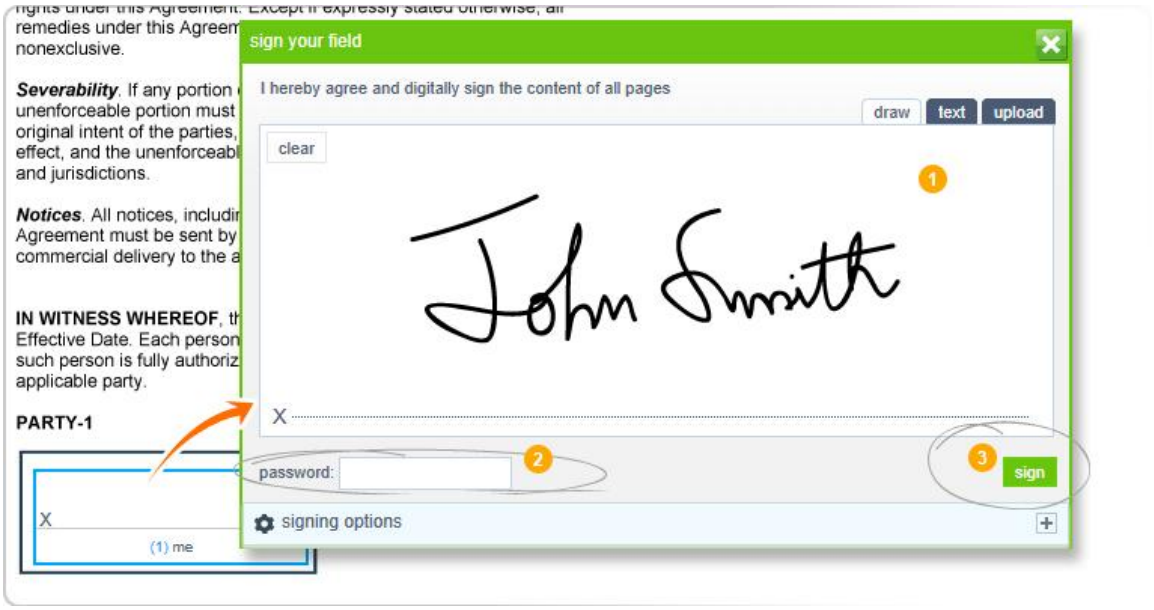

Figure 2. How the signatures look like before being verified. (Code support, 2013)

There are three marks as the working steps before sending signatures in figure 2. The first mark explains the process that signers are required to type their name online. Then they should enter the PIN code provided in their own certificates as the second mark. This step is known as the process to provide identification and confidentiality

of the signers. The last one is to press "sign" button and finish their signing. Depending on different signing applications, the screen would have different outlook.

This is generally considered as the last working step of creating digital signature even though it is required for both users to be certified by reliable third party called Certificate Authorities (Comodo, 2014). In some countries such as Estonia, their citizens get certificates issued by government and software issued by just one single service provider reaching to the standards of legislation issues.

2.2 Benefits

It has been said that digital signature has brought significant advantages to individuals and operation efficiency to businesses. The outstanding benefits of digital signatures are summarized shortly in the following figure 3.

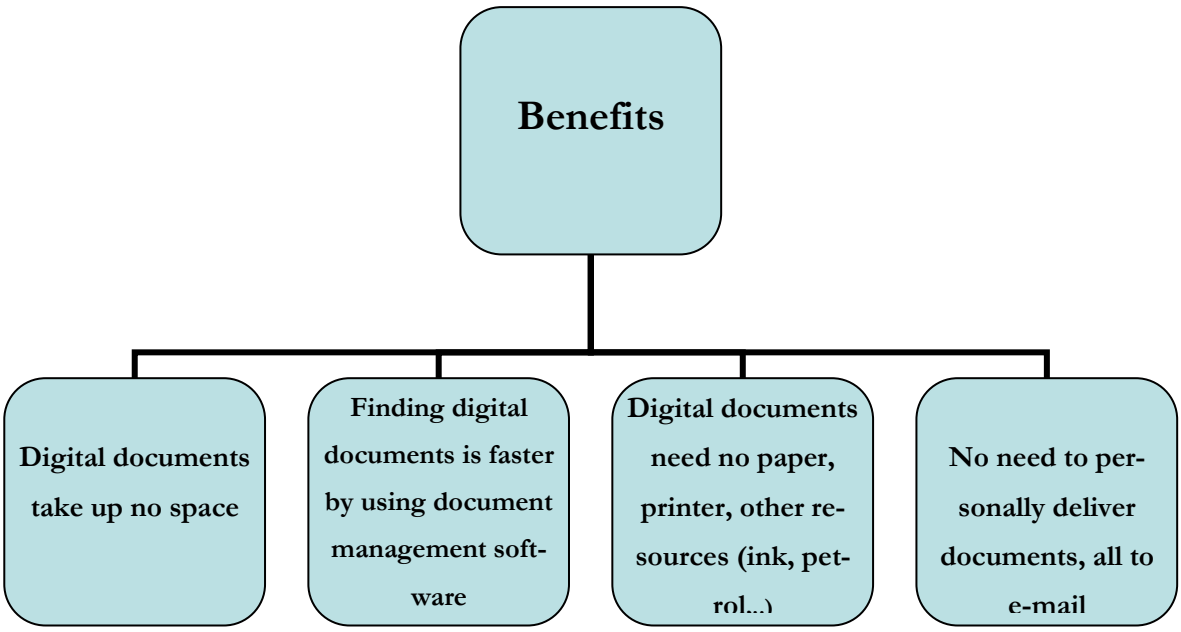

Figure 3. Benefits of digital signatures summary (Digital signature, eesti.ee, 2013)

The first unique advantage is the change in documents management activities**.** Instead of storing paper documents in many different places which are easily lost or damaged, it makes more sense to keep the data on a file online. It is then faster to find digital documents by using document management software (eesti.ee, 2013). Moreover, after a specified period of time, companies would easily figure out the numbers of contracts they have been signing which they tend to forget with paper documents (Piperal SK 2014).

It is **cost-effective** to issue digital signature system for individuals and businesses. Instead of paying money for sending paper documents by post or travelling expense, it is more cost-saving to sign online. Digital signatures need no paper, ink, printer and other materials. Companies would save a great amount of budget from applying digital signature system (eesti, 2013).

When signing documents digitally with personal computers, offices such as banks, tax offices can reduce the queue and the number of customer service teams and helps to speed up the working process (Oone, 2000). Instead of going to the office for signing process, people can stay anywhere like offices, at home or any coffee shop with internet connection to sign online. During the same amount of time, people can instead do many other tasks. Digital signature is a really "time-effective" tool for anyone. In addition, digital signatures make vital influences to **reduce "grey market".** Grey market (Wikipedia, 2014) is not nationalized standard market but is not against legislation for operations. Grey market appears when sales of good imported by not authorized parties and their activities tend not to be protected by law. Individuals and organizations today can do transactions with banks electronically, that is estimated to decrease greatly the amount of grey market (e-estonia.com, 2013)

Lastly, to the wider scale, using digital signature would affect greatly to the environmental protection activities. According to the Cosign customer usage statistics, a person makes 2 documents average per day and 500 documents per year. This would be equivalent to the reduction half of the tree, ¾ barrel of oil and 150 pounds of carbon

emissions per year (Cosign, 2014). According to the calculations of Schwartz, in average a computer will consume 144 kilowatt-hours per month therefore, 2 computers needed for the signer and receiver will double the energy consumption. Using energy more efficiently will reduce the amount of fuel and the emissions of pollution and greenhouse effect (Clean Energy, 2013). The number is still not equivalent to the effects of paper documents to environment.

2.3 Disadvantages

In spite of the significant amount of benefits, digital signature has also encased some difficulties to holders beside advantages mentioned above. However these obstacles can still be under control if the users make time to understand about the system and the way it operates. By not understanding fully the system, people have been now and then under-estimated the functions of digital signature system in online business revolutions (Martens 2013)

The users should pay great attention to the expiry time of the software or applications which enable users to create digital signatures. When the software or applications are expired and not updated on time, signing digitally would become impossible. However, today the providers who issue applications for signing digitally are aware of that and they are responsible for sending the notifications for users to update their software before expiry.

Digital signature system requires private key and public key which are included in the personal certificates as described above. Public key allows anyone to encrypt it while the private key should be kept in a secure manner, for the use of only holder (Mady 2014). When it is lost to someone else, they could use the key to encrypt the signature and lead to illegal perspectives.

> Digital security depends mostly on its users – how they take care of their cards and PIN codes. People in Estonia realize that giving a digital sig-

nature can lead to legal consequences, and that makes them more carefully.
(Martens 2013)

3 Estonia – country for digital signature

Estonia is considered as the leading country for technology development in Europe. Estonian citizens are offered with a variety of e-services mostly free of charge such as company online registration, e-banks, electronic tax fillings or any kind of services requiring for signatures (e-estonia.com). Therefore this chapter encases the next important part of the theory frame, which focuses on specifying how Estonia solved their difficulties and describing Estonian digital signature current working model. It starts with a history review about Estonia and then follows up with explanations about current working model in Estonia. Since certificates and ID cards needed for digital signature creation are eligible for use for a specific period of time, acknowledging about how to do renewal of them is necessary to users. The legislations of issuing digital signature to individuals, providers acknowledge readers in law issues. The reasons for Estonian success are the ending for this chapter.

3.1 Overview about Estonia

Estonia, the official name is Republic of Estonia, is a European country with Finland, Latvia, Russia and Sweden as the neighbour countries. Estonia is a small country with approximately 1.3 millions of habitant with 68% of urban population. Tallinn is the biggest city as well as the capital of the country with 400 thousands of inhabitants, accounting for 29.8% of total population. There are also other big cities like Tartu, Narva, Kohtlä-Järve and Pärnu. Since the beginning of 2011, the currency in Estonia is EURO (Estonia at a Glance, Estonia.eu, 2013).

Estonia used to belong to Soviet Union for several decades and regained its independence in 1991. After being independent from Soviet Union, Estonian economy was still suffered a lot with poor natural resources. However, they Estonia recovered from as the "worst of times" to "the best of times" (About Estonia, Estonia.eu, 2013). It was the result of trying to wipe out all Soviet Union troops in Estonia and

build the country growing by the development of technology. The fastest way for them to capitalism was to invest capacity on technology development.
Today Estonia is considered as one of the most advanced technology country with very open-minded people in adapting to the changes in technology. According to article about facts about Estonia (Estonian information system authority, 2006) the majority of Estonian population get access to internet and more than 1 100 public WiFi networks are covered around the country to provide free internet connections. Until 2015, up to 95% of population declared their income online. Furthermore, it only takes 15 minutes to set up a business in Estonia since 2007 (Estonian information system authority, 2006). These improvements have taken Estonia to the new periodic of development. Figure 4 shows the readers the differences in internet usage during different years in Estonia, typically from 2000 to 2012. (Internet World Stats 2012)

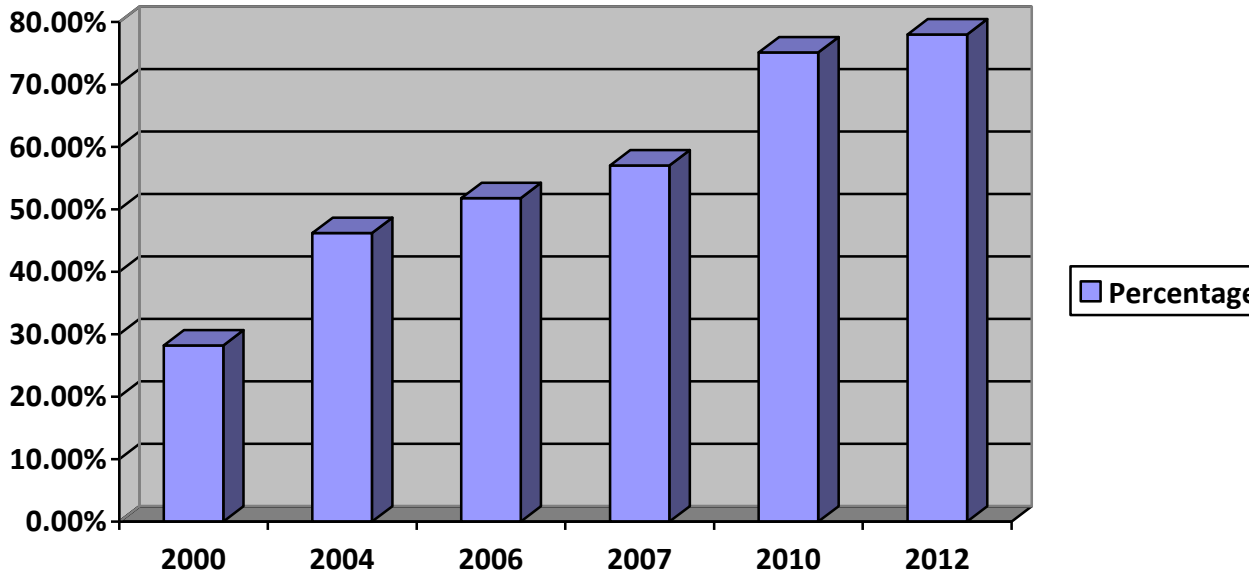

Figure 4. The percentage of internet users from 2000 to 2012 in Estonia (Internet World Stats, 2012)

The amount of internet usage was increasing sharply in Estonia during 2000 to 2012 and it was growing after 2012. The growth of internet encourages the development of e-services in Estonia.

3.2 Estonian digital signature model

Digital signature was introduced in Estonia in 2002 (e-estonia, 2014). In order to learn the digital signature system currently applied, it is essential to define the popular certificate forms used for digitally signing and other purposes. After giving definitions for different cards, the author discusses about the current digital signature working model in Estonia.

3.2.1 Certificate categories for digital signatures

First of all, ID card is important for the electronic signing process in Estonia. The ID card is issued individually to serve for signing documents online, identification and encryption data. The ID card includes two certificates on it, one for identity and the other one for digital signing. Normally, the ID card is valid for 10 years and 3 year validity for the certificates on it. After the valid time, users can still use ID card for identity purposes however they are required to update the ID card to be able to sign documents online. It takes up to a month for the users to update the ID card (Rakendusjuhend, 2014).

The digital certificate of identity is one kind of an electronic document that allows people to verify the signer's identity in "online environment". The validity of the digital certificate of identity is up to 3 years. When the certificate comes to expiry, it takes just several minutes to renew the services from the police or Border Guard Board unlike the updating process of ID card (Rakendusjuhend, 2014).

A digital stamp is important for the creating electronic signatures. A digital stamp is the tool to help people sign documents online legally since it is responsible for evaluating and confirming the origin and time of the signatures made. It ensures the order

of documents stay the same without any changes. As a result of that, signatures can be attached to bills, orders, confirmations, certifications and bank statements (Rakendusjuhend, 2014).

Non - European people living in Estonia are given the electronic residence card. It has the same functions as the ID card which is issued for Estonian people and non - European people living in Estonia. The electronic residence card also contains residence permit of the issuer on it (Rakendusjuhend, 2014).

3.2.2 The current digital signature working model

To start the describing the digital signature working model, it is comprehensive to talk about "government database". The Estonian government did not find it effective to store information of their citizens in many places (Herlihy 2013). It is very time-consuming to look up personal information from different kinds of sources such as paper documents or from many files on the internet. Therefore government put efforts to encourage the technology development to create a new system where all personal information about citizens such as name, date of birth, sex, address and contact information are kept in just one "Population Database" file (Herlihy 2013). The confidentiality and transparency of this file are the most in security data. The data storage is used for identification and the purpose of issuing digital signatures. The database is opened up and available for any citizen under the control of government. Citizens can look up information about their business partners or anyone through the database file and the system later announces to the viewed people about who viewed their personal information. Furthermore, with the identification information provided on the file, users can do electronic transactions and signing documents online which have the same legal rights as paper signed documents. Estonians have full trust for this nearly 100% complete database (Herlihy 2013). Figure 5 below shows how the government's database looks like when users enter the page.

Figure 5. How State database looks like (Herlihy 2013)

The system is considered as a secure foundation for the use of digital signature in Estonia. Being easy for document management and being fast for searching and helpful for the identification as advantages, this population database has been playing an important role in the popularity of digital signature around the country. According to the statistics published by Sertifitseerimiskeskus (Statistics, SK 2014) until 12nd September 2014, there have been 175 223 567 digital signatures made and 1 222 651 active cards with 284 088 756 electronic authentications around Estonia. The number of active cards is equal to the amount of Estonian population.

The article about digital signature published by Eesti.ee (certification centre, 2013) said that Estonian people are offered with 3 options for the format to create electronic signatures. The first choice requiring ID card software reader is **DigiDoc 3** program installed on computer. The second choice is to go straight to the **State Portal www.eesti.ee** which was shown in figure 5 about how State database looks like. **DigiDoc Portal** is the third. Depending on the needs and current situations of each person, they may select the most convenient tool out of these tools above to sign electronically.

a. DigiDoc 3 program

DigiDoc 3 program is one kind of application that allows Estonians to sign documents electronically. This application is provided to residents in Estonia free of charge. Users can just go straight to website of SK "https://installer.id.ee/?lang=eng" and there are detailed instructions for them to update and install the system for their using. The following figure will describe briefly the installing process of DigiDoc 3.

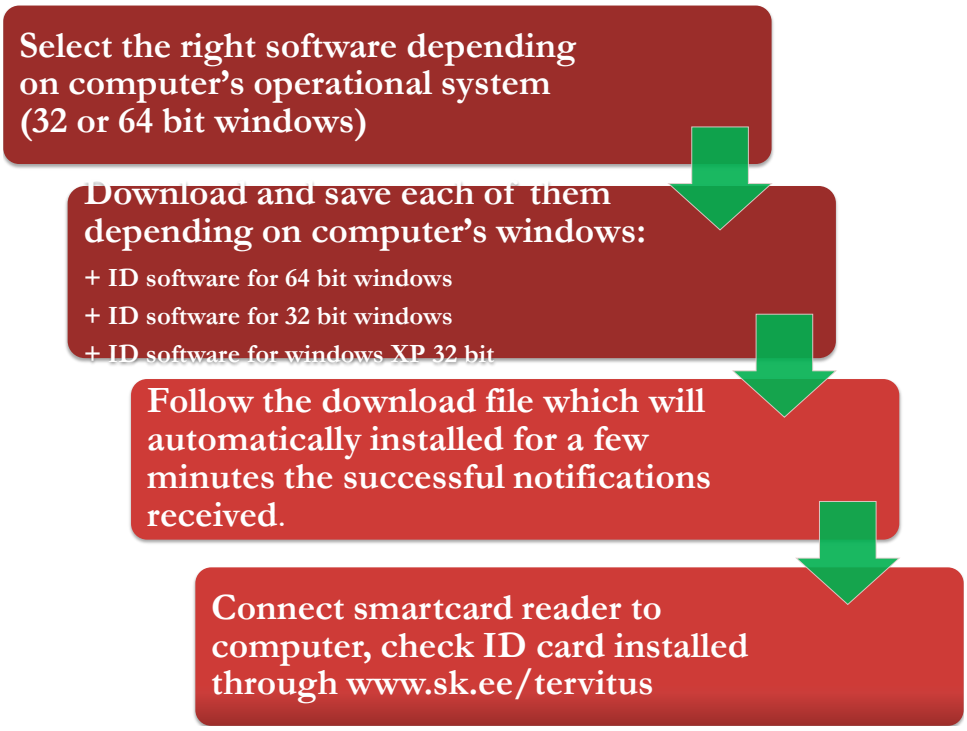

Figure 6. How to install digiDoc 3 program on computer (SK, 2014).

DigiDoc 3 is for the use of computer or laptops, it is not available on cellphones. Through the website of SK "https://installer.id.ee/?lang=eng", guidelines for the installation of software to verify signatures with Finnish mobile ID or the use of Finnish eID with Estonia software is provided (SK, 2014).

b. State Portal www.eesti.ee

State Portal www.eesti.ee is the government website which undertakes the statistics and information related to living and studying in Estonia. Signing documents electronically with ID cards, mobile ID cards or bank ID is one of the unique functions of the site. The figure 4 gives an overview how the State Portal looks like (eesti.ee, 2014).

After visiting the State Portal www.eesti.ee, users should then select "my data" to start signing or checking their own information as well as any others. There are 3 options provided for log into the system. The first option is to log in by ID-card, using mobile-ID is the second choice and the log in via bank. In the bank log in section, users can choose their bank out of SEB, Swedbank, Danske pank, Nordea pank and Krediidipank (eesti.ee, 2014). After logging into the system successfully, users are allowed to check their updated information or create digital signatures.

c. **ID digiDoc**.

ID digiDoc is the third way to help Estonian people sign documents online. The main website SK, https://digidoc.sk.ee/?f=chg_lang&lang=en talks about the information related to digitally signing.

DigiDoc Portal is available for Estonian ID-card and Estonian and Lithuanian Mobile-ID users and allows for digital signing, verification of validity of digital signatures, forward documents to other users of the Portal and to receive documents from other users of the Portal (ID digiDoc).

ID digiDoc allows users to sign in with 3 different types of ID including ID-card, mobile ID and Lithuania ID. Mostly the system requires phone number of users and personal code. The phone number should be updated and informed its use to the government or service providers (ID digiDoc).

3.2.3 Mobile-ID based digital signatures

Nowadays, mobile phone number with a special SIM card for electronic signing has become popular for signing electronically in Estonia. The signatures created by mobile phone have the same security level exactly like the normal identity card using PIN code. In addition, it can also help people avoid taking one additional card when go to travel (Herlihy 2013).

Mobile-ID is a service that allows users to use a mobile phone as the form of electronic ID and protected by a PIN code (Mobile-ID, e-estonia). Mobile-ID has the same functions as the all traditional identity cards except Mobile-ID does not require the card reader. Users can get special SIM card from the phone operator which includes private keys for identification and signing digitally (Mobile-ID, e-estonia).

Users can download free applications for signing digitally from providers and set up on mobile-phone as they do with computers. When it is done, the portal on the mobile phone screen will show the guides, with mobile phone, users click to choose "log in with mobile ID". Mobile ID pin code is required and the website will automatically reload the program to allow signing online (Mobiil-ID, e-estonia). It takes a short time to finish the signing digitally with mobile-ID, users can use mobile-phone for signing digitally in Estonia and abroad. People can use mobile-ID services for the variety of business activities such as payments, transactions or tax fillings. Estonia has become the first country that allows citizens to do voting through mobile phones. Electronic voting with mobile ID has been generated in Estonia since 2005 (The world's most mobile voting service, TeliaSonera).

In Estonia, documents with signatures created by mobile-ID are equal to handwritten signatures in legal status. In 2007, mobile-ID was taken into use in Estonia and at the same year, it won the title as "Best New Product" in a survey conducted by Innovation Center InnoEurope (Mobile-ID, e-estonia).

3.3 Renewal of ID card certificates

Renewal of ID card certificates is one of the most important parts when issuing digital signatures in Estonia. When certificates come to an end or stay 105 days before invalidity, people are required for the renewal in order to start creating online signatures again in Estonia. It is relatively essential to connect to good internet and supply ID card with PIN code for renewal (ID, 2014). The allowance time for renewing the certificates is moderately flexible for users. First of all, the author would like to summarize the kinds of certificates with the needs of renewal. Table 2 below will specify the categories for it.

Table 2: Categories of renewal and non-renewal certificates (ID, 2014)

Certificates for renewals	Certificates for non-renewals
ID-card certificates for login online services.	ID-card certificates for physical identity
Certificates for creating digital signatures.	ID-card certificates for travelling purposes.

Table 2 provides the instructions for renewing certificates in Estonia. Depending on applications or cards users are applying, there are some small differences. According to (ID, 2014) the updating process generally takes a few minutes to complete when users are not interrupted because of bad internet connection.

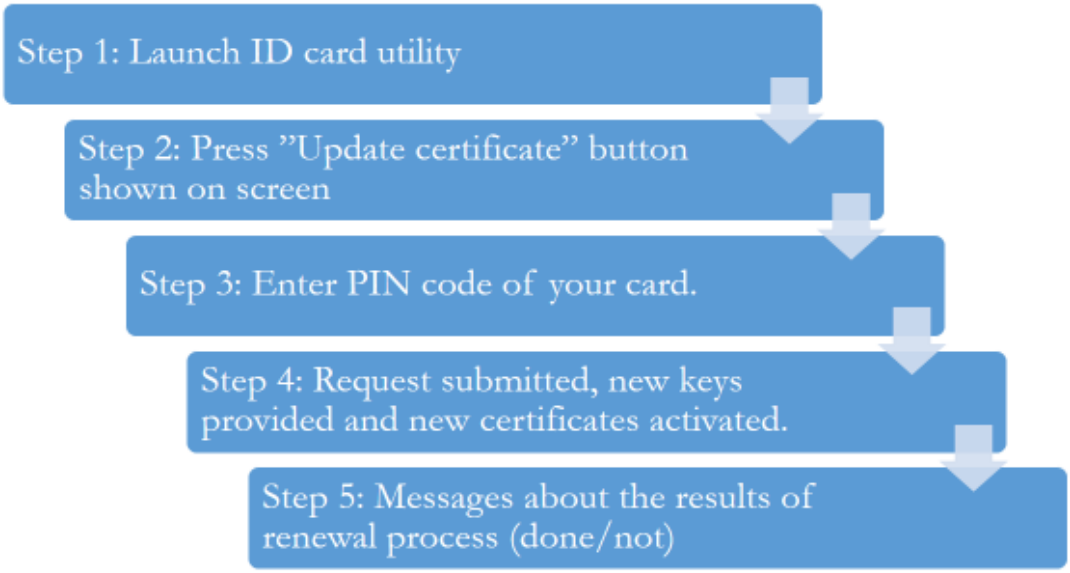

Figure 7: Renewal process of expired certificates in Estonia (ID, 2014).

The brief instructions for how to update the certificates are provided on figure 7.

- The first step is requiring people to launch the ID card utility. People use this ID card to log in the system (ID, 2014).
- After visiting the official page for signing, the button to update certificate shows on the screen of the application, press it and enter the Pin code named on their card (ID, 2014).
- When the request is submitted, the system will provide people with new keys and new validity time of the certificate. Without any internet interruption, the notification for successful updating process will be sent to people for verification after a few minutes (ID, 2014).

There are several important factors that people should pay attention to during the renewal process of certificates. After the first step of renewal, people will see the general details about their personal identity and signing activities so far on the screen. The example of it can be shown on the following figure.

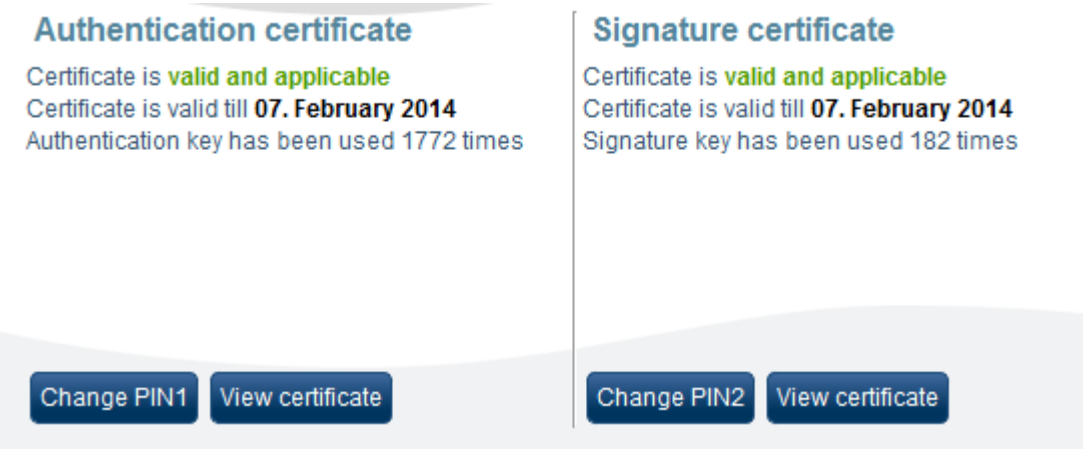

Figure 8: General details of on-going updated certificates (ID, 2014).

After people press the "Update certificates" button, they will see the details about their certificate if it is expired or allowed to start updating (ID, 2014). In Estonia, people can only update certificates when it is not in valid time or 105 days until the expiry. The service does not offer different options for users, they are only enabled to upgrade the certificates when their cards meet the requirements for the expiry time as mentioned above (ID, 2014).

3.4 Legislations

In March 8, 2000 Estonia passed the legislation act about digital signatures. The digital signature act came into force in December 15, 2000 (e-estonia). The legal acts cover legislation requirements about digital signature such as e-signatures, e-identity, time-stamping. The legal acts also help to limit the standards and formats for digital signatures framework (Martens 2013). It includes 10 chapters with different divisions for each chapter. The divisions are divided into smaller sections to fully describe the digital signature demands.

A digital signature is created by issuing the certificate and identity card that satisfies the standards to verify the signers in the future. Section 3, chapter 1 of Estonian digi-

tal signature acts 2000 confirms the legal status of digital signatures with handwritten ones.

> A digital signature is created by using the data necessary for giving a signature contained in a secure signature creation device to which the data needed for verification of the signature contained in a signature verification device uniquely correspond. (Section 2 of Estonian Digital Signature Acts 1/2000).

> a. Enable unique identification of the person in whose name the signature is given.
> b. Enable determination of the time when the signature is given
> c. Link the digital signature to data in such a manner as to preclude the possibility of changing the data or the meaning there of undetectably after the signature is given (Section 2 of Estonian Digital Signature Acts 1/2000).

It is a "must" for a legal certificate to provide information such as name of the holder, ID number, public key, validity, registry code and the use for the certificates in accordance with laws and legislation. The validity of the certificate depends on the validity set out on the card (Section 5 of Estonian Digital Signature Acts 2/2000). Private and public key are created depending on the needs or the request of the certificate issuer. The agreement should be made between parties: issuer and service provider. The providers are not allowed to copy the keys for themselves and the third parties (Section 7 of Estonian Digital Signature Acts 2/2000).

The certificate providers are responsible for the quality and information of the cards. They have the rights to ask for checking users identity if there is a reasonable doubt about incorrect information (Section 12 of Estonian Digital Signature Acts 2/2000). Informing about the expiry to users and providing guidance for renewing the certificates are the liabilities of providers (Estonian Digital Signature Act, 2000).

> a. The issuer of a certificate is required to verify that the application submitted for the certificate complies with this Act and that the data contained in the application are accurate.

b. A certificate is issued to a person promptly after entry of the corresponding data in the database of certificates which is maintained by the issuer of the certificate.
c. The issuer of a certificate is required to notify the applicant for the certificate of the conditions of use the certificate, the rights and obligations of the certificate holder and other circumstances related to the use of certificate.
(Section 10 of Estonian Digital Signature Act 2/2000).

Chapter 3 of Estonian digital signatures Act also acknowledges the readers with the information about standards to become legal providers in digital signature making process. The following entities and individuals are eligible for issuing certificates.

a. Public limited companies
b. Private limited companies with the share capital of which exceeds 25 000 euros
c. Legal persons in public law if this is prescribed in an Act concerning the legal person in public law
d. State agencies determined by the Government of the Republic.
(Section 18 of Estonian Digital Signature Acts 3/2000).

In order to issue certificates, providers are required set up the basic information of their business such as name, address, terms of certificate procedure and technical issues. They should be liable for the confidentiality of information of certificates (Section 20 of Estonian Digital Signature Acts 3/2000).

In addition to the certificate service provider's standards, time stamping-services providers are also taken into account in digital signature Act. Time – stamping verifies the time of the signatures made online. Legal Act about digital signatures requires time stamping services set up the same legislation sides with certificate providers before they are eligible to issue time stamping services such as duties and standards to become a legal time stamping-services providers (Chapter 4 of Estonian Digital signature Acts, 2000).

3.5 The success reasons of Estonia

Estonia goes ahead in front of other high-technology development countries powerful countries such as Germany or Italy in issuing digital signatures to be ranked as the number one of digital signature system. In order to fully provide knowledge about success reasons of Estonia to readers, the author evaluates the reasons on macro issues and micro factors. The macro issues are the opening for this chapter.

Estonia is a small country with over 1 million of inhabitants (Herlihy 2013), one fifth of Finnish population. It was fast for the technology revolution around the whole country. Moreover, according to the project "Broadband", Estonia wanted to provide fast internet connections to all homes, companies and institutions with around 100 Mbit/s connections and build "broadband" connections for rural area (Harjo 2012). This is considered as the motivation for the popularity of digital signatures.

In March 2000, Estonian government set up the acts to protect the rights of online signatures and approve the same legal status of digital signatures as handwritten ones (e-estonia.com). They expected for the economic growth from hi-tech development after regaining independence from Soviet Union. The shortage of labour force with low tax rate leads to the low tax revenues for government budget providing with the poor natural resources also actively interfered to the technology ambition in Estonia (Herlihy 2013).

There are also a number of relevant activities that pushed the plan go forward. Firstly, Estonian people are offered the "tools" for creating digital signatures **free of charge**. All they need to do is to buy the identity card with cheap price from government, then download the free applications and install it on their computer (Martens 2013).

Moreover, Tarvi Martens, the development director of Estonia's Certificate Centre, said value the synchronization of digital signature framework as the main factor to the popularity of digital signatures in Estonia. As the example of it, there is only one

service provider in Estonia until the current time. Tarvi approved the obstacles of issuing many different software programs for digital signatures. This would lead to difficulties to the government management's activities because of the incompatibility among different software programs. Many European countries have been facing up with the same obstacles as the result of issuing several different programs and file formats available on the market (Martens 2013).

4 Finland as a potential market

This chapter comprises of the most key characteristics about the Finland such as economic factors, technology and digital signature situation in the country. Then the chapter is followed up with the discussion of the legislations for digital signature in Finland and ended with the types of certificates that have been issued in Finland to serve the purpose of signing digitally. The overview about Finland part is made with the goal to compare between Estonia and Finland to outstand the opportunities for digital signatures in Finland. The legal act part provides information for companies who are interested in owning digital signature system or becoming providers. The types of certificate issued in Finland are used to analyse if digital signature would still work in Finland and bring benefits to Finnish people.

4.1 Overview about Finland

Finland, the Republic of Finland is a Northern European country with 5.4 million inhabitants. Sweden, Norway, Russia and Estonia are Finland's neighbour (Wikipedia, 2014) Helsinki is the biggest city with around 600 thousand people and other big cities are Espoo, Vantaa, Turku, Tampere and Oulu. The EURO became the valid currency in Finland since March 2002 instead of markka. Finland is an industrialized country focusing on pulp, paper industry, metal industry and electronics. Finland is also the country which is the best in controlling inflation rate in Europe with high social welfare budget (Korpela 2014).

Science and technology have been playing a vital role in the growth of Finnish economy and Finland has been at the center of the continent's tech industry for years. Around 3.5 percent of national gross domestic product comes into research and development (R&D) activities and only two or three countries have been spending that much amount of budget for R&D (Vanhanen 2008). Finland is from a country with the main industries like forestry, energy and retail to a high tech place producing wireless technologies, software development and sensors (Invest in Finland, 2013).

According to the global information technology report 2013, Finland is ranked as the first country in embracing information technology thanks to business-friendly environment and education system. Finland stands out as the center for digital innovation. Finland is the country with the highest number of patent applications per capital. 90 percent of Finnish population gets access to internet connection while US has 70 percent and 85 percent of UK people connect to internet (Global information technology report 2013). Figure 9 draws the trend of internet usages in Finland from 2014 to 2017.

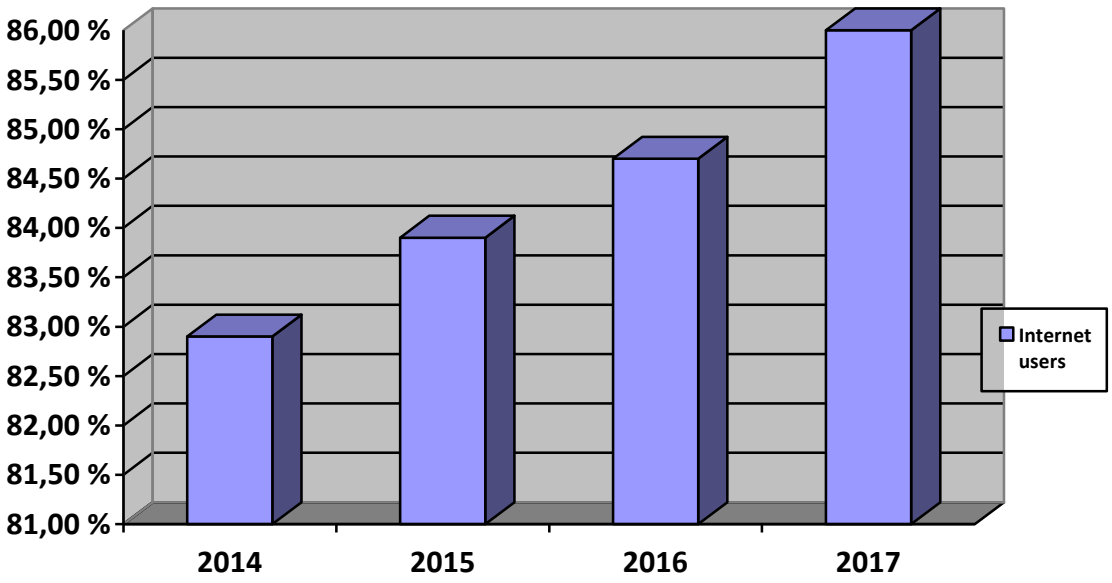

Figure 9. The trend of internet usages from 2014 to 2017 (statista, 2014).

The proof for the increase of internet usage in Finland in the next 3 years is shown in figure 9 and it is forecasted to going up dramatically year by year until 2017 reaching to the peak up to 85% of the whole population (statista, 2014). Furthermore, "Broadband" project is allocated that Finland has been working to provide faster internet connection and cover the whole area with internet access (brodynt, 2010). This is a very compromising project which enables the development of e-services activities around the country. The increase of the internet usage is to open the bright future prospect for digital signatures in Finland. When everyone gets access to internet, it has become the basic necessity for enterprises to modernize the working proc-

ess, typically signing digitally. As the results of briefly summarizing the characteristics of Finland, the author analyses the reasons for Finland as the potential market for digital signature system.

Doing transactions online has been increasing greatly to become important to business operations today in Finland. All banks have been offering online services to their customers such as transactions, billing and ensuring about the security of the system. Digital signature is forecasted as a very developing part of the information society, especially to a technology developed country like Finland (Global information technology report, 2013). Finland is a huge market for digital signatures with over 5 million citizens with over 100 ongoing projects conducted within state authorities among around 0.5 million employees in addition to a great amount of private sectors such as banks, telecommunication companies compared to 3 million people in Estonia (Finnish population registration centre). However, the protection for the reliability and safety for digital signature system in Finland requires more work than in Estonia as a result of higher population rate. In addition to the huge market for the product, Finland is considered as a leading country in technology development which is the perfect fit for digital signature since building a safe and reliable digital signature system demands the modern and technical solutions based on open standards (Finnish population registration centre).

> Digital signature like a mobile phone 20 years ago, no one understood the real nature and benefits of it!
> (Kaljumäe 2014).

4.2 Legislations

The Finnish electronic signature act came into force in 2003 (Finnish electronic signatures, 2003) with the goals to protect the rights of the signers as well as providers and strengthen the reliability of the electronic signatures. Even though signing digitally is not well-known in Finland recently, Finland already comprises the very detailed legislations for digital signatures. The content of the Acts includes 5 different

chapters with many sections included in each chapter describing the requirements related to reliable digital signature system.

Finnish Acts on electronic signatures (1/2003) describes:

> The purpose of this act is to promote the use of electronic signatures and the provision of products and services related to them as well as to promote data protection and data security of electronic commerce and electronic communication.
> (Section 1 of Finnish Acts on Electronic Signatures 1/2003).

First of all, the certificates must be issued by a trusted certificate service provider with the identification of the provider. In both sides of the card, there should be enough required information like identification information of the signer, validity date, card holder readable format and any relating information about holder and the legal card (Finnish Acts on electronic signatures 2/2003).

> a. An indication that the certificate is a qualified certificate
> b. The identity of the certification-service provider and the State in which it is established.
> c. Signature verification data
> d. The validity period
> e. Identity code of the qualified certificate
> f. The advanced electronic signature of the certificate provider.
> g. Limitations on the scope of use of qualified certificate
> h. Specific data relating to the signer
> (Section 2 of Finnish Acts on Electronic Signatures 1/2003).

In addition to certificates issued outside Finland, the providers must belong to European area and be a registered one satisfying to the requirements from Finnish legislations for a qualified certificate (Finnish Acts on electronic signatures 8/2003). According to Finnish electronic signatures acts (2/2003), users are encouraged to provide "advanced digital signatures". Advanced electronic signature is defined as.

a. Which is uniquely linked to the signatory
b. Which is capable of identifying the signatory
c. Which is created using means that the signatory can maintain under his sole control
d. Which is linked to other electronic data in such a manner that any subsequent change of data is detectable "

(Section 2 of Finnish Acts on Electronic Signatures 1/2003).

Moreover, the companies conducting digital signatures should be legal entities belonging to European entities and have appropriate economic power to provide required devices for their operations (Finnish Acts on electronic signatures 8-10/2003).

> The certificate provider is established in a State belonging to the European Economic Area and the certificate meets the requirements laid down for a qualified certificate in the State of establishment.
> (Section 8 of Finnish Acts on Electronic Signatures 2/2003).

> The certificate provider ensures that it's personnel has sufficient expertise, experience and qualifications. Provider ensures it has sufficient financial resources to arrange its operations and to cover any liability for damages.
> (Section 10 of Finnish Acts on Electronic Signatures 2/2003).

Service providers are required to provide their business information and business performance to the government. They must supply customers with legal certificates and devices. Verifying the identity of the holder before providing the certificate and informing the terms of using it are the responsibilities of the providers. (Finnish Acts on electronic signatures 12/2003).

> A certificate-service-provider that intends to provide qualified certificates to the public shall, prior to the start of the provision of qualified certificates, submit a written notification to the Finnish Communication Regulatory Authority.
> (Section 9 of Finnish Acts on Electronic Signatures 2/2003).

> Finnish Communications Regulatory Authority may designate inspection bodies to access whether a signature-creation device meets the requirements required by legislations.
> (Section 6 of Finnish Acts on Electronic Signatures 2/2003).

Moreover, it is noted that providers are required to be responsible for any damage to the holder except the situation when the holder loses the private key (Finnish Acts on electronic signatures 16/2003). Informing the validity time online to the holder also belongs to the liability of the providers. The providers need to make sure that their hardware and software have no working errors (Finnish Acts on electronic signatures 11/2003).

> A certificate-service-provider providing qualified certificates to the public shall ensure that the systems, hardware and software it uses are efficiently trustworthy as well as protected against alterations and forgery.
> (Section 11 of Finnish Acts on Electronic Signatures 3/2003).

4.3 Finnish Population Register Centre's electronic identity and certificates

The Finnish Population Register Centre is known as the reliable provider that has capacity to issue secure certificates. Certificates issued by the population register centre are evaluated to be qualified ones. In 1999, they created the electronic identity providing personal identity code for Finnish users a long time ago and until now they are still the only certificate authority in Finland (Population Register Centre, 2013).

The electronic identity is used for electronic users in a safe online transaction. It is like a database with the set of numbers and identification information about individuals which is used to identify Finnish individuals and foreigners with information entered in Population Information System.

When user receives the certificate card and check their own Citizen Certificate which includes individual's name and electronic client identifier, the digital client identifier is

activated. The Citizen Certificate is for identifying, encrypting emails, documents and allowing people to sign electronically (Population Register Centre, 2013).

Table 3. The addresses for electronic identity's information (Population Register Centre, 2013).

Population Register Centre: electronic identity and certificates	**Population Register Centre fineid.fi**
- The use of ID card - The use of certificates - The role of certificate authority	- Technical descriptions of certificates: content, revocation list, directory specifications. - Certificate policies, legislations and free card reader software

Even though Population Register Centre provides the qualified certificates based on the requirements of Finnish electronic signature Acts 2003, the system is still not widely used in Finland. Governmental providers are more highly valued since it is easier for management and building pressure as well as introduction about the system to Finnish people.

4.4 Katso identification

"As a representative of your organization, you can sign in to Katso to set up Katso ID, manage organization data, sub-IDs and authorizations." (Katso, Vero).

The Katso system is the free of charge application which serves for corporate taxpayers to start using digitally and safely by the Finnish Tax Administration. It is essential for the corporate taxpayers to have a Katso ID in order to start using the services online. The following parts provide the knowledge about factors of Katso system to users including service descriptions, Katso ID, how to join the system and how to set it up.

Katso ID is evaluated as a confidential and the most complete system. However, they are still waiting for the permission from government to legally issue the system widely. Katso IDs are freely provided to business enterprises, tax offices, public entities and estates of deceased people (Katso identification, Vero).

4.4.1 Katso service descriptions

The website of Katso is set up with the purpose to allow users to manage their Katso ID, data and the use of it for their company's activities. According to Katso identification, Vero, users are enabled to change passwords, check out the lists of passwords used and make sub-IDs through the website interface (Katso identification, Vero, 2011).

Two types of Katso IDs that are widely known in Finland are Katso ID and Katso sub-ID. Katso ID is made up with user name, password and one-time password through Finnish Personal identity code. One-time password keeps on changing every visiting time like the PIN code you use to log in your netbank account. Katso ID is on the use of one representative of an organization called Master User. While Katso sub-ID requires username and password only and has no relation with Finnish personal identity. Katso sub-IDs are created for the use of the employees by Master User (Katso ID types, 2011).

4.4.2 How to request for the Katso ID

Katso ID is very convenient to business enterprises, therefore owning a Katso ID is recommended to any of them. Table 4 below provides the information for each category in order to own a Katso ID.

Table 4. How to request the Katso ID (Katso identification, Vero, 2011).

For a business company	- The person with the rights to sign company's name (Master User) for starting using Katso ID - Master User create sub-IDs for employees - System converts sub-IDs into Katso IDs
For a self- employed business	- Katso ID can be obtained without physical Trade registration by the owner of business
For associations	- Issuing rights are from relevant register data
Estate or consortium	- Authorized person with network banking and microchip + Send power of Attorney + Within 3 days, visit Katso website to set up the system
	- Authorized person without network banking or microchip + Launch **Set up Katso ID from** https://yritys.tunnistus.fi + Prove identity by showing personal documents to tax office physically.

4.4.3 How to set up Katso system

After successfully request for the Katso ID, it is important to know how to set up the Katso ID and password. The set up process is divided into 2 categories with "network banking and password" and without "network banking and password" (How to set up Katso ID and password, Vero, 2011). Table 5 specifies exactly what users should do to set up the system depending on their situation **with** or **without** network banking and password. Table 5 comprises of 2 columns with "with" as setting up the system with network banking and password and "without" for the users owning no network banking and password.

Table 5. How to set up Katso system (How to setup Katso user ID and password, 2011).

With	Without
- Set up Katso ID - Identity and issuing authorizations are checked. - Confirming email sent before using	- Set up a Katso ID - Registration for Katso at tax office physically - Confirmed email sent to eligible people

Basically, the difference between setting up the system with network banking and without it is that without networking banking or password requires individuals to visit tax office in person for registration.

4.5 Tupas Identification services

Tupas service allows banks to identify their customers who own a Tupas certificate. The Tupas certificate is registered by its holder including the identity information of him. Tupas certificates are used to do electronic identification and create electronic signatures and get involved by banks in Finland. They provide secure identification and transactions digitally (Tupas Identification Services, 2011) There are 4 parties in total involving to the Tupas service system that need to be mentioned here in the figure 10.

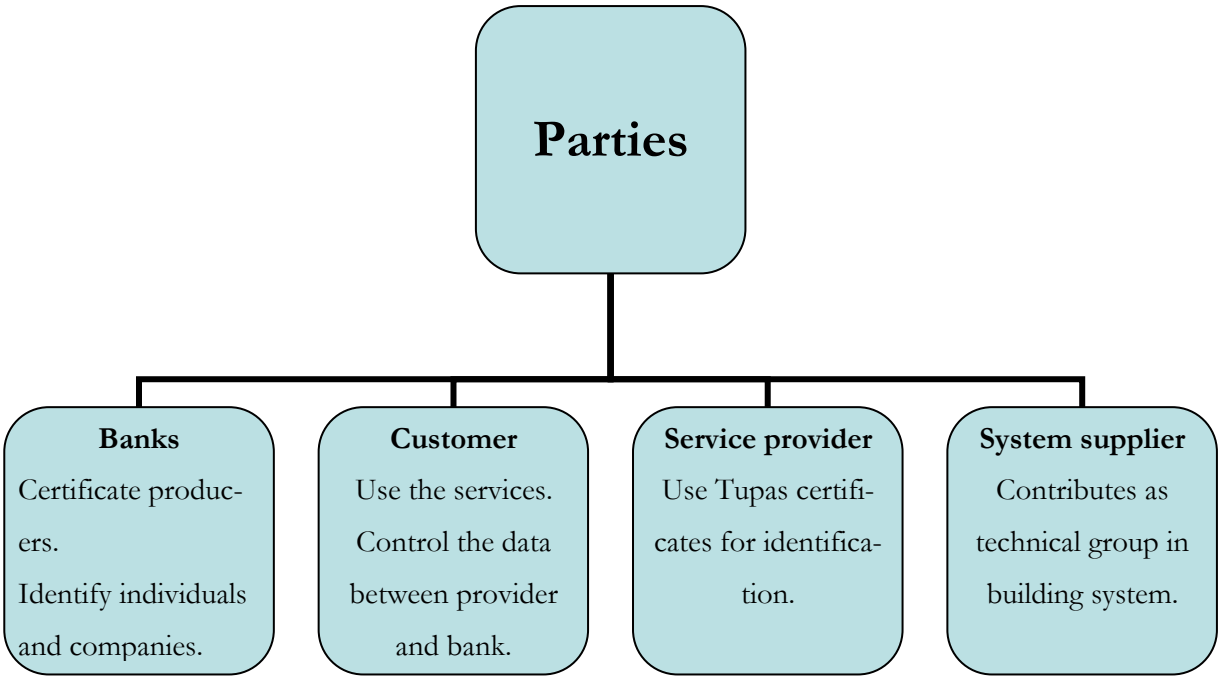

Figure 10. Parties involving in Tupas service system in Finland (Tupas Identification Service, 2011).

Figure 10 above concludes the parties that are jointly specified in Tupas service system. They have relationships to manage providing the trusted Tupas system. The Federation of Finnish Financial Services controls the information related to Tupas identification and is liable for doing updates for the system (Tupas Identification Services, 2011). However, as evaluated Tupas is still not considered in national level standards, it is owned by the financial services and issued by banks and all of them are private sectors. It is more recommended to issue the system under the administration of government offices.

5 Cost analysis

Cost analysis is a powerful tool to help companies make important decisions in their business (Braun & Tietz 2013). The chapter provides the basic theory about cost analysis in business. The first part starts with the definition of cost analysis and why cost analysis is important in business decisions, typically in this thesis. Then, the author draws up the ways to apply the numbers to the cost analysis tools.

5.1 Definition

In general, cost analysis shows the connection among costs, volume and profits of the company. Companies often use cost analysis in order to make the important decisions in their operations by comparing the sales, profits among many selections (Braun & Tietz 2013). However, a good cost analysis strategy identifies the belonging consequences of selections (Kenneth, Maureen, George, Robert, Lester & …).

Cost analysis is considered as the effective tool for the companies to adapt with changes in market and estimate the sales products to satisfy the needs of their customers. These following components are the ones which affect the cost analysis strategy in general (Braun & Tietz 2013).

+ Sales price
+ Volume
+ Variable costs
+ Fixed costs
+ Profit or lost or the differences among volume of many products

In this thesis, cost analysis is applied to classify the price for every category and total costs needed of issuing digital signatures and handwritten signatures. The results collected are used to evaluate which form of signature will bring the most effectiveness which can be easily found out by comparing the total cost between 2 types of signature.

Cost analysis plays a very important role in the decisions making of managers. It is a useful tool to help managers to determine:

+ Production units to reach target profit or to reach breakeven point (Braun & Tietz 2013).
+ Evaluate positive factors
+ Identify the negatives and costs
+ Compare choice among many different product plans for example between the price issuing between digital signatures and handwritten signatures.

5.2 Cost analysis method

In order to make the most accurate cost analysis results, it is essential to know the production/consumed units, the fixed cost and variable costs (Braun & Tietz 2013). In this research, it is required to both find out the total volume for issuing digital signatures and hand written signatures. The total volume 1 is represented for the total cost of hand written signatures while total volume 2 is for digital signatures. With the needed numbers provided, the total volume is listed in the following.

Total volume 1 = fixed cost 1 + variable cost 1 * consumed units 1
Total volume 2 = fixed cost 2 + variable cost 2 * consumed units 2

After finding out the total cost for creating both 2 types of signatures, it is then easier to evaluate the differences by subtracting the total cost 1 to total cost 2. The results found would analyze which kind of signature is more efficient and economic for the company. As the result of it, the decision makers can choose which plan would bring better benefits to the operations of their company.

6 Research methodology

This part comprises of the selecting process of the research methods, coming up with research problem and investigative questions, companies selected for interviews, planning and analyzing the results. Based on the amount of secondary research collected mainly from online sources and some academic books, the theoretical framework has been designed to fully support the primary research throughout the following chapters. The primary research of this thesis has been conducted through interviews with SMEs in Finland and in Estonia. The outcomes of the research are analyzed at the end of this chapter after applying the research methods.

6.1 Selection of the research method

The purpose of this study was to learn more about digital signature, its benefits as well as disadvantages from Estonian companies. The author was also encouraged to learn more about expectations and characteristics of Finnish companies towards digital products. As a result of unavailable information in public secondary data, this practical part would provide exploratory information to readers.

Qualitative research is the kind of exploratory research which provides the researchers insights into a problem by gaining the understandings about opinions and reasons. Qualitative methods are also the most flexible and unstructured. Qualitative research is conducted by observing what people do and say openly and then comprises of collecting, analyzing and interpreting data. (Burns & Bush 2014, 146-148). Therefore, in order to have specific insights about Estonian and Finnish companies, qualitative research was the most suitable method for the author to satisfy for the needs of the commissioning company.

6.2 Research problem and IQs

By conducting interviews with companies in Estonia and SMEs in Finland, the author collected the results to answer the investigative questions and objectives set up

by the commissioning company. The research problem focuses on the clear, accurate and practical results about the study of Estonian digital signature as well as its efficiency to Finnish SMEs. Therefore, the research problem is "**Potential efficiency of digital signatures to Finnish SMEs".** All investigative questions are included again in the following table.

Table 6. Investigative questions.

IQ 1 How does Estonian digital signature system work in practice?
IQ 2 What are benefits and drawbacks to Estonian companies in practice?
IQ 3 What are Finnish legislations and what are customers's expectations toward digital products?
IQ 4 Would digital signature bring cost efficiency for Finnish SMEs?

The first investigative question is set up to discuss about the Estonian digital signature system. The commissioning company is expecting to clarify the working system of digital signing and what Estonian government has been doing to protect the rights of digital signatures. The second investigative question is to find out the benefits and drawbacks that Estonian companies have been involved in. The findings are important for the opportunities of digital signatures in Finland and used to eliminate the risks for users. The third investigative question focuses on expectations of Finnish companies when signing documents digitally. With the hope of providing more unique and effective digital signature system, it is advantageous for the commissioning company to understand the needs of potential customers. And the last investigative question is to estimate if the same digital signature model used in Estonia would bring cost profit for Finnish SMEs operating in construction and real estate field. Based on the investigative questions, the researcher read, collected, planned and designed questions for interviews to obtain the answers for each of them. After collecting the results from interviews, the researcher did the analysis and summed up the most important key findings.

The author has outlined the following figure 11 as the research process. In this research, interview questions have mainly provided the answers for the investigated questions of the theoretical framework. The first investigative question to the third investigative question has been referred from experience of companies, that's why the results are collected from interviews with companies. The last investigate question is explained by combining the primary research and secondary research.

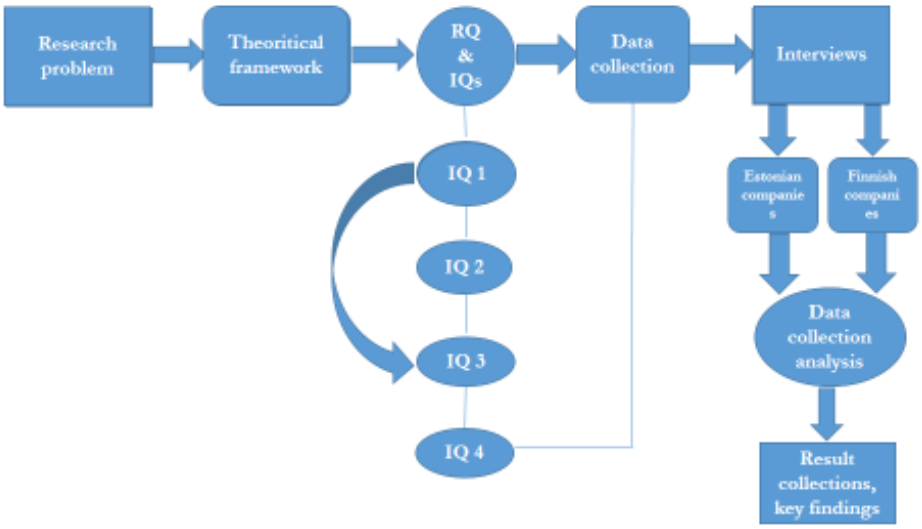

Figure 11. Research design process

Estonia cases refer to the questions designed for interviews with companies in Estonia in order to gain practical knowledge about their digital signature system. Finnish cases talk about the interviews with Finnish SMEs in construction and real estate, where the expectations of Finnish companies in signing digitally were provided. The first investigative question has connected closely with the IQ 2 and the IQ 3. The answer for the last investigative question encloses the combination of literature review and interviews.

Based on the investigative questions the author designed the interview questions which would obtain the explanations for each investigative question. The interview

questions were mentioned in the table 4 in a flexible manner to suit the requirements of each investigative question.

6.3 Data collection

Originally, six Estonian companies issuing digital signature system and six Finnish small to medium sized (SMEs) construction and real estate companies were required to conduct for the interviews. However at later stage, five Estonian companies were selected for the interviews because the author figured out the majority of the interviewed companies provided the same knowledge about digital signature system in Estonia as well as benefits and difficulties they have been facing up with. The author believes five companies are sufficient for obtaining the results for the research about digital signature in Estonia. The number of six Finnish SMEs about construction and real estate stayed remained since the results collected from them differed greatly among each other.

One Estonian company that is operating in producing signing applications was provided by the commissioning to start conducting interview. The other companies were found from real estate and construction Association website and other internet sources. They were contacted first by email or phone calls to set up the time for the interviews. Since there are eleven companies in total and some of them do not want to publish their name, the author decided not to mention the specified name of interviewed companies in this report.

In general, the interviews with Estonian companies tend to last longer than the ones with Finnish companies. They were very helpful to describe about digital signature and it benefits in very detailed manner. There was one Finnish real estate company chosen for the interview and they were very curious about the research. They expected about its success to bring the economical issues to their old-fashioned operation way. The following table 7 and 8 provide the basic heading about interviewed companies in Estonia and Finland.

Table 7. Interviewed companies in Estonia

Company	Title of interview	Interview method	Duration
E.A	Head of IT department	Skype	30 minutes
E.B	Head of sales department	Skype	30 minutes
E.C	Head of IT department	Email	/
E.D	CEO	Skype	40 minutes
E.E	Secretary of CEO	Skype	1 hour

Table 8. Interviewed companies in Finland

Company	Industry	Title of interview	Interview method	Duration
F.A	Real Estate	Head of sales department	face-face	1 hour
F.B	Construction	Head of marketing department	Skype	40 minutes
F.C	Construction	Marketing department	Skype	35 minutes
F.D	Construction	Sales department	Email	/
F.E	Real Estate	Marketing department	Face-face	35 minutes
F.F	Construction	Engineer	Face-face	35 minutes

Interviews were mainly conducted through Skype with companies in Estonia and face to face meetings with Finnish SMEs even though skype and email were used for the interviewing process. The contents of face to face and Skype interviews are recorded in the recording for further checking by the author.

6.4 Data analysis

It was struggling to collect the data from 11 interviews which were conducted in various methods: face to face meeting, skype and emails. Each interviewed method used required the author apply different data collection version to ensure the most effective and accurate results.

Face to face interviews were mainly used with Finnish SMEs due to their advantage of location compared to Estonia companies. During the interviews, the author asked questions and record everything interviewees replied while let them openly talk more about their information. That's why face to face interviews tend to last longer in content than skype, especially emails. After completing interviews, the author listened to recording tape again, took note the main findings to easily check up in the future.

Skype interviews have the less difference to face to face meeting than email. It was used to Estonian companies or Finnish SMEs far away from Helsinki region. The data collection method was applied as the same as face to face interviews. Except, skype interviews tend to finish in shorter time than face to face meeting.

Out of 3 data collection methods were used, email was the one which is the least recommended. All emails interviews were used as a result in the change of schedule of interviewees. Spending time to contact again each other to find up the solution couldn't convince the interviewees available for anytime soon, then email was selected. The contents of email interviews are concrete and logical. It took less time to finish data collection, even though the author had to email interviewees back for unclear answers.

7 Research results

This chapter will include the paraphrased answers obtained from the 5 interviews with companies in Estonia and 6 Finnish construction and real estate SMEs. The outcome for interviews with Estonian companies is set up in subchapter 7.1.1 and 7.1.2 sums up the interview results with Finnish SMEs. Moreover, with the discussion subchapter provides the findings during research process and answers for investigative questions.

7.1 Outcomes

This subchapter will summarize the answers from interviews with companies in Estonia and SMEs in Finland.

7.1.1 Results from Estonian companies interviews

Interview question 1. Why did your company start using digital signature?

Each of the interviewees explained the motivations which pushed them involving in the digital signature system. The answers's details depend on different companies however 4 out of 5 interviewees answered their company started using digital signature due to its great benefits such as freely available, make things done faster through emails. They can save a great amount of time thanks to the signing electronically system. Especially Estonian legislation protects the rights for digital signatures which conclude the same legal statuses of signing digitally as handwritten signatures. Banking syste, in Estonia joined the campaign to promote the use of e-ID system. They introduced their e-banking services and made digitally signing well-known around the whole territory.

Out of five interviews, company C issued the digital signature system for the first process due to the external pressure from government which it was compulsory for individuals and enterprises to issue certificates for identification and signing online.

These certificates were the base for the start of digitally signing. However, after a short time using the system, they enjoyed the benefits it brought out to their operation with saving time and being more convenient to just use emails.

Interview question 2. Could you describe about the digital signature system that your company is applying?

Five interviewees provided the same answer for this question generally. At the first stage, government issued ID cards which are used for identification and digitally signing. The ID cards include all personal information of the holder such as name, address, date of birth. The personal information included is enhanced the reliability and checking if needed. Public key and private key also on the cards were described in chapter 2.

Then they use the software from the site www.id.ee for signing or share documents through online digitdoc-sk.ee system for digitally signing purpose. The next step is to wait for the partner signing and send back the signed documents to his email for acknowledgement. In order to encrypt the signed documents from sender, the receiver is required to use his private key to reply back of his "receiving". Signing digitally within the operation of interviewed companies or with their partners inside Estonia are compulsory up to now.

Interview question 3. You apply signing digitally with only companies inside Estonia? Do you face up with any legal difficulties?

As the current time, digitally signing is just eligible within companies and organizations in Estonian region. Company A expressed her wish that the other countries, ideally Finland, Estonian neighbour would have the right awareness of digitally signing software and spread the system to their country.

Since legal acts that support the use of digital signature ensures the equal legal status of it as handwritten ones, interviewees have been facing up with no legal difficulty for the use of the system.

Interview question 4. How do you deal with problems such as expiry of the software, certificate? Does renewing the certificate cause you a lot of work?

In order to solve the expiry problem, people need to update software with application for signing digitally, certificates and renewing the ID card which is easy and fast up to several minutes for updating with clear instructions.

The application used for signing will be automatically updated or giving clear instructions when there is a new version provided. It is the responsibility of holders to visit governmental office to update ID cards, telecom companies to announce the renewal of mobile ID-cards. Holders receive notifications for the upcoming time to update their card.

Nowadays documents and certificates (with pin codes last together) generally have the same validity up to 5 years. Whilst documents used to be valid within up to 10 years and certificates lasted from 3 to 5 years. There have been changes in legislations and rules for the validity of documents and certificates to protect the reliability of signatures better. Specifically, Estonian ID cards require renewing 2 times per year with automatic updated function. For example, users get software from Appstore by Mac OSX.

Interview question 5. What benefits has digital signature brought to your company?

The benefits digital signatures have brought to interviewed companies are listed briefly in the following figure.

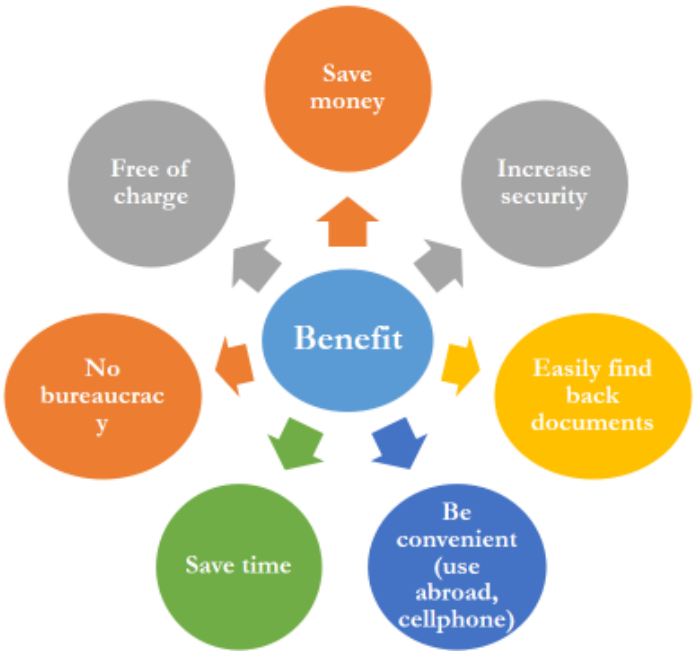

Figure 12. Benefits of digital signatures to interviewed companies in Estonia.

Each interviewed company provided practical advantages from applying digital signature system. They are all very pleased with benefits the system has brought. The author was introduced the official site from which people can calculate themselves how much money they would save from using digital signatures instead of handwritten ones: SK, digital signature cost-profit calculator: http://eturundus.eu/digital-signature/ by the head of IT department of company E.A, . Filling the numbers from the use of the company during the process of signature creation, companies would get the amount of saved money.

Interview question 6. What about disadvantages?

Company C and E have not found any difficulty when issuing digital signature system. The interviewee considered signing electronically as the most effective tool for their business operation. Some obstacles as well as worries of the interviewed companies are mentioned in the following part.

The first difficulty mentioned by company A is that people do not have physical documents or contracts to put into develop and safe deposit boxes, unlike printing

documents with handwritten signatures. The author later recognised of this as the great benefit of digital signatures.

Moreover, company B provided the author the obstacle of digitally signing when doing international business or signing documents from abroad, virus programmes might affect the computer and influence to the security of password of users. This should require the work from the application providers and the holders's computer as well.

The last difficulty is the worries of the company D for the security and archiving of documents after over 10 years. They expected there would be a safe and efficient way to maintain the quantity as well as quality of signed documents online after a long period of time. According to the company D, the current document format .ddoc uses SHA1 has and it is known to be broken most within some years. Therefore there is a huge need for the protection and maintaining of the current documents. It would take too much work to resign before the format will be broken. As a result of it, digital signature seems to be effective and useful for the use of documents that are related to the current purposes. Non-current ones should still encourage users to apply the other ways to keep the signed documents in the best condition.

Interview question 7. Estonian people can use their mobile phone to do signing online. Is there any effect and difference with using PIN code from identity card?

Interviewed companies provided interesting facts for the usage of mobile phone for signing in Estonia. In order to start signing electronically, one mobile ID Sim card issued by telecom companies is equivalent. However, the usage of it is popular among individuals due to the convenience and longer existence of normal ID within organizations. People are provided different selections with special ID card for signing and SIM card for signing on mobile phone. They compare the choices for ways to create signatures online just like choosing which pen you prefer to use when signing a document.

Interview question 8. To whom would you recommend digital signature?

In spite of some disadvantages, all interviewed companies still would like to recommend digital signature for usage to everyone, government, businessman, individual. They still consider benefits of digital signatures outstanding and huge.

"Digital signature is like a mobile phone 20 years ago, no one understood the real nature and benefit of it" (Tarmo, head of sale department, company E.B, 2014).

7.1.2 Results from Finnish SMEs interviews

The answers from 6 interviews with Finnish SMEs are briefly expressed in the following parts.

Interview question 1. How often do you work with contracts or documents requiring signatures?

The interviewees estimated the amount of documents which are varied in types such as working contracts, bills, receipts from banks, insurance companies or Kela they have been signing in a day though it is flexible and changeable in different time of the month as well as the year. In general, they have been dealing with a lot of contracts and paper documents in a day depending on different companies with couple of times a week or several times per day. Table 9 summarizes the amount of signatures made in each interviewed company.

Table 9. Amount of signatures made in interviewed companies.

Interviewed company	Amount of documents with signatures
F.A	Make signatures a lot, couple times per day.
F.B	Several times per day (5-7)
F.C	Several times per week
F.D	10 times per week
F.E	Very often, 5-10 times per week
F.F	Several times a day

Interview question 2. Which forms do you often use for signing process?

Most of the interviewed companies have been using just paper documents requiring handwritten signatures. However, 2 companies are not limited to only paper documents. Depending on the importance and the urgency of the documents, they still use internet form documents. As the results of the interviews, real estate companies require physical identification with handwritten documents and face to face meetings more than construction companies with a variety of documents such as acceptance of the offer, sale and purchase agreement. Real estate companies consider that as the most effective way to get signatures and build relationships with customers.

Interview question 3. Could you please describe how you manage to get handwritten signatures? With clients nearby and with clients far away?

This question is divided into 2 different situations that signatures are made in Finnish SMEs. They are very flexible in acquiring signatures from their customers or business partners.

In this first situation, in order to get signatures from customers close to office, it is easy to organize face to face meetings for signing documents. All interviewed companies have sale people to go out to see customers to get signatures. They believe that this way provides them the most confidential signatures and also helps them build secure relationships with customers even though companies need to pay travelling expenses and working hours for sale departments.

The second situation is how interviewed companies do with customers so far away. There are 2 methods they have been using to get signatures. Some companies use post office service to send documents to the customers. After signing the required documents, customers send back to them by post. This way requires a lot of time and money. That's why interviewed companies do not use it often recently. The more effective method has been used is to scan documents, signing and then send to customers after scanning back documents with signatures made. It is more time-saving and economical than the first method. However, these ways can be only used with customers or business partners that interviewed companies have close and reliable relationship with since in long distance, signatures can be faked without identifications.

Interview question 4. How long does it take each time in general? And how much does it cost? Do you find this way provides confidential signatures and economical issues to your company's operation?

In general, all interviewed companies are pleased at the current methods they have been using to get signatures from customers or business partners. They believe in the reliability of the used method. Even though as calculated in chapter 8, they have to pay more money and spend more time for handwritten signatures than digitally signing. Especially they consider face to face meeting as the most reliable and effective working method.

Interview question 5. Do you face up with any challenges?

Construction companies sometimes find it challenging to always go out to meet customers to just get signatures due to a large amount of inquiries from customers. Finnish SMEs considers themselves as being traditional in creating signatures for always requiring face to face meeting. However, they consider it as effective method for building relationship with customers. Beside that reason, construction and real estate companies have been facing up with no challenge.

Interview question 6. Have you heard about digital signatures? What do you expect about digital signature products? Would you be willing to try it?

All interviewed companies have heard about digital signatures but they do not have much knowledge about it. During the interviews, the author tried to define digital signature with its benefits and challenges with the way it works, interviewees still showed their doubts toward digital products especially to signing online model. However, all of them are curious to try using the system and considers the system as a very useful tool for their work with saving time and money as benefits like described.

Interviewees also expressed their expectations when choosing a digital product, especially the application to allow them signing online important documents. Their expectations are shown in the following figure.

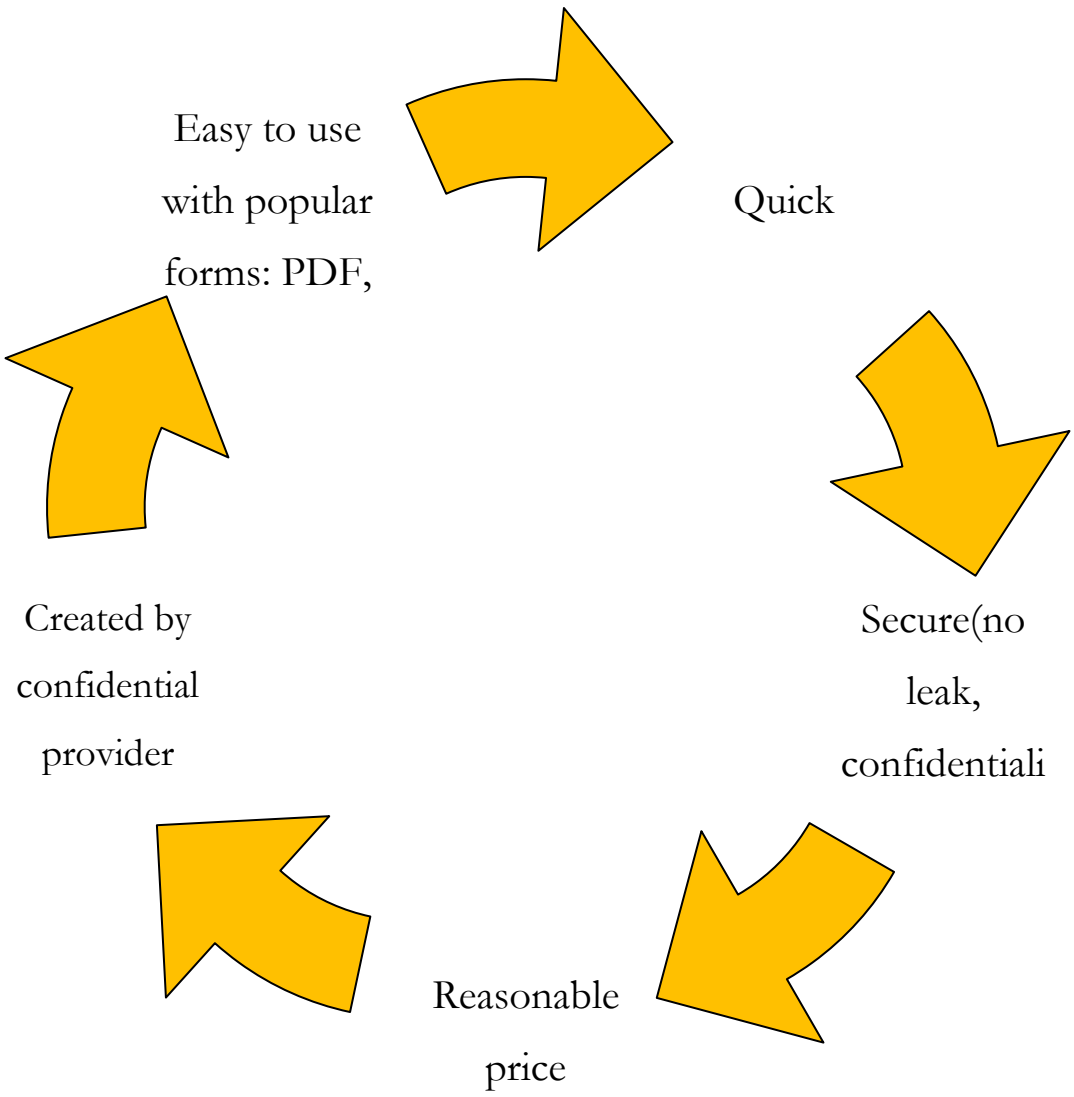

Figure 13. Expectations of interviewed companies about digital signatures

7.2 Discussion

This subchapter tells what has been found during the research and answers the investigative questions.

IQ1. How does Estonian digital signature system work?

Even though the answer for this question was carefully explained in chapter 3 and the interview result part about how digital signature system works in Estonia. The author would still want to briefly summarize the main steps here.

In order to start digitally signing, government issued ID cards for identification and signing electronically. These ID cards include personal information about its holder such as name, address and contact information. On each ID cards issued by the government, there are public key and private key which are used for signing and encrypting the signatures of the partner.

With the cards available, users use software from the site www.id.ee to sign and share documents. Following the instruction on the sign would lead the users to wait the signature back from the partner to his email and encrypt it.

IQ2. What about benefits and disadvantages of the system?

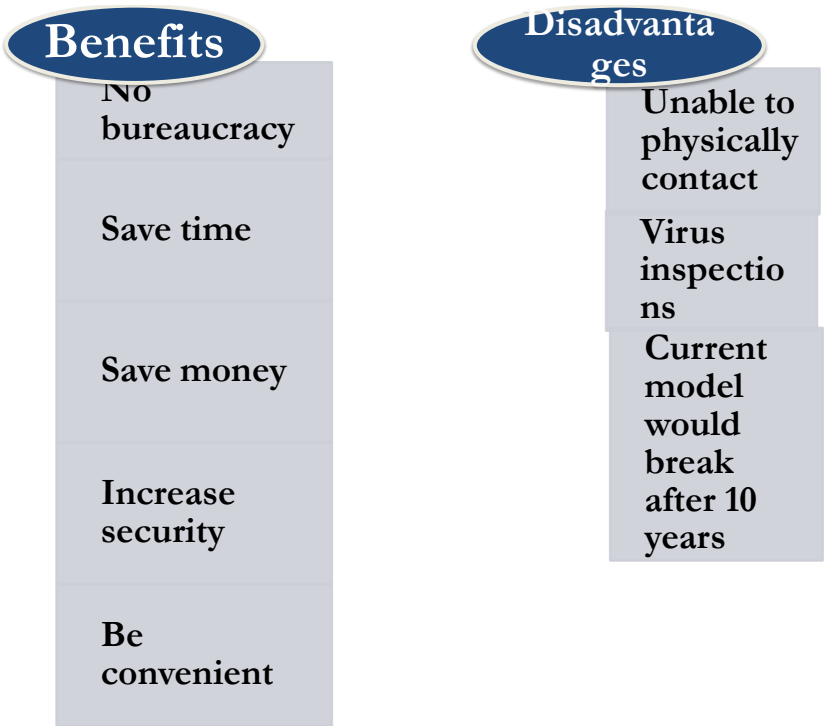

Figure 14. Benefits and disadvantages of digital signatures.

Benefits as well as disadvantages of digitally signing are included in figure 14. The benefits outstand the disadvantages of the working model. Digitally signing would make no bureaucracy since it is directly done everything through internet. Save time and save money as benefits will be more explained in the following chapters. More-

over, signing online is safer than documents with handwritten signatures sent by post. It is easier for the documents to be lost. Thanks to digital signature model, users can sign their contracts or documents when they are in holiday abroad just by using their cellphone. Digital signature application is free of charge and signed documents would be faster to find again than physical ones are also mentioned in the figure 14.

However, being unable to put documents physically to envelope is considered as a disadvantage. Even though, the author realizes this should be listed as benefit since it would save space for storing the documents. Signing documents abroad is risky with virus inspections. That really should be taken consideration when using digital signature. Lastly, it is disadvantageous of using digital signature for documents that are important in the long-run.

IQ3. How do Finnish companies create signatures? And their expectations about digitally signing.

Finnish SMEs mainly use handwritten signatures due to its reliability and its marketing function, though in some specific circumstances, they still issue signatures online, but with reliable business partners.

With customers close by, the sales departments organize face to face meetings to them to sign the needed documents. This method is known for not only being reliable but also helps them build trusted relationships and expand business networks with potential customers. With customers far away, such as in other cities or other countries, companies often use posti services or sometimes online services to less important documents and more reliable partners.

Interviewed companies showed their doubt toward the digitally signing system, however they still would love to try to system, especially construction companies. Their

expectations towards digital signature system are summarized in figure 8 of subchapter 7.1.

IQ4. Would digital signatures bring cost efficiency to Finnish SMEs?

In order to give the most specific answers for this investigative questions, the chapter 8, "cost analysis" will be made. The results collected from chapter 8 will answer the 4th investigative question in the most detailed and accurate way.

8 Cost analysis calculations

The aim of this chapter is to provide readers with the understanding of the cost factors for signing documents electronically and sign them by hands. It was mentioned often in the previous parts of the research that creating digital signatures is more cost-effectively than handwritten signatures. However, the measurement of how much exactly each type would cost in total has not been shown yet. Therefore, this chapter is made to show the calculations in using digital signature system and handwritten signatures.

Company A is a SME operating in construction field in Helsinki. Company A is taking consideration into selections between maintaining handwritten documents system as usual and applying the digital signature system. The author took the numbers from the interview with company A to do cost analysis. This cost analysis part will compare the efficiency of digitally signing and signing by hands.

Electricity and internet are fixed costs of the operations whilst consumed papers, printing costs and ink price are variable ones. The variable costs will still change dramatically depend on the use on different periods of time of the company.

Fixed costs	Electricity and internet costs
Variable costs	Papers, printing costs, ink, post office services and petrol price or travelling fee

The following numbers are the assumptions for the consuming habits related to creating signatures in company A. Assume that company has no damage with paper or contracts that require them to print the contracts many times or company gets finished contracts from the first printing time.

8.1 Papers

Estimately company A produces 5 pages with signatures per day in average and from that the weekly and monthly amount are listed in the following figures.

Printing papers	A day (pages)	A week (pages)	A month (pages)
Amount used	5	25	100

According to the Top Office (Top Office, 2014), the price for a package with 200 pages costs 2,50 euro. This is the cheapest paper out of many selections as Top Office suggested. Therefore, if company A prefers higher quality papers, they would need to pay more for it.

8.2 Ink price for printing documents

The article "Saving money on printing costs" (Ink & Toner Solutions, 2013) said the price to print one page would cost 6 cent in average while printing color documents is said to be even more expensive. The printing price is also considered as one of the most expensive. In this cost – benefit analysis part, the author choose to use the printing no color documents so the amount of money spent to print 100 pages monthly would be:

Ink	1 page	100 pages
Price	6 cents	10 euro

8.3 Electricity and Internet connection

Company A in Finland pays 50 euro per month get the electricity for all activities within the society as fixed cost. Then to supply the strongest internet connections, company A spends 35 euro per month to get 100mB/s to cover the internet on all area of the company (Expat Finland, 2014). The internet cost is considered as the fixed expense as well.

8.4 Petrol and Posti price

Moreover, according to the results collected from interviewed companies, the sales teams are always required to drive to visit the customers nearby for handwritten signatures. As a result of it, companies spend a specified budget for the petrol monthly. According to statistics provided by MyTravelCost (Mytravelcost, 2014), the price of petrol is 1.62 euro per litre and a car can go up to 10 km per litre. Company A sponsors to 50 euro per month for contracting dealing person as travelling expense to meet customers nearby for signatures. With customers far away from the office, the company A chooses to use posti services to send the documents to acquire signatures for documents. Therefore, it is crucial to include the amount of money for posti services of a company in the far away customers. Let assume company A normally spends 30 euro per month for posti services.

8.5 Price in total

With amount of money per each category provided, the cost analysis for company to issue either digital signatures or handwritten signatures is listed in the following table. It is noted in the table that, petrol and posti price are spent only to handwritten signatures process since digital signature system does not require petrol consumption and posti services.

Table 10. Price of digital signatures and handwritten signatures in total monthly

Options	Papers euro	Ink Euro	Electricity Euro	Internet Euro	Petrol Euro	Posti Euro	Total Euro
Digital signatures	0	0	50	35	0	0	85
Handwritten signatures	2, 50	10	50	35	50	30	177,50

According to the table 10, company A spends 85 euro to do signing online while it costs to 177.50 euro monthly for getting handwritten signatures. Therefore, in average company A would spend 1020 euro yearly for digital signature services and 2130 euro for acquiring handwritten signatures. Using digital signatures would help the companies save a great amount of budget up to 1110 euro per year for a SME operating in Finland.

Table 11. Price of digital signatures and handwritten signatures in total yearly

Types of signature	Cost total yearly (euro)	Differences (euro)
Digital signatures	1020	1 110
Handwritten signatures	2130	

As seen in the table 11 above, issuing handwritten signatures is 1 110 euro more expensive than digital signatures. Or the cost of handwritten signatures doubles the one of digital signature yearly in average. Moreover, to be able to produce handwritten signatures, a printer and a scanning machine are neccessary. According to the standard price of Verkokkauppa, a printer costs 129.90 euro and the same price for the scanning machine. Therefore, the total cost of creating handwritten signatures should include the price of a printer as well.

When adding the price of a printer, handwritten signatures are 1 369.80 more costly than digital signatures yearly.

In addition to money-saving, it is widely known that handwritten signatures are much more time-consuming than digital signatures based on the services that they acquire. Online signatures enable users to do every working step digitally while with handwritten ones, companies are required to visit customers in person for signatures or use post office services. It normally takes around 2 to 3 days to get signatures by using post office services or at least it takes several hours to get signatures from customers nearby (Hirvela, company A 2014).

9 Conclusion

The objective of this chapter is to finalise the main findings and key points for the whole thesis process and suggest recommendations for the commissioning company to notice in order to make the most accurate evaluations.

9.1 Summary

The information required in order to answer the objective of the commissioning company is included in the previous parts which are explained clearly in words, tables and figures.

Pressures from Estonian government acknowledged individuals to try to learn more about the use as well as the advantages of digital signatures and that led to the popularity of digital signature system around Estonia nowadays. Making people understanding the practical benefits of the system is the more efficient way to benchmark digitally signing.

Finland has been issuing many different kinds of methods which allow people to sign electronically so far such as Katso ID, Tupas or by the population register centre. Whilst, the success of Estonia in spreading the benefits of digitally signing is from issuing only one system and control the creation and popularity of any other system in the country. It is easier to control and identify whenever there are errors by applying one system for the whole country.

Real estate companies are known to be traditional in creating signatures. From the interview results, they stayed persistent with the use of handwritten signatures though they are willing to try the new system. All of interviewed real estate companies concluded handwritten signature as the most effective and reliable working way which also helps them to do marketing and build relationship with their customers.

In general, Estonian companies have been enjoying the benefits digital signatures have brought to their daily business operation, whilst Finnish SMEs have been underestimating about its functions.

9.2 Recommendations

In this sub-chapter, the author would like to make some recommendations for the commissioning company to pay attention to produce the most efficient and accurate final decisions based on her experience during the process of this research.

This is a considerably huge topic and it took time to search information to answer the objective set up by the commissioning company. Still, the author was unable to focus on every part in too detail, especially legislation. Estonia and Finland include very detailed and long legal acts for digital signatures. Therefore, it is recommended if the commissioning company would do a research, specializing on only "legislation" on both two markets. This is considered as the best method to cover up everything related to law in Estonia and Finland. In addition to the difficulty in legislation part, the author was not too flexible in searching documents in Finnish due to the language barrier. Even though, the needed information was enclosed in this report, it would be valuable to go through with some key words in Finnish. There might be still some interesting facts left which the author did not succeed in searching for.

During five interviews with companies in Estonia, the author values their helpful cooperation and useful information they brought up for the research. However, it was clearly shown that Estonian companies are really interested in the idea if Finland would issue the same system to Finnish companies and individuals. They expected to make the business process between two countries proceeded in a much more easy way thanks to digitally signing. As a result of it, the benefits mentioned are worth being be carefully taken consideration again by the commissioning company.

The last recommendation is for the data collection method, especially to companies in Estonia. As a result of long distance, the author did not manage to interview face

to face with five companies there, whilst some were conducted through emails. The answers collected are concrete but holding some more face to face meetings are recommended if the commissioning company would like to go further in this topic.

10 Evaluation

This chapter will evaluate the whole thesis process as well as the personal learning of the author. The whole thesis process would analyse the main difficulties the author faced up with during result producing steps. While the personal learning would briefly talks the key factors the author learns by following this topic for nearly 1 year.

10.1 Thesis evaluation

Thesis process was long and challenging at times. The final version of this research has experienced a huge change compared to the first version, while there has been significant improvement for the next one. Due to the large number of interviewed companies required, the work process took longer than originally anticipated. The author had difficulty in researching and contacting companies for interviews. The partial time was spent on just researching whilst the collection of results was fast and effective. Based on the objective set up by the commissioning company, the author was following up the research process in order to answer the main question, "Would digital signatures bring efficiency to Finnish SMEs?" It was not hard to give the clear answer. Problem that plagued the entire research was to provide as details as possible about the current working system of the successful country, Estonia and analyse the benefits of it correctly before making proper recommendations. This forced research problem has a broader look at not only Estonian system, but also real estate and construction market to fully understand reasoning and benefits if they issue the same system.

10.2 The author's learning

During the thesis research, the author the author gained a good experience in research, analysis and practicing skills in doing cost analysis as well as understandings about the e-services and customer behaviours. This is a really helpful and interesting topic. Along with the research, the author got the opportunity to develop the interest in research and digital signature that she has started to consider it as the option

for her future study and career. Furthermore, the author gained practical experience in working with customers during conducting interviews and persuading companies for interviews.

Overall, this research has given the author good academic experience in the field of business, especially in financial management and planning.

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Attachment 1.

Overlay matrix

Investigative questions (IQs)	Theoretical framework (concepts, models)	Methodology	Results
IQ 1	- Certificates - Application - Mobile IDs	- Interviews	
IQ 2	- Benefits - Disadvantages	- Interviews	
IQ 3	- Signing methods - Handwritten signatures/digital signatures. - Expectations	- Interviews	
IQ 4	- Cost analysis - Speed analysis - Authenticity analysis - Reliability analysis	- Calculations based on interview results	

Attachment 2.

Interview questions to Estonian companies

1. Why did your company start to use digital signature? Was it because of pressure from public or commercial side?

2. Could you describe about the digital signature system that your company is applying? Like working process, how you manage to use the system?

3. You use digital signature to work with only companies inside Estonia? Have you ever faced up with any legal difficulty?

4. How do you deal with problems such as expiry of the software, certificate? The providers take care of this? Does renewing the certificate cause you a lot of work?

5. What benefits has digital signature brought to your company?

6. What about disadvantages?

7. I have heard that nowadays with special SIM card, people can use their mobile phone to do signing online. Is there any effect and difference with using PIN code from identity card? Like are signatures the same with the ones using identity card? And does Estonia limit the amount of phone number each person can own?

8. To whom would you recommend digital signature to?

Attachment 3.

Interview questions to Finnish construction and real estate SMEs

1. How often do you work with contracts or documents requiring signatures?

2. Which forms do you often use for signing process? (online documents, paper documents)

3. Could you please describe how you manage to get handwritten signatures? With clients nearby and with clients far away???

4. How long does it take each time in general? And how much does it cost? Do you find this way provides confidential signatures and economical issues to your company's operation?

5. Do you face up with any challenges?

6. Have you heard about digital signatures?

7. What do you expect about digital products? Would you be willing to try it?