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DIFFUSION OF THE ESTONIAN ID-CARD AND ITS ELECTRONIC USAGE: EXPLAINING THE SUCCESS STORY

Master's thesis

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I hereby declare that I am the sole author
of this master's thesis and it has not been
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Abstract

Estonia has an image of a technologically advanced country – 90% of people use Internet banking, the state has a multitude of e-services, and digital signature is a reality. Estonia introduced the ID-card in 2002, it includes the electronic identity (eID). The dissemination of the card took five years. Usage of the eID has not been taken up that quickly.

This research looks at the success factors in the diffusion of the ID-card and eID. Theoretical framework for Public Sector Innovation and also technology acceptance models are introduced.

The work concludes that success in Estonia is context-based. The political consensus and private sector support have been crucial. The government's actions were premeditated and their processes resulted in the complete rollout of the ID-card. The diffusion of eID can be attributed to the private sector. The latter is accountable for education and information, and takes steps to force usage (decisions of the Estonian Banking Alliance from 2007-2009 to lower transaction limits for less secure methods, for example). They are also in the forefront for improving service and customer convenience – EMT introduced mobile-ID in 2007, now it's showing steady growth in user rates.

Key words: Diffusion, Innovation, DOI, Public Sector Innovation, ID-card, eID.

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Introduction

Estonia is viewed as an advanced and visionary state technology-wise. This image arose in the 1990s when the government started to set up computers and Internet connections. The Tiger-leap project was pioneering in the mid-90s, aiming to give all schools Internet access. The aura has stuck. Today it is supported by the widespread usage of Internet and Internet banking, people can use a wide range of e-services that help save time and money (TNS Emor 2012), and digital signature is a reality.

The increasingly faster development of information and communication technology is forcing countries to innovate in order to keep up with the changing times (Bekkers *et al.* 2006a, van Duivenboden *et al.* 2006, Pollitt 2010, León *et al.* 2012, De Vries *et al.* 2016). The technology has led to a widespread modernization of the state sector, but it is important to notice that the influences of ICT are much more far-reaching than going online or being more efficient. The development of technology has also profoundly changed the environment where we live. New social pressures and demands have arisen and the public sector has to respond (*Ibid.*).

The technological advancements have resulted in a general fascination with e-government and e-governance (Heeks and Bailur 2007). The development of e-government in Estonia has tight links to the development of the ID-card and x-road portal. In the context of Estonia's e-success the ID-card is often mentioned but there seems to lack a more profound understanding into the relationships of why and how. Especially since the ID-card is one authentication method out of many.

Estonia introduced the mandatory ID-card in 2002 and it includes the electronic identity (eID) component. It took about five years until almost everyone in Estonia had an ID-card. The electronic usage has not grown at the same pace though e-services have been available since the beginning and are developed and updated continuously.

The aim of this work is to understand how the dissemination of the ID-card has been different from the eID, what are the key antecedents for both processes, and how have

e-services influence the eID usage. Innovations cannot be looked at separately from their environment, thus case study methodology is employed.

The work is divided into two main chapters. The first looks at the relevant theoretical frameworks, such as Public Sector Innovation framework, technology acceptance literature, and technology life cycle. First chapter also elaborates on the influence of technology in the public sector.

The second chapter deals with the empirical research. It looks at the events surrounding the dissemination of the ID-card and its dissemination data, and then push and pull factors are analyzed. Next, the e-ID rollout data is viewed. The growth of new unique users as well as active users is described. There is a separate section devoted to the most used e-services and data about their eID usage is explored. Also support from government sector and private sector for the eID usage is discussed. The role of e-services in encouraging eID usage is examined. A small section is dedicated to the comparison of Estonia with other countries. In the end, some conclusions are presented for the ID-card and eID usage in Estonia.

1. THEORETICAL FRAMEWORK IN UNDERSTANDING PUBLIC SECTOR INNOVATION AND DIFFUSION OF INNOVATION

My work aims to analyze the adoption of the ID-card by the Estonian public. This section looks at different theoretical frameworks that can explain the dissemination of the ID-card and the diffusion of the usage of the eID[1] in Estonia.

In order to explain the mandatory ID-card dissemination, I will introduce the Public Sector Innovation framework. For the eID take-up I will additionally present technology acceptance framework. This section will also deal with the specifics of information and communication technology (ICT) in the public sector.

It this work innovation is defined as "an idea, practice or technology that is new to an organization which is considering its adoption" (Polyviou and Pouloudi 2015, 2086). Rogers (2003, 6) explained diffusion as communication – the spread of ideas between different people over time. Diffusion is "a process in which an innovation is communicated through certain channels over time among the members of a social system" (*Ibid.*). It is possible to distinguish diffusion – the passive, unplanned, informal spread of innovation, from dissemination – the centrally planned and controlled, directed and managed efforts to convince target audiences (Ibid., 6, Greenhalgh *et al.* 2004, Korteland and Bekkers 2007).

1.1. Public Sector Innovation Framework

There is no one established theory for public sector innovation but an interdisciplinary framework for understanding innovations in the public sector. It incorporates different aspects of established theories depending on the specific aspect under inspection. The literature that gets cited most often is diffusion literature, technology transfer literature, Technology Acceptance Model, innovation within organizations, the social psychology Theory of Reasoned Action, but also economic innovation theory, sociological planning theory, and public administration theory, Concerns Based

[1] eID is the elctronic identity and it can be used for identification by two means – ID-card or mobile-ID.

[2] Today it is a part of the Police and Border Guard Board because in 2010 the Police Board, Central

Adoption Model and the Unified Theory of Acceptance and Use of Technology (Greenhalgh *et al.* 2004, Korteland and Bekkers 2007, Sorensen and Torfing 2011, Tiits *et al.* 2014, De Vries *et al.* 2016).

Innovation in the public sector is inevitable. It is triggered by the need to keep up with the changing times. The constantly changing environment requires the state to answer to the new emerging societal demands (Bekkers *et al.* 2006a, León *et al.* 2012, 2, 7). The innovations in public sector are the product of co-dependency of conflicting demands and pressures that arise from the very same local context that they are embedded in (Bekkers et al. 2011 in De Vries *et al.* 2016, 156).

It is essential to comprehend that the political authority itself, its role in society, and in government impacts the development and outcomes of innovations when discussing the public sector. The influences are two-fold – direct and indirect. The indirect influences are based on effects on the antecedents that shape and modify the legitimacy of that same authority (De Vries *et al.* 2016, 162). This relates to the realization that a significant driver for innovation in the public sector is often the need to create trust in the government and reinforce its legitimacy (Bekkers *et al.* 2006a, De Vries *et al.* 2016). And trust, at the same time, is an essential prerequisite for innovation in the public sector – the acceptance and adoption of the new technology by the society depends on the level of people's trust in the government and civil servants (Bekkers *et al.* 2006a). The empirical research by Tiits *et al.* (2014, 5-6) confirms this – if the awareness of the public is low, the overall belief in the integrity of the government becomes an important factor.

1.1.1. Innovation Objectives

It seems that the main driver for innovation is effectiveness or efficiency – improving performance (or cutting costs) in other words (Bekkers *et al.* 2006b, León *et al.* 2012, De Vries *et al.* 2016). De Vries *et al.* (2016, 154-5) suggest that the striking eminence of efficiency and effectiveness goals can be attributed to the two competing functioning logics of the public sector. The functional theories put results on a pedestal – the logic of consequence demands efficiency and environmental fit (Pollitt 2002, 481-2). They look at results of different alternatives and are related to the emphasis of effectiveness and efficiency goals which are in line with the prevailing

NPM ideology (Ibid, De Vries *et al.* 2016, 154-5). If the innovation application will bring about increased efficiency, the decision to adopt is made (Korteland and Bekkers 2007, 141). This approach displays the significance of innovation and adopter characteristics (*Ibid*, 140).

The competing approach is constructivist and the logic of appropriateness deals with the legitimacy, rules, symbolism and fashion, in addition recognizes the importance of institutional path dependency (Pollitt 2002, 482, Korteland and Bekkers 2007, 141, De Vries *et al.* 2016, 155). This logic leads to the eminence of trust and legitimacy as reasons for public sector innovation (Bekkers *et al.* 2006a, Bekkers et al. 2011 in De Vries *et al.* 2016, 155). Thus, it is logical that public sector states participation and cooperation as goals of innovations; that being tune with the importance of participatory democracy to public institutions (De Vries *et al.* 2016). The logic of appropriateness gives the innovation a wider context and underlines motives of adoption that are more determined by the environment (Korteland and Bekkers 2007, 140).

1.1.2. Drivers and Barriers in the Innovation Process

In order to implement a successful change, sufficient resources in time, money, and people, and commitment is needed.

Based on empirical research De Vries *et al.* (2016, 155-9) come up with a comprehensive categorization of four levels of antecedents: environmental, organizational, innovation and individual/employee level pressures. The external context and environment, internal and organizational, and political factors have been also stressed by other authors (Borins 2001, 18, Walker 2007, 314-5).

Environment related factors refer to the unique circumstances and specific contexts that the innovations occur. It stands for the pressures or support from the media, public opinion, societal challenges and crises, regulatory and legal aspects, rivaling organizations etc., which can either hinder or facilitate change (León *et al.* 2012, 19, De Vries *et al.* 2016, 156). There are numerous cases that show, how government is forced to pull back from an agenda, due to criticism from the public or opposition.

This is what happened in the UK in 2013, when they were forced to cancel the e-ID-cards and abolish the National Identity Register (Tiits *et al.* 2014, 1).

León *et al.* (2012, 3) summed up their report that risks for innovations lie in carrying out massive projects in complex and politically delicate areas, and there are "substantial obstacles in legislative systems, [and] institutional autonomy". Innovations in governance, by definition they are above organizational boundaries in aims, scope, etc., are expected to be tied to environmental antecedents, especially since they tend to attract private funding (Moore and Hartley 2008, Schoeman *et al.* 2012, De Vries *et al.* 2016, 160).

The organizational level or internal antecedents are the available resources, leadership and good management, education and preparation, incentives and evaluation, risk aversion, but also bureaucracy and organizational structures (León *et al.* 2012, 18-9, De Vries *et al.* 2016, 157). De Vries *et al.* (2016, 160) reported that organizational antecedents were the most important enablers for all innovations. The innovations in ICT obviously change information systems and data handling, but also organizational procedures, processes and even structures (van Duivenboden *et al.* 2006, 238, León *et al.* 2012). The changes in organizational characteristics can create resistance (van Duivenboden *et al.* 2006, 238) – the main barriers to innovation in the UK local governments have been identified as resistance from employees – the reluctance to change, trying new solutions and working in unison with stakeholders or private sector (Dunleavy *et al.* 2006, 27). León *et al.* also noted that the reasons for less impressive outcomes or failures were generally incompatible organizational structure, lack of leadership and low managerial capacity resistance to change and (2012, 41-3).

Innovation level antecedents as perceived by the adopters include such intrinsic attributes of an innovation like the ease of use and compatibility, relative advantage and usefulness (De Vries *et al.* 2016, 158). León *et al.* (2012, 41-3) has drawn attention to the fact that failed innovation project share such commonalities as – large scale of implementation (generally national level) resulting in high complexity; poor innovation development in assessment of users' needs, performance management and evaluation.

Individual/employee level antecedents (characteristics of individuals who innovate) are such as autonomy and empowerment of employees, position, professionalism and creativity, commitment and shared values (De Vries *et al.* 2016, 158). León *et al.* (2012, 3) report that the lack of success can be attributable to the lack of skills of civil servants, and their attitudes. Schoeman *et al.* (2012) look at successful public-private sector cooperation in new innovative services and reached the same conclusion that the main barriers for such collaboration are the civil servants' mentality and skills, not the lack of potential for success.

1.1.3. Preparing for Success

The factors that have been empirically deemed as important are firstly, the significance of agreement on objectives and in government (Dunleavy *et al.* 2006, 27, van Duivenboden *et al.* 2006, 237, León *et al.* 2012, 9-10). The goals and objectives of an innovation have to be set realistically (León *et al.* 2012, 9-10). That requires proper problem definition or needs analysis (*Ibid.*). Secondly, securing support and sufficient resources in money, people and commitment, know-how (Ibid., van Duivenboden *et al.* 2006, 237). The complexity of the public sector context requires collaboration with stakeholders. Such partnership demands a clear understanding about the roles of the actors and division of responsibilities (*Ibid.*, 238). Fruitful cooperation can only be achieved if the distribution of costs and benefits among the actors is balanced, giving them sufficient incentives to commit to the project (*Ibid*., 237, 239).

1.2. Unified Theory of Acceptance and Use of Technology

The Unified Theory of Acceptance and Use of Technology (UTAUT) is one of the most commonly used technology acceptance models today (Tiits *et al.* 2014, 1). The theory was formulated based on empirical results gathered from an elaborate research on eight technology acceptance models (Theory of Reasoned Action, Technology Acceptance Model (TAM), Motivational Model, Theory of Planned Behavior (TPB), Combined TAM and TPB, Model of PC Utilization, Innovation Diffusion Theory) by Venkatesh *et al.* (2003). The new theory was then tested and cross-validated – UTAUT outperformed the previous theories in its ability to predict results and show correlations. There are four determinants of intention or usage of technology, such as performance expectancy, effort expectancy, social influence, and facilitating

conditions (Venkatesh 2003, 447). The UTAUT has additional four key moderators such as gender, age, voluntariness, and experience, which influence the adoption rate.

Performance expectancy in UTAUT refers to the "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" (Venkatesh 2003, 428). The performance expectancy can also be broadened to include the personal gains in the private life as a layman. Performance expectancy also incorporates some of the risks of technology such as issues with privacy and safety from falsification.

Effort expectancy is related to the perceived ease of use of the technology (*Ibid*.). Thus, in order to increase the use of technology, it has to be very useful and user-friendly for the end user. This also means technology support for all the different platforms and continuous development on them, to guarantee a smooth user experience.

Social influence is about peer pressure. In Rogers's diffusion of innovations theory the social system was an intrinsic element in diffusion while the UTAUT states that the social influence describes "the degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh 2003, 451). Because the influence from family, friends and role models or opinion leaders has the ability to encourage or discourage the use of technology, it is crucial to publicly address the fears and threats that the new technology might generate and openly disseminate information about it. Public information is critical because different people in society look to different sources for information, though some the word-of-mouth is most important. It will benefit the agenda, if there is plenty of information available and people do not have to resort to speculation; or at least there is a greater chance for the arising misconceptions to be disproved.

It is important to gain the trust of the public. Trust in this context stands for the general opinion of integrity, conviction that the authorities have the best interests of citizens in mind, and confidence in the authorities' to ability to fulfill their tasks (McKnight et al. 2002 in Rufín *et al.* 2012, 371, Tiits *et al.* 2014, 3). It is empirically proven that trust is essential in e-government adoption – it is the direct antecedent of

intention of use (Rufín *et al.* 2012, 370, 380). Therefore, the people need to trust that the authorities live up to their role when they are going to communicate with them and divulge (delicate) information. Thus, proactive and honest information dissemination by the authorities is critical.

Fourth, the UTAUT model introduces facilitating conditions which describe users' belief that the authority offers support and aid in the process of usage and that the innovation will prevail (as opposed to discontinued or called back) (Venkatesh 2003, 453).

1.3. Technology Diffusion

The theoretic approaches that have been introduced until now are concerned with the public sector environment and its complexities, and the individuals and their decision to adopt or not to adopt an innovation. The next section deals with technology diffusion. The Technology Hype Cycle describes the evolution or life cycle of a technology – the level of the technology's maturity and the degree of its adoption and commercialization (Jun 2012). The limitation of the Hype Cycle model is that the cycles have different shapes for different technologies in different environments (Jun 2012, van Lente *et al.* 2013). But it is still useful for its general explanatory nature.

The Technology Hype Cycle Model is used to describe the process that follows when a new technology will be introduced; how the expectations for that technology change over time and how it will spread on the market and be used by different actors (Borup *et al.* 2006, Jun 2012). The pattern has been called hype cycle because initial enthusiasm and anticipation is based mostly on high-rising but unsubstantiated expectations, which likely will not materialize as such, but will "shape the materializations that eventually occur." (van Lente *et al.* 2013, 1616).

Technology adoption is related to its life cycle. Rogers (2003, 279-85) has described adopter distribution based on their innovativeness. This categorization follows the normal distribution and distinguishes between innovators, early adopters, early majority, late majority and laggards (*Ibid.*).

The innovators would adopt the technology early on. Of the five-phases in Hype Cycle, they would enter in the first (*Ibid.*, 282-3), Technology Trigger phase, when the technology emerges and becomes known, is talked about in the media etc. (van Lente *et al.* 2013). In first phase the expectations are driven by the potential of the technology (Jun 2012, 1414). At this moment the technology may seem to lack merchandising potential and it may also fail to commercialize (*Ibid.*). The initial phase is followed by the Peak of Inflated Expectations phase or the hype or bubble phase; this period is about constantly growing interest, reports of success stories, but the number of users/adopters is relatively low (*Ibid.*). This is roughly the time for early adopters to enter the playing field according to Rogers (2003).

High expectations usually end with disappointment because the actual outcome of the technology could not match the anticipation. Trough of Disillusionment is often characterized by a sharp collapse in the interest due to the poor results of the technology – it is realistic re-adjustment for the market (Jun 2012). The disillusionment phase is followed by a gradual recovery or growth in the stabilization phase called the Slope of Enlightenment (Jun 2012) when the early majority comes on board. The enlightenment refers to a wider understanding about the potential and realistic gains that the technology can bring. When half of the potential users have come on board the late majority starts entering. This more or less coincides with the final growth phase – the Plateau of Productivity where the commercial feasibility is turned into success and broad market penetration (Jun 2012, van Lente *et al.* 2013). The laggards, traditionalists according to Rogers (2003, 284-5), adopt the technology after it has reached maturity, perhaps even declining, and are the last to do so.

1.4. Information Communication Technology

The development of information and communication technology (ICT) has been seen as important driver for the modernization in the public sector (Bekkers *et al.* 2006b, van Duivenboden *et al.* 2006, Pollitt 2010, De Vries *et al.* 2016). However it is important to keep in mind that the modernization of the public sector is more than the usage of ICT for the improvement of public service delivery or going online.

E-government and e-governance are the new buzz-words that are used relatively criticism-free and optimistically as if it is the cure for all (Heeks and Bailur 2007).

There seems to be a superficial overrating of the influence of ICT occurring simultaneously with an underrating of indirect or unintended outcomes (van Duivenboden *et al.* 2006, 237). It is obvious that technology has quickly, thoroughly, and righteously been employed in the processes of the state, because as a instrument, it offers more efficient results – it speeds up data collection, processes, analysis etc., makes time and place irrelevant, and allows people to communicate with each other (Bekkers *et al.* 2006b, 15-6).

Bekkers *et al.* (2006b, 17) stress the co-evolution of societal changes and technology which in the end determines the tangible consequences of the ICT-driven innovation. In other words, the specific attributes of the technology should not be the focus, but rather evaluation the effects that the usage of technology has brought about. Both, in the interactions between people in organizations, and in the role or meaning the technology has acquired (*Ibid*).

It is wise to keep in mind "that the effects of ICT are ambiguous" (*Ibid.*). Research shows that though ICT is hoped to make the playing field more equal, it actually tends to solidify the existing power positions and frames of reference, in addition extending and reinforcing the existing biases and power relations in governmental structures and processes (Bekkers and Korteland 2006, 29). Interestingly, young democracies, such as Estonia, do use the ICT in parliamentary context in a way that adheres to the nature of representative democracy – the Internet is a forum for discussion and inclusion (Bekkers *et al.* 2006b, 17). Thus, it can be concluded that ICT has enormous potential; it is the question of whether it will be realized fully. The realization depends largely on the context because the results from technology application are determined by the intricate and dynamic institutional environments where they are developed, disseminated and used (*Ibid.*).

2. CASE STUDY: DIFFUSION OF THE ESTONIAN ID-CARD AND ITS ELECTRONIC USAGE

2.1. Research Strategy

Technology, the ID-card, has two facets – the actual plastic card with the smart-card (the hardware aspect) and the eID function with certificates (the software aspect) (Rogers 2003). Thus, in order to analyze the usage of eID, one has to look at the dissemination of the ID-card, because in Estonia the ownership on an ID-card is a prerequisite if eID usage.

The aim of this research is to understand what were the factors that contributed to the wide-spread diffusion of the Estonian ID-card and its electronic usage. The research employs case study methodology and establishes a timeline for the events. The previous chapter emphases that innovations cannot be looked at separately from their environment, thus a case study is a suitable method to look at the evolution of a process in its natural context.

Case studies allow in depth understanding of the case in question but to do not permit bold generalizations. Even more, literature (Bekkers *et al.* 2006a, Tiits *et al.* 2014, 6, De Vries *et al.* 2016) has pointed out that in public sector innovations the generalizations are difficult because the results are largely dependent on the political, social and administrative context. Therefore, the aim is to test how the environmental, organizational, innovation-related and individual antecedents contributed to the outcome in the case of Estonia. It is an attempt to create a comprehensive picture of the developments that have led Estonia to be viewed as a leading e-country.

The unit of analysis is the ID-card project since its initiation in 1998 until today (2016). The development of the idea began in 1998, the first ID-cards were issued in January 2002. The uptake of the usage if eID was initially very modest, but subsequent information campaigns and software support development and the like, have tried to change the situation.

2.1.1. Research Questions

The case study seeks to find answers to the following questions:

1) How has the diffusion for ID-card and eID been different?
2) What have been the critical (success) factors in both processes?
3) Have the electronic services of the state helped increase the eID usage?

2.1.2. Data Collection

The information has been collected via desk research and electronic correspondence with different key experts (Tarvi Martens, Linnar Viik) and organizations (Estonian Tax and Customs Board, Certification Centre, Information System Authority, Nordea Bank, Police and Border Guard Board, Swedbank). Based on the information received, other statistics, written materials and reports, studies, press releases and articles from the media, a timeline has been set up to complement the data about the issued ID-cards and the new unique users of ID-cards online.

2.2. Case History – ID-card

The ID-card is a mandatory identity document for Estonian citizens aged 15 and over (and also European Union citizens) (PBGB 2016). It can be used for physical identification but Estonian citizens can also use it as a travel document in the European Union (*Ibid*). The ID-card holds the public key infrastructure (PKI) and therefore also an electronic identity component – eID. This allows for identification online (cardholder authentication) and digital signing. The first ID-cards were issued in January 2002.

2.2.1. The Emergence of the Idea and Formulation of the ID-Card Project

The idea for a new generation electronic identification document emerged in 1994-95 in the Institute of Cybernetics (Tallinn University of Technology). However, since technologically the RSA-based smart cards were not yet developed and there was no backing for the project, the idea remained dormant. The idea reemerged in 1997 when the Citizenship and Migration Board[2] (from here on CMB) realized the need for electronically readable next generation ID-documents and the discussions about form and function of the future ID-cards began. (ID.ee 2016) (see also Appendix 1 for the timeline).

[2] Today it is a part of the Police and Border Guard Board because in 2010 the Police Board, Central Criminal Police, Public Order Police, Border Guard Board, and Citizenship and Migration Board were all merged.

In 1997 a workgroup was formed in the Estonian Informatics Centre[3] to start preparing the Digital Signatures Act. The work was complex and the law was passed four years later on the 8th of March in 2000. The act prescribed the establishment of the State Register of Certificates. It was supposed to start work in December 2000 but was delayed and in reality started operating in February 2001.

At the end of 1997 a team of three with private sector background (Küberneetika AS and Hansapank) presented the CMB and Informatics Centre a project for the introduction of ID-card implementation, that originally expected to take at least 15 months of preparations (ID.ee 2016). Political disagreements and legislative issues delayed progress (Modinis 2007, Martens 2016) so it took three times that long.

The idea of the introduction of an ID-card became publicly known in 1998. Several workgroups and committees were formed with people from the public sector and a few representatives from the private sector. They commissioned two analyses – first dealt with the requirements and desires of the stakeholders and the other with the available technologies of that time. If one reads the analysis, it is evident that the thoughts and understandings of different contributors were diverse. (ID.ee 2016)

The project team was open to public-private partnership already in 1998 (ID.ee 2016). The idea took off in 2001 when EMT, Hansapank, Eesti Ühispank ja Eesti Telefon founded the Certification Centre (AS Sertifitseerimiskeskus) to manage the ID-card certificates[4]. In July a public procurement was announced that the Certification Centre won. Today the Certification Centre is the primary, and at the moment the only certification authority. In addition to certification and time-stamping services they are responsible for the development and operation of the software necessary to use these services. (ID.ee 2016, SK.ee 2016)

In 1998 an article in an Estonian daily newspaper reflects high hopes on what the role of the ID-card could be (a replacement for all kinds of cards such as parking, door,

[3] It was a government institution under the juristiction of Ministry of Economic Affairs and Communications from 1997 til 2003.
[4] The Digital Signature Act from 2000 created a need for such a certification body who could become a partner to the state and offer the necessary services.

phone and bank cards but also sick fund membership cards etc.) (EPL 1998). The author very perceptively states that it is important to gain the trust of the public and for that information dissemination is important. As public image was important to the initiators of the ID-card program, a public seminar was held in the Estonian National Library in December 1998.

In 1999 a new advisory expert-group on the issue of ID-cards was created. Their role was to deal with ID-card pilot projects and standardization. The members of the group included people from the private sector (including banking sector) and public sector (Estonian Informatics Centre, Citizenship and Migration Board). (ID.ee 2016)

The ID-card initiative had attracted support from very significant organizations – Eesti Ühispank, Estonian Telefon, and Look@World Foundation (Vaata Maailma SA) who signed a cooperation agreement for "large-scale implementation of the ID-card" with the Ministry of Internal Affairs in September 2001. (ID.ee 2016)

The ID-card automatically includes the electronic identity component – eID. During the development process it generated debates. Tarvi Martens and Linnar Viik concur that the aim of the development team was always one card with e-ID. However, at some point the discussion was about whether it would be cheaper to make it separate. Viik further explained that the issue was not so much the digital signature function on the ID-card, but on whether the ID card should be made mandatory or not. The reasoning was, that if the card is mandatory, the eID should be included. If this is not the case, the absence of eID would diminish costs. (Martens 2016, Viik 2016)

There were fierce political debates about the compulsory nature of the ID-card. The Estonian Association of Information Technology and Telecommunications (ITL) sent a public letter to the Prime Minister (Mart Laar) where it is stated that the applications for the ID-card will not appear before there is a critical mass of users (holders of the ID-card), but they are convinced that this will not happen if the card is optional. They were not the first to voice concern – the leaders of EMT and Estonian Telephone (today both have been united into Telia) and two major banks Ühispank and

Hansapank sent a warning letter to the President of the Riigikogu[5], Prime Minister, and Minister of Finance about the dangers of a voluntary ID-card (BNS 2001).

The more the ID-card was becoming a reality, the more critical opinion pieces were published (Fjuk 2001), which can also be seen as a tool in the political debate about the necessity and usefulness of the ID-card. The "official" stream in the media was supportive of the project and negative pieces were mainly related to the coverage of disputes in the coalition about the mandatory or compulsory nature of the card (ETA 2001, Roonemaa 2001).

In November 2001 political consensus was achieved and the ID-card was made mandatory identification document in Estonia (ID.ee 2016).

A vivid example of the positive hype that surrounded the project is seen in the Citizen's day campaign. On the 26th of November in 2001 from noon until 6 PM (Ideon 2001), people had the opportunity to sign up for ID-cards the portal www.pass.ee. 5165 people signed up (*Ibid.*). 250 people managed to register themselves within the first minute of application. The traffic generated was huge. The system couldn't cope and went offline at 12:06 one and a half hours. The expectations of Citizenship and Migration Board were surpassed tenfold by the actual number of people who registered (EPL 2001, ID.ee 2016).

In January 2002 TNS Emor (2002) published survey results which showed that 38% of the population deemed the ID-card necessary and 27% of them were likely to apply for one in the coming six months. The Internet users were twice more likely to regard the ID-card necessary (every fourth vs. every second person) (*Ibid*). 20% of people did not have an opinion about the usefulness of the ID-card (*Ibid*). Those who stated that they will not apply for an ID-card in the coming six months listed the lack of need as primary reason, but also high cost and lack of time and information (*Ibid*).

[5] The name of parliament

2.2.2. Rollout and Penetration of The ID-Card

The rollout of the ID-cards started at the end of January 2002. The potential user base for Estonian ID-card is estimated at 1,1 million people (people over the age of 15, 80% of the population) (Graux *et al.* 2009). The rollout has been a steady increase (see Figure 1, for detailed data see Appendix 2). The first four years the number of issued ID-card grew, but after that there has been a steady decline dropping from almost 300 000 annually to 20 000 in 2015. The end of the rollout period has been dated in October 2006 when the one millionth ID-card was issued[6]; then 66% of the population and 87% of people aged 15-74 had an ID-card (SK.ee 2006b). At the end of the year, there are 910 600 valid ID-cards (Abram 2016).

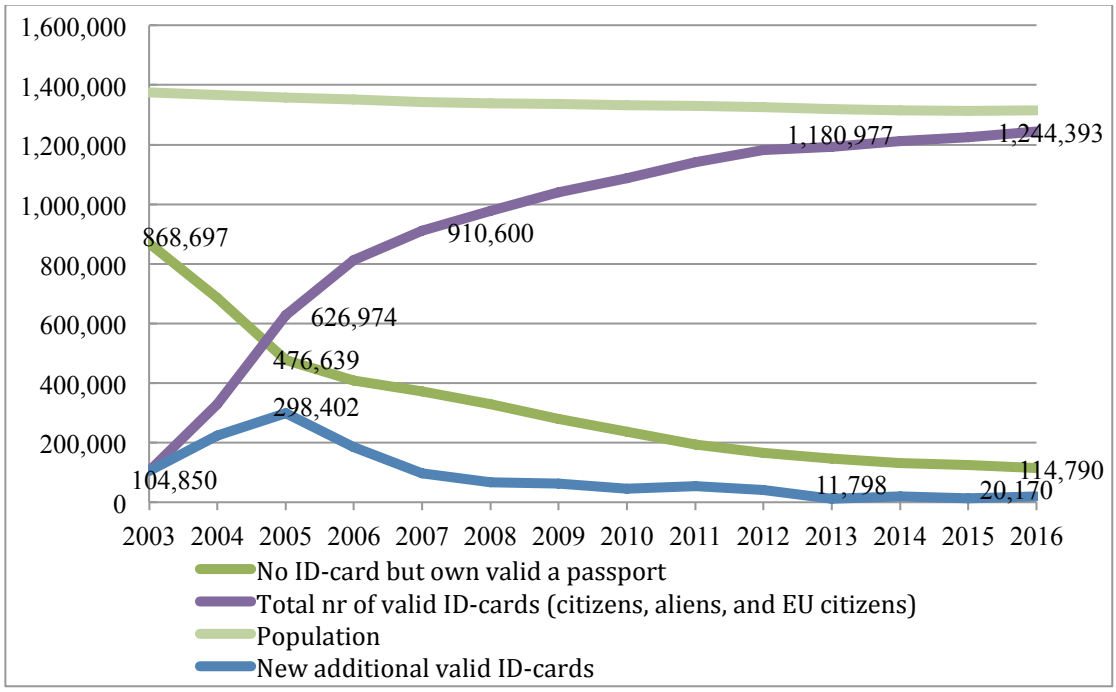

Figure 1. The Change in the Number of People With a Valid ID-Card, the Annual Number of Additional Valid ID-card Holders (Includes Citizen's IDs, Alien's IDs, EU Citizen's IDs and Residence Cards), the Population of Estonia, and the Number of People Without a Valid ID-Card Who Own a Passport from 2003-2016. (Data point January 1st) Source: Police and Border Guard Board

Estonia is proud of its penetration rate and complete rollout within five years. However, to compare, Belgium with population of 8 million, reached complete rollout within a year (Mariën and Van Audenhove 2010, 28) and within four years Spain

[6] Of those one million ID-cards issued 892 957 were valid (Certification Centre 2006).

managed to issue 9 million e-ID cards (Heichlinger and Gallego 2010) (for a country with 47 million inhabitants it is still less than 20%).

The similarity of the Belgian and Spanish cases to Estonian case is that in all of those countries the national identification card is mandatory. If we were to look at countries where the ownership of an ID-card is optional, such as Finland for example, the picture is very bleak and there is no comparison. Finland started issuing FINEID cards in 1999 and ten years later about 5% of population has a valid ID (220 300 people in July 2009) (Rissanen 2010).

The issuing of the ID-cards coincided with the massive expiry of passports issued in the first years of the republic. In 2002 about 95 000 and in 2003 about 300 000 passport were expiring (KMA 2008, 112). Though the mandatory identification document was ID-card, passports remained more popular – about 800 000 passports were issued between 2002-2004 compared to almost 600 000 ID-cards (*Ibid.*).

What is interesting about the actual rollout from the first year is the fact that it was very popular with the older generation. Customarily one would assume that the young would be dominating ID-card holder. Based on the TNS Emor survey from January 2002 those more likely to apply for an ID-card were men, Estonian, up to 35 years old, with higher incomes, and inhabitants of Tallinn (TNS Emor 2002). The data from 01.01.2003 shows that the share of people holding a valid ID-card out of total ID-card owners was greater for people over the age of 45. Figure 2 depicts the statistics for ID-card ownership and population relationships. One can see that the share of age groups in population starts to slowly decline after the age of 46. At the same time the share of people over 46 having a valid ID is very high and even grows with age until the age of 70[7]. This seems surprising, since the generally the younger generations would have more knowledge about and experiences with technology, also the

[7] The data on population does not cover the potential recipients of the ID-cards (Estonian citizen, EU citizen, alien and residency card) fully. For one, the Estonian citizens who are issued an ID-card can also permanently reside outside of Estonia. Two, in 2003 the population data was based on Census data updated only with Population Register's data, but it is very low quality because it does not adequately record migration data (Estonians and aliens were not oblidged to (and did not) register their place of residence, which led to the poor quality of migration data)
Statistics Estonia (2016a). RV0212: Rahvastik aasta alguses ja aastakeskmine rahvaarv soo ja vanuse järgi..

necessary skills, and thus feel more at ease with it (Tiits *et al.* 2014). There might be two plausible explanations – one relates to the mandatory nature of the ID-card and the correlation of age with lawfulness but also to the opinion leaders who received the first ID-cards (read more in 2.2.2.1.).

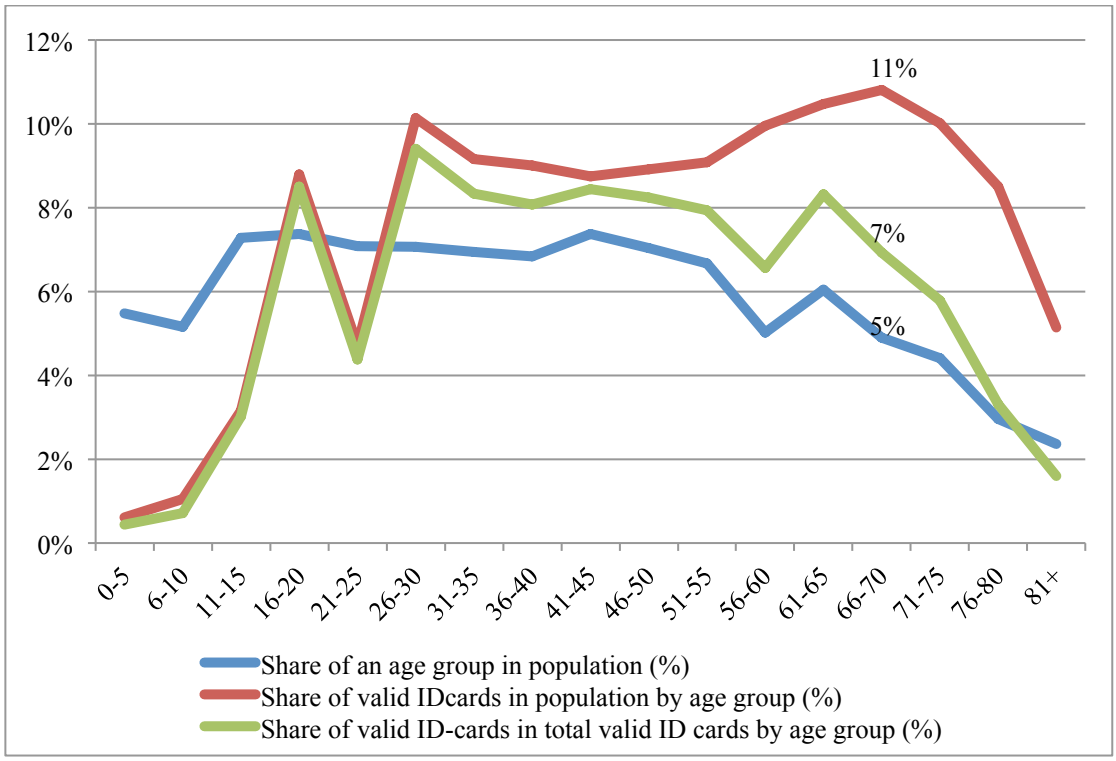

Figure 2. The Share of Valid ID-cards in Population Age Groups, Share of Valid ID-cards in All Valid ID-cards by Age Group, and the Share of Age Groups in Overall Population on 01.01.2003, percentages. Source: Police and Border Guard Board, Statistics Estonia.

The other interesting fact is that for some reason there is a steep drop in ownership of valid ID-cards for the age group 21-25. Out of all the owners of a valid ID, the youngster from 16-20 who have a valid ID make up 8,8% and the young adults from 26-30 make up 10%, but people aged 21-25 only hold 4,7% out of all valid ID-cards (see also Appendix 3 for detailed statistics).

The statistics for 16-20-year olds are not surprising, as this is the age group that has just become of age to own an identification document. The results for the next age group might be explained by the fact that in 1992 they were 10-14 years old and did not have to apply for a passport. They started applying for them in the next five years, which means that their passports are also going to expire in the future between years 2003-2007. The Identity Documents Act stipulated that ID-card is mandatory, but a

person can apply for it when their previous identification document expires (§38) . Thus, this might be the age group comparable to the very young (0-6; 6-10; 11-15).

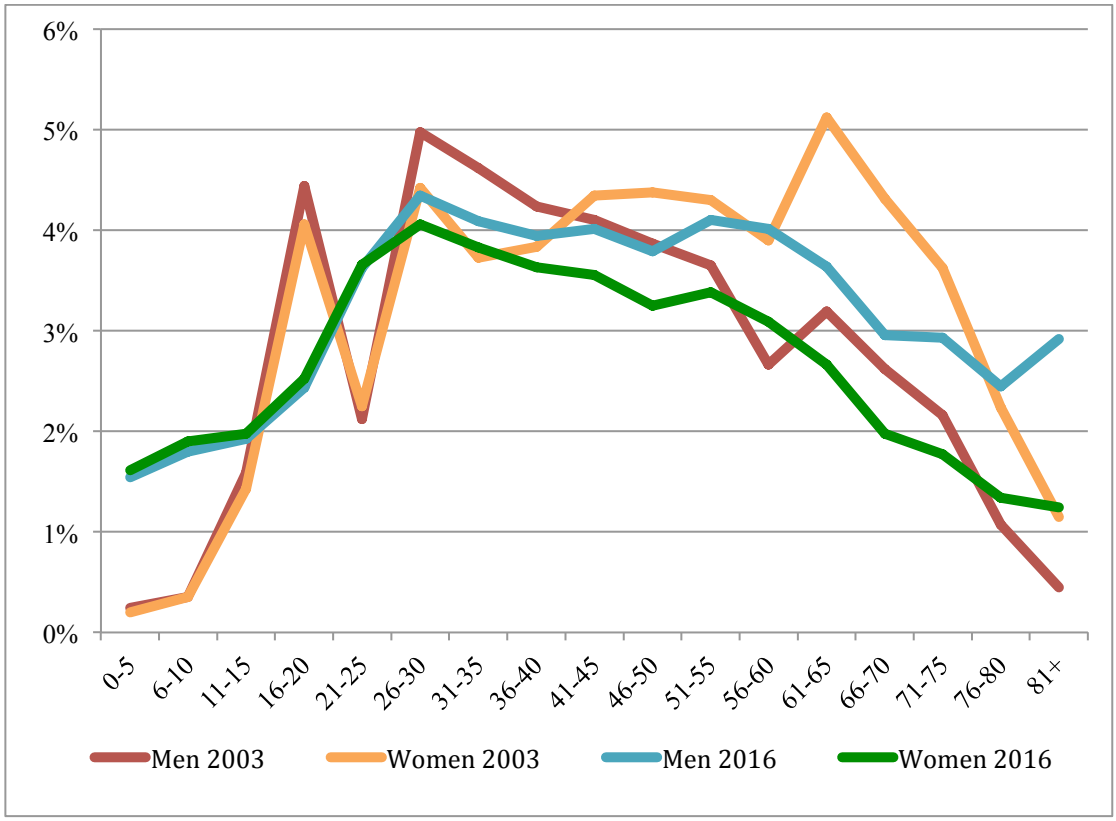

Figure 3. Valid ID-card Owners by Gender in Age Groups out of Total ID-card Owners on 01.01.2003 and 01.01.2016, percentages. Source: Police and Border Guard Board

Figure 3 compares gender based statistics for ID-card owners in 2003 and 2016. It shows that for both years there is not much difference in peoples behavior about ID-card ownership until people reach their thirties. The situation, however, has changed drastically in the older users categories.

If we look at the share of ID-card holders in population in 2016[8] (for detailed statistics see Appendix 4: Table 5) then the coverage is full for all on those above the age of 15. In 2015 almost all people above the age of 50 (97%) have an ID-card (TNS Emor 2015). This can be explained by the practices of the Police and Boarder Guard Board. When elderly people apply for documents in the service offices, they are asked if they plan to travel outside of the European Union (Sein 2016). In addition, it is stressed

[8] Look at these statistics as indicative of the dissemination trends, because the data is not totally compatible. This becomes evident when in some age groups the coverage with ID-cards is more than 100% and in case of older men, in some cases there are twice more ID-card holders than should be people living in Estonia.

that the ID-card is cheaper (for persons who have attained Estonian general pensionable age, the passport is almost three times more expensive (7 EUR vs. 20 EUR)) (*Ibid.*). Thus, this process might be swaying the elderly to adopt an ID-card instead of the familiar passport.

In 2003, the share of women holding an ID-card grow bigger than the share of men for those older than 45 years. In the older age groups (56-75) for every two men holding an ID, there were three women. For the oldest age groups (76 and up) women were even more heavily represented – for every man two or three women had the card.

In 2016, men take the upper hand in ID-card ownership after the age of 26 and the differences in ownership continue to grow (Appendix 4). After the age of 65 there are three men holding an ID-card for every two, or even less, women. This far it is all based on absolute numbers of ID-card owners – none of this has been scaled to population in age groups. Even more – the share of men in population for these age groups is opposite to their share in ID-card holders in 2016 (Appendix 4, Tables 1 and 3).

In conclusion, if in 2003 women were in the forefront in the ID-card usage, then by 2016, men have started to dominate in the owners of ID-card and their dominance is even more substantial if we take in consideration that after the age of 46 their share in population starts to decrease.

2.2.2.1. The Push And Pull Factors

2.2.2.1.1. Compulsion

In discussions about Estonia's e-government, the adoption of the ID-card and its mandatory nature are stressed as success factors (Kalvet and Aaviksoo 2008, Kalvet 2012). The ID card concept is similar to Estonia and also mandatory in Belgium, where the rollout is complete, in Spain, where they are well on their way (Heichlinger and Gallego 2010, Mariën and Van Audenhove 2010, Martens 2010). ID cards are voluntary in Finland and Sweden but they haven't been embraced by the population (Grönlund 2010, Rissanen 2010). Thus making a scheme mandatory does have its

influence. However, the issue is complex, highly dependent on national contexts, thus concluding that making the ID-card compulsory was the key, might be presumptuous.

For the laws to have any effect on people's behavior, they must be aware of them. A study on the knowledge-ability of the population about legal matters pointed out that the level of education and awareness are related but not absolute (Ministry of Justice 2007, 24-27). In general, more informed people are relatively younger (around 40 years of age), better educated, employed (often in the public sector), living in bigger urban areas (*Ibid.*). It has a lot to do with engagement in society and the experience of living in this legal system, combined with the experiences of having to deal with different life cycle events and communicating with the state (*Ibid.*). Therefore, the very young may lack such competences and knowledge because the have not reached that point in their lives when it becomes necessary.

If to look at the general tendencies in Estonians' behavior regarding the law, then the picture from 1990s shows that drastic changes have taken place. The early '90s were turbulent times with fundamental social changes. The collapse of the Soviet Union caused the breakdown of earlier control mechanisms and the significance of social control diminished radically (Saar 2010). The changing value system and moral norms in Estonia were typical to transitioning societies (Kasemets and Ilves 2006, 16-17). The mid-1990s are characterized by high crime rates and social disorganization (Saar 2010). "Offences against the person (homicides, above all) have been regarded as important from the perspective of characterizing the moral level and proneness to conflict of the population" (*Ibid.,* 241). The crime rates have continuously dropped three times when comparing 1995 and 2009. With this I am trying to suggest that perhaps the compulsion to own ID-cards, was not so convincing for the inhabitants of Estonia in early 2000s.

In Estonia, the mature generation seemed to apply for the mandatory ID-cards quicker compared to the rest of the population. Research has shown that age has strong correlation to lawful behavior which could be one explanation (Healy 2004, Ulmer and Steffensmeier 2014). There are also no repercussions if one doesn't have an ID-card (Figure 1 shows that even today there are more than 100 000 people who prefer passports to ID-cards). This might also be one of the reasons why some of the people

have decided to wait until getting the ID-card or have opted to not get one at all. The Police and Border Guard Board has responded that firstly, having no sanctions does not relieve the person of the obligation to have an ID-card. Secondly, the main motivation has been the inconvenience that the e-services are not available without the ID-card, so that the majority has complied with the law despite the lack of sanctions (Abram 2016).

2.2.2.1.2. Cost

The state made a strategic choice in pricing the ID cards. From 2002 until 2007 the state offered them a subsidized cost (over 50% cheaper) (Kalamees 2001, Martens 2010). The price for ID-card or passport in 2002 was 150 EEK (≈9,6 EUR), the cost of ordering both documents was 250 EEK (≈16 EUR). For children (under the age of 15), retirees and the disabled a diminished price was charged – 25 EEK (≈1,6 EUR) for the ID-card and 75 EEK (≈4,8 EUR) for passport, and both documents together 100 EEK (≈6,4 EUR) (Saidla 2002).

Today the pricing still favors ID-cards though the price has gone up considerably: for grown-ups the price of the ID-card is 25 EUR, passport is 40 EUR and both documents are 50 EUR. The diminished price for children, the retirees and disabled is 7 EUR for the ID-card, 20 EUR for passport and 25 EUR for both documents (PBGB 2016).

2.2.2.1.3. Cooperation

For the first five years the state had also signed a cooperation agreement with the Certification Centre which guaranteed that the public had the chance to retrieve their ID-cards and passports from all the bank offices of Hansapank and Ühispank (together their market share was 83% (Sõrg 2004, 214)). This definitely added to the convenience of the people who wanted to get new identification documents.

2.2.3. The Electronic Usage of the ID-card – eID Rollout

The data for eID usage starts with August 2002. Data for the first six months (February to July) are unavailable. The available data from the Certification Centre were three fold. Monthly data for new unique users of eID starting from August 2002 and compound data for the number of all users who have used their eID at least once.

That data is based on the personal codes of people, not on the serial number of ID-cards. In others words, every person can be a new unique user only once, regardless on how many ID-cards they will have during their life.

The second recorded data is the percentage of active users. Beginning with September 2008, the Certification Centre has recorded the percentage of active (6m) users who have used their eID at least once in the previous six months and since September 2013 they also record the data for active (12m) users who have used the eID once in the previous 12 months[9].

Thirdly, the certification Centre also periodically receives data about the number on valid ID-cards and based on that information they mathematically find the percentage of eID users in all valid ID-cards and the percentage of active (6m,12m) users as well.

The data for the eID monthly unique new users shows that at first the rate of adoption was extremely low – hundred, two hundred and five hundred new unique e-ID users in first three years respectively (see Figure 4 below; for a detailed timeline of events see Appendix 1). The first significant rise was in four years after the introduction of the ID-card in 2005 when Estonia held local government election on the 16th of October and electronic voting was possible for the first time. The increase is even more spectacular than can be witnessed in the annual average of the monthly new unique eID users. The statistics on new unique users from August to September were 369 in August, 1 389 in September, 5 574 in October when the elections took place, and 646 in November after the elections.

The eligible voters were able to vote online for three days beginning from 10th of October 2005 and about 2% of all the voters chose this method (Madise and Martens 2006). Out of all electronic voters (9 317 people) 61% (5 774 people) used their ID-card electronically for the first time (Madise and Martens 2006)[10].

[9] The Estonian Digital Agenda 2020 requires it, because it defines an active user as a user who has used the e-ID at least once in 12 months.

[10] Either the Certification Centre or Madise and Martens have made a data error, because the data from Certification Centre shows that the number for new unique users of eID in October of 2005 was 5 574 but the article by Madise and Martnes suggests it should have been at least 5 774.

Faster growth in new unique users per month started in 2007, when affordable I-card readers were widely distributed, Firefox official software was released, and EMT started offering Mobile-ID. The next year the number almost doubled – each month saw an average of 7 600 new users.

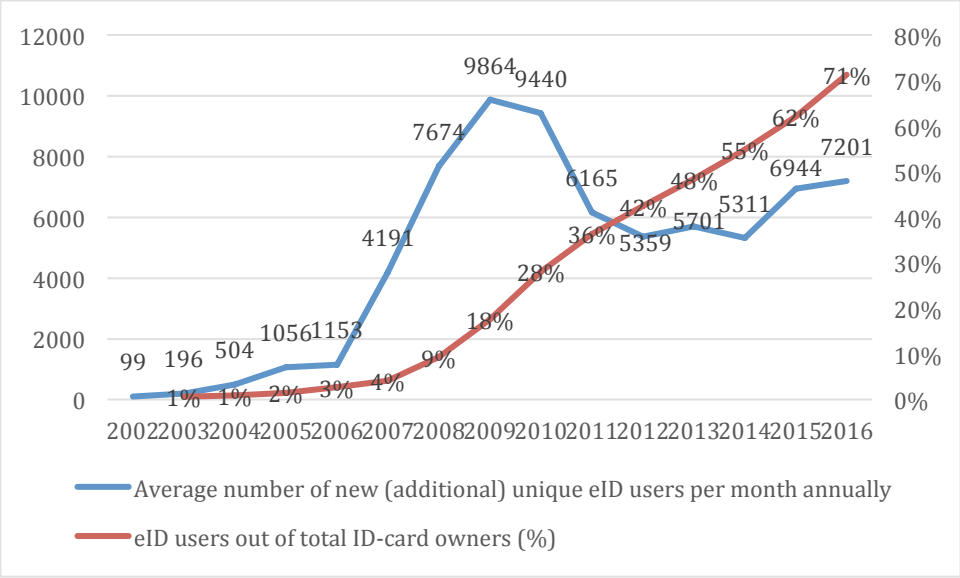

Figure 4. Annual Monthly Average of New (Additional) Unique eID Users and the Share of eID Users Out of Total ID-card Owners from August 2002-March 2016. Source: Certification Centre

In 2009, the average number of new unique users reached almost ten thousand (9 864). So far that has been the year with the fastest growing number of new users. In 2009, the banks made their final limitation to transactions so far, making it impossible to transfer more than 3 000 EEK (191 EUR) in a day with pin-cards.

2010 saw a slight decline in the new users numbers though Linux and Mac users finally received official ID-card software. The years from 2011 to 2014 marked a sharp drop in the new users of ID-card per month. The number bounced between 6 150 and 5 300.

The year 2015 was characterized by a 30% rise in new unique users and the numbers for the first three months in 2016 support this trend of increase. However, it is important to note that usually February and March offer bigger numbers for new unique users than other months. As this seems to happen annually, one could speculate that it has to do with the beginning of filing the natural person's tax declarations for the previous year (see more in 2.2.4.)

2.2.4. The Depth of eID usage – All Users and Active users

Figure 4 depicts the increase in eID users as a percentage of all ID-card owners and Figure 5 shows the same developments in a more detailed way for the past seven years.

Certification Centre has recorded data for user activeness since the end of 2008. The share of people who have user their ID-cards online has grown three times in seven years from around 20% in the early 2009 to 62% at the beginning of 2016. During that time people have also started to use the eID more vigorously. The share of people who have used their eID at least once in the past six months has grown from a meager 12% at the end of 2008 more than three times to 42% in early 2016. The certification Centre also measures those active users whose last eID usage took place during the passed year. The relatively small (15%) difference between the two types of active users compared to the bigger difference (30%) between users who have used their eID, but not in the last 12 months could suggests that the more a person has used their eID, the more likely they are to use it again. However, this is a speculation and needs further detailed analysis.

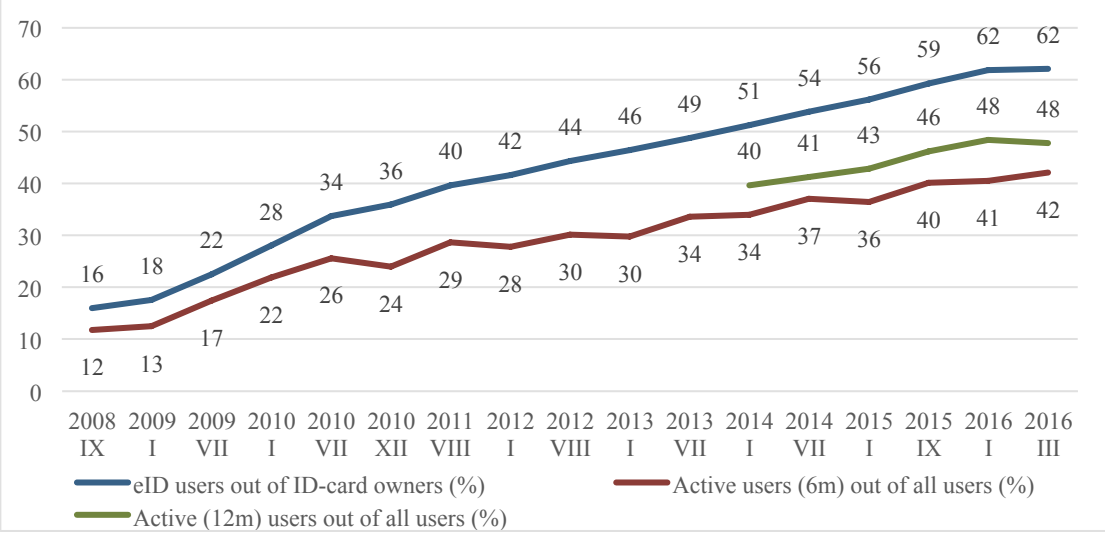

Figure 5. The Share of eID Users and the Share of Active Users Who Have Used Their eID At Least Once in the Last Twelve Months and At Least Once in the Last Six Months Out of All Valid ID-cards. Source: Certification Centre 2016

2.2.5. E-ID Usage in e-Services

2.2.5.1. Eesti.ee Portal

The statistics from Information System Authority, who is responsible for the state portal eesti.ee, support other sources that the prevailing method for authentication is not the eID. More than half of the authentications are done by bank links (supposedly using pin-cards)[11].

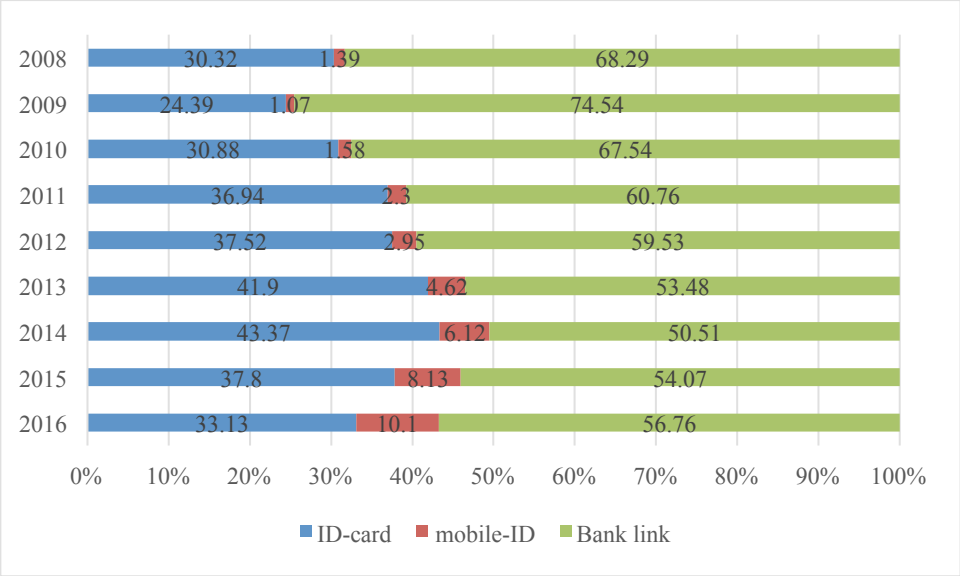

Figure 6. Statistics on Different Authentication Methods for the Eesti.ee Portal from 2008-2016. Source: Veidenberg 2016

The data on Figure 6 shows that the growth in eID usage was continuous until 2014 but for some reason it has started to diminish afterwards. Also the graph suggests that the growth in mobile-ID usage comes (at least to some extent) from the ID-card users who are switching to a more convenient platform.

2.2.5.2. Banking Sector

Estonia is known for its high usage of internet banking (90% of working age people (Statistics Estonia in MEAC 2013, 7)). In the years 2013-2015, the banks have been

[11] The data cannot specify which identification method specifically people used (password-card, pin-calculator or perhaps even eID), when opting for bank link. However, it is logical to assume, that if they already have mobile-ID or ID-card at hand, they will use those to directly log on to eesti.ee and not use a bank-link for logging in with eID.

responsible for around 65-75% of all the OCSP inquires[12] (Lukin 2006). Thus, for these two reasons looking at the financial sector can offer insights to the eID diffusion.

There are some statistics available from 2008-2009 that might suggest how the decision of the Banking Association in May 2009 affected users' behavior. Figure 7 shows that after setting the ceiling for maximum daily transactions to 3 000 EEK the usage of eID had almost doubled for both banks. The growth was 4,5% for Swedbank and twice more – 9% for SEB[13].

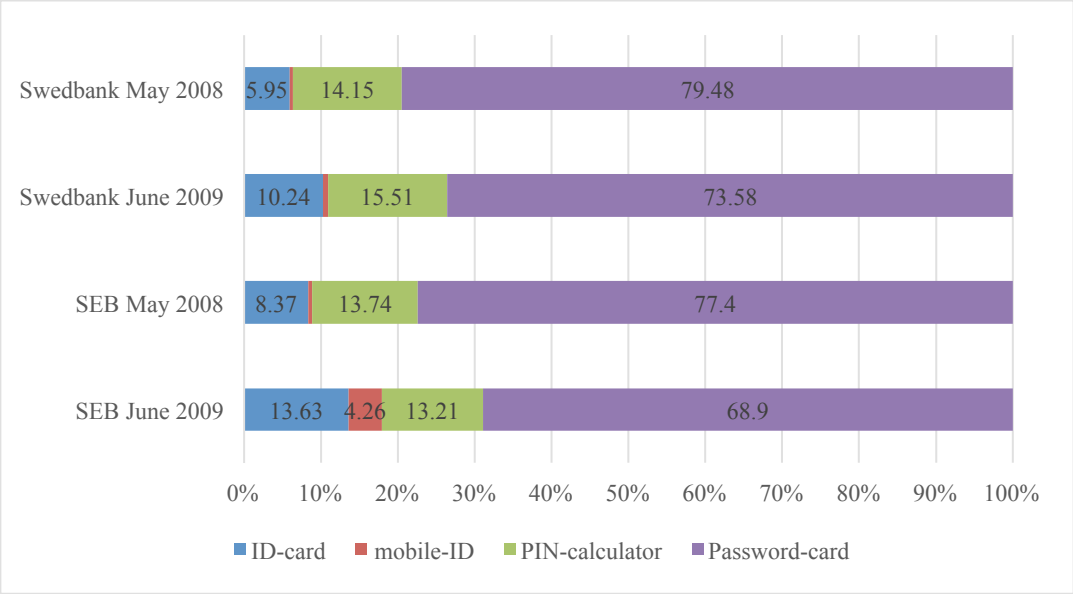

Figure 7. Online Authentication Methods for Swedbank and SEB in May 2008 and June 2009. Source: Martens 2010, 227-8

I also have more recent data from Swedbank (Raba 2016). Figure 8 depicts the monthly authentication covering a period of four years and five months[14]. It shows a slow but steady increase for eID users. The ID-card usage has increased by 40% and mobile-ID usage has more than tripled in that time. The eID usage has grown from a share of 27% to 42% which means a 55% increase in that period.

[12] OCSP inquery determines if the certificates of the eID are valid. The certificates are checked prior to authentication or digital signing and both of the procedures can be done only with valid certificates.
[13] The difference in the growth rate might be explained with their size. Based on household savings on June 2009 the absolute leader was Swedbank with 55% market share and SEB was second with 23% (Financial Supervision 2016).
[14] Over 70% of Swedbank's clients use internet banking and there are about 5,5 million sessions a month (Raba 2016).

This data on Figure 8 also points to an interesting regularity – every year in February there is an increase in the share of pin-card usage. This can be explained with the beginning of tax declaration in February[15][16]. It also confirms the opinion of expert Tarvi Martens, that natural persons are more inclined to use pin-card instead of eIDs.

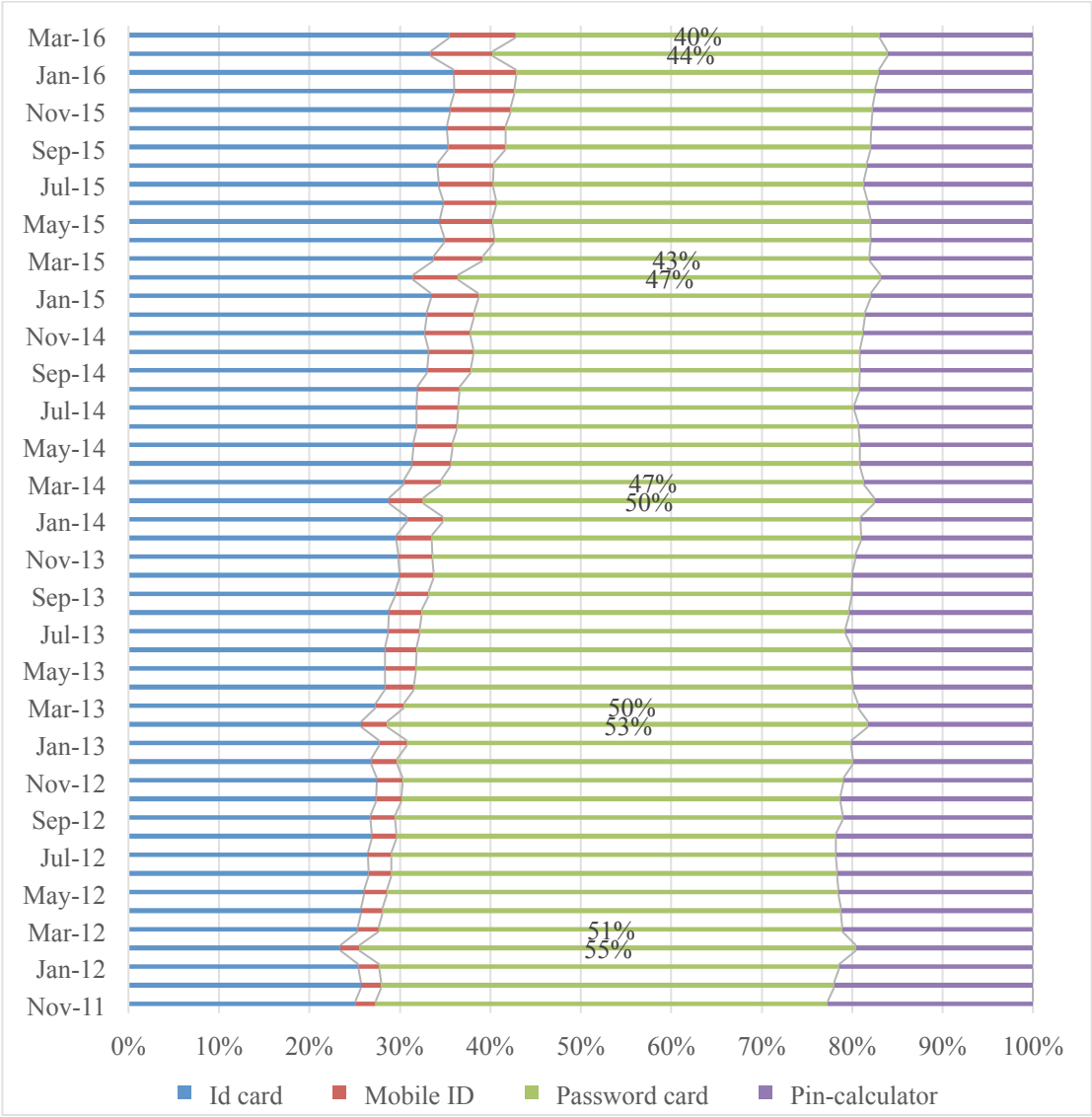

Figure 8. Share of Different Authentication Methods for Swedbank's Internet Bank Sessions from November 2011 until March 2016. Source: Swedbank

Another example from April 2016 is from Nordea bank which is the third biggest

[15] During that time the banks generally remind the people of the obligation in the internet banking environment and offer to forward clients to the e-service in e-Tax.

[16] In recent years people try to file their declarations as soon as possible, often causing so much traffic that the system goes offline. Almost 18% of expected target group had filed their statment in the first 14 hours (Rudi and Mägi 2016).

bank in Estonia with a market share of 7% in household savings (Financial Supervision 2016). They reported 40% of ID-card users, 25% of mobile-ID users, 25% of password-card users, and the last 10% used the Nordea password option (Kibena 2016)[17]. Nordea bank does not have a PIN-calculator option. For transactions that require added security (over 200 EUR), Nordea's clients are forced to use either the ID-card or mobile-ID. Thus, it is logical, why the share of eID's is relatively high – 65% for Nordea. The picture for less secure means in identification, is similar to that of Swedbank. According to the latest data about 40% of session in Swedbank use pin-cards, and in Nordea password and password-card users make up 35%.

The relatively substantial size of people who still use password-cards for identification demonstrates the issues relating path dependency – if people have a working method and no need or pressure to change it, they are unlikely to make switch (Högselius 2004, 252, Rissanen 2010). This point also explains why the share of pin-calculator based sessions is around one fifth in Swedbank (though diminishing). One can suggest that if Swedbank's clients wouldn't have historically had pin-calculators as an option, the authentication data of Swedbank might resemble that of Nordea.

2.2.5.3. Estonian Tax and Customs Board

The Estonian Tax and Customs Board introduced an online environment (E-Tax) to declare taxes in 2000. At first the take up among natural persons was low (see Appendix 5) – in 2001 8,7% and 2002 21% of all Natural Person's Income Tax Declarations were filed online (Aleksandrov 2014). In five years the share of Income Tax returns filed online was more than half (56%) for natural persons (Lindroos 2016). The companies had realized the helpfulness of the possibility several years earlier. Today almost all data is filed in the online environment.

In Discussing the Tax and Customs Board, the fact that Internet is used for online tax declarations, does not necessarily mean that the ID-card is used to file. In the mid-2000s many people (65%) declared their taxes online, but used bank-links instead of the ID-cards (Modinis 2007, 21).

[17] These statistics are a combination of session-based and user-based statistics. Nordea bank gave the data based on the most frequently used method per user.

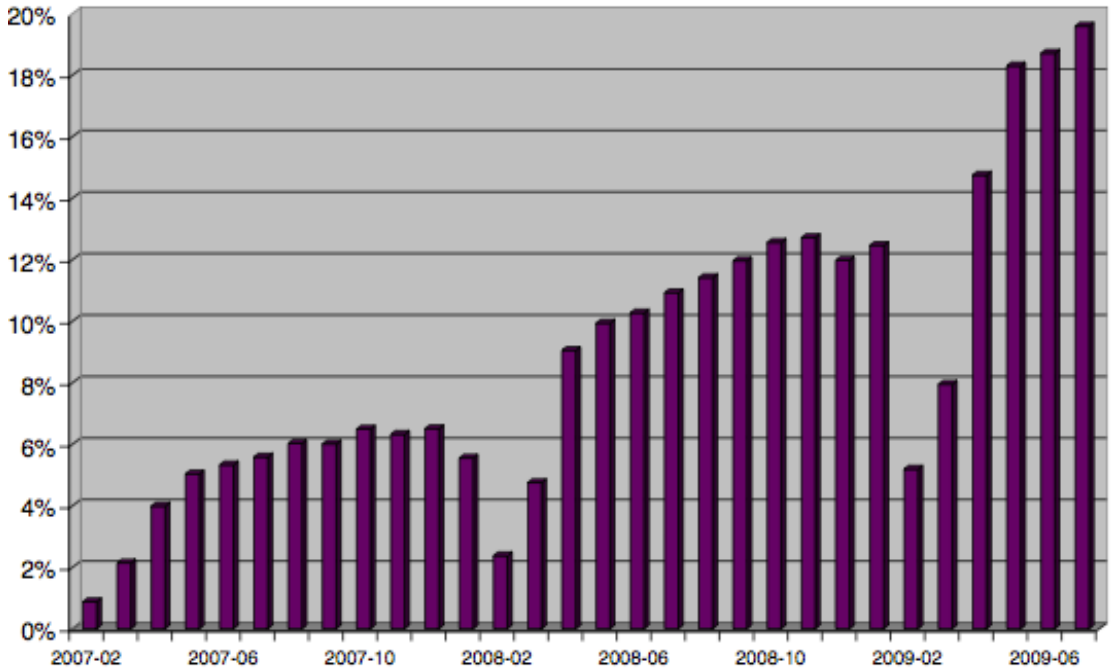

Figure 9. The Usage of ID-card and Mobile-ID in the E-tax Board from 02.2007-07.2009.
Source: Martens 2010

Figure 9 shows the state of ID-card and mobile-ID usage for logging into the online environment of Tax and Customs Board. For the three years depicted, the growth has been about 6% a year. It is clear that the usage of ID-card or mobile-ID is much lower in the beginning of the year. This is due to the fact that February and March are the main months for natural persons to declare their taxes[18]. Figure 9 concurs with the expert Tarvi Martens, who suggests that businesses (people in a professional role and representing legal persons) are more likely to use eIDs and ordinary people pin-cards (Martens 2016).

More recent data (1st of May 2015 – 9th of May 2016) from the Tax and Customs Boards shows that almost half of the log-ins are done with an ID-card (49%)[19] (Lindroos 2016). Bank links are the second most used method with 35% and mobile-ID is used in 11% of cases (*Ibid*). The remaining 4% of cases the Tax and Customs Board issued passwords were used.

[18] Natural persons usually communicate with the Tax and Customs Board only once a year. Businesses (legal persons) need to interact with the authority more frequently (several times a month – different taxes have different declaration dates). The influx of natural persons diminishes the usual share of ID-card users.
[19] The total number of log-ins was 8 235 576.

Based on this data we can conclude that the usage of eID in the electronic environment of Tax and Customs Board has increased reaching 60% of sessions[20].

2.2.6. Governments Actions and Events Potentially Promoting eID Usage

The Digital Signatures Act was passed in 2000 and entered info force the next year. In 2003, this act was tested in Tallinn Circuit Court when Tallinn Administrative Court had refused to accept a digitally signed document (Roonemaa 2003). The ruling of the court concurred with eth Digital Signatures Act – digital signatures have to be considered equal to hand written signatures (*Ibid.*). This incident also helped to develop further the ID-card software. To the request of the Ministry of Justice, Certification Centre added the possibility of printing out the summary page that shows who and when have signed the document digitally (*Ibid.*).

In 2004, Ministry of Economic Affairs and Communication proposed to all state authorities that in order to secure wider usage of ID-card, all computer hardware procured by the state should have ID-card readers in their basic equipment (RIA 2004). In 2006, the Information System Authority carried out a legal analysis whether the notification function in eesti.ee is incompliance with the law and documents can be forwarded electronically (RIA 2006). Technical solutions for signing digitally or encrypting documents add possibilities to the extensive use of electronic channels and everything can happen in accordance with the law (*Ibid.*).

In the light of the coming Local Government elections and the first time use of e-voting in 2005, the government took the opportunity to promote the ID-card and its digital use. A campaign offering new and free PIN-codes for ID-cards during more than three weeks was initiated (SK.ee 2005a). The certificates were made free for the end user already in 2004 and the state covers that cost (SK.ee 2004).

The year 2008 marks a change. The Information System Authority started to engage more in the ID-card area. The state took the control in the development of the ID-card software in 2008 when Information Systems Authority declared AS Smartlink the ID-

[20] This data refers to sessions and cannot be assigned to users.

card and digital signature software procurement winner (RIA 2008). In 2010 Certification Centre took over where Smartlink left off (RIA 2010).

In the summer of 2008, the Information System Authority also initiated a nation-wide ID-card awareness campaign (Post 2008). It lasted five and a half weeks and the aim was to get 50 000 digital signatures (*Ibid.*). It ended up collecting 11 126 signatures, but 18% of people it was the first digital signature (*Ibid.*). It hard to evaluate the effectiveness of that specific campaign or the one that followed in November (see also Appendix 1) but the years that attracted the most unique new users were from 2007-2009 (see also 2.2.3.).

2.2.7. Support from The Private Sector to Encourage eID Usage

Promoting the usage of ID-card has been a nation-wide campaign that has stretched beyond the state sector. Many private initiatives have decided to jump on the band wagon and promote ID-card related services.

Usability is an enormously important issue. In Estonia's case usability was also somewhat lacking at first. At the beginning of 2002 when first ID-cards were launched, there were no applications for them (Martens 2010, 226). It was supposed to be the responsibility of the Ministry of Economic Affairs and Communications. In October 2002, the Certification Centre launched the first ID-card software version of DigiDoc (SK.ee 2002). It was commissioned by the Look@World Foundation and privately financed by Eesti Telefon, EMT, Hansapank and Ühispank (*Ibid.*).

At first the software only supported the Microsoft IE and Firefox support came only in 2007 (SK.ee 2007b). This is inline Finnish and Danish experiences that state that technical difficulties (Hoff and Hoff 2010, 164) in usage or just support for one platform, can be discouraging to users (Rissanen 2010, 191). Linux (Ubuntu 10.04, Open Suse 11.3, Fedora 13) and Mac (10.5, 10.6) software was developed in 2010 and Windows XP, Vista and 7 support came in early 2011 (SK.ee 2010).

In the summer of 2005, leading Estonian computer manufacturer ML Arvutid announced that they will start installing the ID-card software on their computers (SK.ee 2005b). In 2006, SEB started selling cheaper ID-card readers and a year later

Look@World foundation followed (Roosaar 2006, SK.ee 2006a). Another important step technology wise was in 2007, when internal ID-cards for laptops became available (SK.ee 2016).

The private sector has led the way in several innovative moves regarding the eID. In 2007, EMT introduced the mobile-ID (SK.ee 2007a) service and Elisa (SK.ee 2009) and Tele2 (SK.ee 2016) joined them in 2009. Though initially it was marginally used, it is gaining users now. Today it is a service which (unlike the ID-card) requires a monthly service fee of one euro (Elisa 2016, Tele2 2016, Telia 2016).

In 2007, the Estonian Banking Association started to diminish the amounts for transactions that can be made daily with pin-cards. In 2007, they lowered the amount to 10 000 EEK (640 EUR) (EBA 2007), in 2008 to 5000 EEK (320 EUR) (EBA 2008), and in 2009 to 3000 EEK (192 EUR)[21] (EBA 2009). See also 2.2.5.2.

In Addition to the Citizenship and Migration Board's campaign to give free ID-card PINs, there have been much wider and influential campaigns that have included the banking sector. Such campaigns were taking place to facilitate the change in transaction limits and encourage eID usage. During the years of 2008, 2009, 2010, 2011, and 2015 one of both of the major Estonian banks offered to give new PIN-codes free of charge for a period of at least two months (SEB 2008, SEB 2009, Swedbank 2010, Sakala 2011, Williams 2015).

2.2.8. The Role of e-Services in Promoting eID

The importance of services has been mentioned throughout the development of the ID-card project. Estonia is a very IT-friendly state – there are a lot of online services, such as the e-Tax for tax declarations, eesti.ee citizen portal, e-kool for parents and schools to communicate, e-Health and digital prescription to name a few.

Based on data from 2011, the most often used e-services were e-Tax (65%), digital prescription (50%), paying state fees and for public services in Internet banks (47%), and the using the eesti.ee portal (43%) (Kalvet *et al.* 2013, 16). However, none of

[21] With the introduction of euro, the sum was rounded up to 200 EUR.

these services use exclusively eID for identification. The only exception is e-Health[22] that requires added security and doesn't allow other methods. But to use the popular digital prescription service, one doesn't need eID identification[23].

I would suggest that the possibility of making transaction in sums over 200 EUR[24] should be considered a perk and an e-service of the ID-card. In the long run it will increase the number of eID users. For one, there are talks of lowering the limit even further to 150 EUR (BNS 2016), for two, inflation. Comparing the average gross salary of 2009 to that of 2015, there has been an increase of 35% (Statistics Estonia 2016b). This suggests that the limit for transactions has become more constricting today than it was in 2009. All that should increase people's motivation to use eID.

2.2.9. Bench Marking

The rollout if the ID-card is complete and the more than half of ID-card owner have used their cards online. In early 2016, the share of ID-card holders who have used their eID in the last six months is 42%, in the passed year – 48%, and at least once is 62% (see more in 2.2.4.).

The full penetration of the card definitely signals success. The eID usage is somewhat more questionable, because the rate of eID usage is not 100%, and thus we have to rely on benchmarking. If we compare the rate of eID usage for filing tax returns in 2009, we see that Sweden is in the lead with 24,4%, Estonia follows with 19%, then come Denmark with 18,8%, and Belgium is behind with 14,4% (half of those were filled out by service of tax office) (Kubicek and Noack 2010a, 243).

The Estonian and Belgian systems are alike – for both the eID has only one mandatory carrier card and the rollout is complete (*Ibid.*). In 2009, about 80% of Belgians had used their eID while only 50% of Estonians had done the same (*Ibid.*). Thus, somewhat higher shares of eID usage might have been expected for Belgium.

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[22] http://www.e-tervis.ee/index.php/en/; Patient portal www.digilugu.ee is avaiable only in Estonian.

[23] The service works in a way that the patient only has the tell the pharmacist their personal identification number and based on that info the prescription is found and issued.

[24] The original limitation was introduced on May 2nd 2009, then in the sum of 3000 EEK (191 EUR).

The other two countries, Sweden and Denmark, are different from Estonia, because for one, it isn't mandatory, secondly there is no one card that can hold the eID (Ibid., Hoff and Hoff 2010). It is interesting that in Sweden there is a national identity card NIDEL, but it doesn't carry an eID; four private providers or the Tax Authority provide only provide eIDs[25] (Grönlund 2010-7). The rollout for eID is small compared to Estonia – 21% of the population in Demark and 33% in Sweden (Kubicek and Noack 2010a, 243), thus one might expect also lower rates in eID usage for tax declarations.

With this section, I have tried to show that eID rollout is very context dependent. In addition, making comparisons is very difficult because the schemes and situation differ greatly – the correlations that one might expect to find, are not always there. For example, eID is mandatory in Austria, everyone has it, and yet no one uses it (Aichholzer and Strauß 2010).

2.3. Analysis and Conclusions

2.3.1. ID-card dissemination

In public sector innovations the environmental factors have an enormous influence of the success of a project. In Estonian case the overall attitude was supportive – the media, the public sector – everyone seemed to be on board. Even the politicians were able to reach a common understanding and changes in government didn't derail the project (Martens 2010).

The legal and regulatory aspects are tricky and time-consuming. For example, the work on the implementation of the ID-card began in 1997. The initially planned 15 months turned into more than four years. In a way, this is a clear signal, that the process has been very complex. The legal and procedural factors have taken a lot of time. For example, the work on the Digital Signatures Act took four years (ID.ee 2016) until it was finally passed in March 2000. Thus, the availability of time is essential and luckily Estonia wasn't heavily pressed for time. In 2002, about 95 000 passport were to expire, but main body of 300 000 was expire in 2003 (KMA 2008, 112).

[25] In Sweden there is also a software-based eID available.

It took five years for the ID-card to reach complete rollout in Estonia while in Belgium only a year (Mariën and Van Audenhove 2010, 28). In this instance speed was not the primary goal for Estonia. The Identity Documents Act allowed for people to wait until the expiry of their passports, which also meant the transition from passports to ID-cards as the mandatory identification document will be gradual. It is also important to keep in mind the administrative capacity of the authorities when planning a large scale change like this one was. Forcing a quick transition can have the opposite effects.

The problem with public sector innovations is often the lack of resources – money, time, people and commitment, know-how etc. Financially, Estonia had already chosen the path of investing into technology and from the early 1990s the investments in ICT had continuously grown (Kalvet and Aaviksoo 2008, 88). This means that the leaders share a vision and understanding which made all cooperation simpler.

The ID-card project is inundated with different work-groups for different purposes. This could insinuate that the project at hand was taken seriously and the preparations were seen as very important and adequate man-power was allocated. Also, in this case we can see that the same names get mentioned in different contexts again and again denoting to the commitment of people. The ID-card project is characterized by deep involvement of specialists and cooperation with the private sector.

The latter is especially important and uncharacteristic to old bureaucracies (Dunleavy *et al.* 2006). The close cooperation with banks, for example, in issuing documents from 2002-2007, is also appraisable. It increased the convenience of the people. However, I doubt that such a decision could be born in 2016 – the context has changed tremendously.

The state took the lead in carrying the financial burden for the cost of the ID-cards[26]. The cost of the ID-card was made relatively low, thus becoming more attractive even though in the early years more passports were issued (see also 2.2.2.). Also, the

[26] In actuality they subsidised the cost of ID-cards with the cost of passports.

government, through the actions of Police and Border Guard Board, advises people, especially the older generation, to adopt ID-cards (Sein 2016).

In the actual dissemination, among the first recipients of the ID-card were the presidents of Estonia and their wives. The president in office Arnold Rüütel (73 at the time) and his wife Ingrid Rüütel (66) and his predecessor Lennart Meri (72) and his wife Helle Meri (52) were among the first to receive an ID-card. It could be that these well-known and respected people inspired others to also apply for the ID-card.

The opportunity to use ID-card as a travel document within the EU is an added bonus which did not have that much significance back in 2002, but today it is very convenient. That same sort of convenience is given by the possibility to use eID.

2.3.2. eID Diffusion

People have not implemented the electronic identities as fast as they accepted the actual ID-cards. It is suggested that the diffusion of abstract innovations is more difficult than that of tangible ones (Rogers 2003, 258-9). In this case the contexts for ID-card dissemination and eID diffusion are different and the diffusion of innovations framework might be better suited to analyze this process.

The ease of use, compatibility, relative advantage, usefulness (De Vries *et al.* 2016, 158) are the important characteristics on an innovation that influence the person. The dissemination of eID is difficult due to the perceived attributes of the innovation. It is difficult for adopters to grasp the intrinsic attributes, especially if they have no prior experience.

The eID in 2002 was almost science-fiction – it was so different from what people were used to. At first, the user numbers were really low. eID was the domain of specialists or enthusiasts – the innovators and early adopters according to the diffusion of innovations literature. At first, the software was much less user-friendly than today and many people had problems with using the software (Veri 2008). This in turn supported the notion that eID is only for the IT-specialists, and the non-professionals have nothing to do with it.

The fact that the technical processes of authentication or digital signature are very complex, does not help the matter. The more complicated the processes, the more people have to rely on their trust in the service provider or in the state (Bekkers *et al.* 2006a, Kubicek and Noack 2010b). Thus, trust is an important facilitating condition – trust in the system, trust that it will prevail (vs. cancelled), and that support is offered (Kubicek and Noack 2010a, 243).

If compatibility is low and ease of use is viewed as dubious, relative advantage and usefulness remain as potential drivers for usage. Experiences from other countries such as Finland (Rissanen 2010) or Belgium (Mariën and Van Audenhove 2010) show that if the habitual methods are still in use and working, there is no motivation for users to make the switch to eID. The added security of the channel is not viewed as a relative advantage because security is an elusive concept.

In 2007, half of the people who didn't use eID explained it with the lack of need (TNS Emor 2007). Thus, the usage of eID requires (perceived) need and usefulness. Already in 2008, the ID-card users agreed that the financial sector has pushed them to used eID (Veri 2008). There have also been analyses into the cost effectiveness of digital signatures (SK.ee 2011) and the impact of x-road (Mihkel Solvak 2016, 29-37) stating that such innovations save money and time. The doubling of active users that has occurred in the last six years suggests that people are gradually recognizing the benefits of the eID. In other words, using the eID is a pragmatic choice.

When trying to locate the eID-diffusion on the technology life cycle curve, then in 2016, when the e-ID is somewhat used by less than half of the possible users, the technology is still on the Slope of Enlightenment, and we are still looking at Early Majority adopters. Soon we should enter the Plateau of Productivity, when the late majority comes on board and then the third generation applications start to emerge. I would suggest that the second-generation application of the e-ID was the mobile-ID in 2007, even though it did not really catch on back then. What I am trying to suggest, is that the eID technology is evolving, becoming more user-friendly, and offering new avenues for usage – thus, faster growth in user-numbers can be expected.

Undoubtedly, the eID usage is gaining momentum. The reasons are three-fold in my opinion – public awareness has increased, customer service and support has enormously improved, and force is exercised. The private and third sector has initiated several campaigns that support eID usage – Look@Word smart devices safety activity, EMT and Elisa's campaigns for mobile-ID usage etc. The reliability and usability of the software has done major leaps from 2002 to 2016. The financial sector is demanding[27] eID usage for daily transactions over 200 EUR and that inconvenience also triggers eID usage.

Estonian e-services are important in the context of the eID development, but in my opinion, not the driver for eID usage. The importance of services implies to the understanding of the need for usefulness (and awareness about the possibilities). The x-road had practical advantages (Mihkel Solvak 2016) – it was welcome by the users. If the eID is seen as indispensable, that too, will reach complete rollout. The reason why the e-services cannot be linked to the growth in eID usage, is that they include also other authentication options.

[27] eHealth is using only eID authentication. Unfortunately I could not recieve any user numbers from them that I could state whether or not this service is actively or margnally used, but likely they cannot be compared to the banking sector (not Nordea and definitely not Swedbank).

Summary

This thesis deals with the dissemination of the Estonian ID-card and the electronic identity that accompanies it.

Innovation processes in the public sector is very complex because it involves many actors – the government, public servants and their organizations, the private sector and the public. Each has their own agendas and priorities.

In the analysis of the ID-card dissemination the Public Sector Innovation framework is employed. It states that the most decisive aspects for the state sector in the implementation context are trust and legitimacy, which are a precondition but can also be the goal of innovation (Bekkers *et al.* 2006a, De Vries *et al.* 2016). The success depends on environmental aspects, such as public opinion, other simultaneous events (crises), which hinder or advance the process significantly (*Ibid.*). Organizational aspects often receive too little attention. Often it is overlooked that the changes are going to alter the power-relationship between organizations, and resistance can appear (León *et al.* 2012, 18-9, De Vries *et al.* 2016, 157).

The ID-cards are mandatory identification documents in Estonia and rollout began in 2002. In five years it was complete. The key factors in the success of the process were:

- cooperation – among politicians (agreement in goals), with experts in the field in working towards solutions, with the private sector (the issuing of ID-cards and passports in bank offices);
- ample amount of time (the process of development began in 1997, but first ID-cards were issued in 2002; in the transition to mandatory ID-cards, the valid passports were allowed to be used until they expired);
- covering the costs – the price of ID-card (the state substantially subsidized the real cost of the ID-card until the transition to new mandatory identification documents was complete);
- 'convenience services' (travel document within the EU, electronic services);
- positive public opinion.

The usage of the eID has not matured that fast. By the beginning of 2016 only 62% of ID-card users had used their card online and 42% had done so in the past six months.

The diffusion of eID should be described through the technology acceptance frame. The main arguments are personal gain and subjective cost, additional factors are social influence and other features (such as the faith in the innovation's potential).

The main antecedents for eID usage were/are:

- the continued support for earlier methods of authentication (password-cards);
- the user-friendliness and compatibility of the software;
- the daily transaction limit of 200 EUR (when using passwords or password-cards);
- information campaigns and more forceful marketing of the eID.

Kokkuvõte

Antud töö vaatleb Eesti ID-kaardi levikut ja sellega koos oleva elektroonilise identiteedi (eID) levikut.

Innovatsiooniprotsess avalikus sektoris on keerukas, kuna see hõlmab mitmeid osapooli – valitsus, avalikud teenistujad ja organisatsioonid, erasektor ja avalikkus. Kõikidel neil on oma huvid ja eelistused.

ID-kaardi leviku analüüsil on tuginetud avaliku sektori innovatsiooni raamistikule, mis ütleb, et antud kontekstis on määrava tähtusega usaldus riigi vastu ja legitiimsus, mis on eduka elluviimise eeldusteks, kuid võivad samal ajal olla ka innovatsiooni eesmärkideks (Bekkers *et al.* 2006a, De Vries *et al.* 2016). Riigi sektori innovatsiooni edukust mõjutavad eelkõige välised tegurid nagu meedia ja rahva hoiakud, samuti kriisid või muud ühiskonnas toimuvad muutused jne (*Ibid.*). Teiseks on tihti mööda vaadatud organisatsiooni puudutavatest aspektidest. Kuna muudatused mõjutavad ka organisatsioonide võimusuhteid, võib esineda ka muutustele vastutöötamist (León *et al.* 2012, 18-9, De Vries *et al.* 2016, 157).

Eestis on ID-kaart kohustuslik ning neid hakati väljastama alates 2002.aastast. Viie aastaga oli ID-kaardi levik täielik. Antud protsessi edu võtmed olid:

- koostöö – nii riigis sees (ühine eesmärk), koostöö valdkonna spetsialistidega lahenduse väljatöötamisel, koostöö erasektoriga (ID-kaartide ja passide väljastamine pangakontorites);
- piisav ajaline ressurss (protsessi alustati 1997, kuid esimesed ID-kaardid said omanikud alles 2002; ID-kaardile üleminekul otsustati lubada kasutada passe kuni nende kehtivusaja lõpuni);
- kulutuste enda kanda võtmine – ID-kaardi hind (riik doteeris olulisel määral ID-kaardi tegelikku maksumust kuni üleminek uutele isikutunnistustele oli toimunud);
- ID-kaardi ‘mugavusteenused’ (reisidokument EL-s; elektrooniline asjaajamine);
- avalikkuse soodne hoiak.

Elektroonilise komponendi kasutus ei ole nii kiiresti juurdunud. 2016. aasta alguseks on korra oma eID-d kasutanud 62% ID-kaardi omanikest ja korra viimase kuue kuu jooksul on seda kasutanud 42% inimestest.

E-ID leviku põhjuseid tuleb vaadata tehnoloogia kasutuselevõtu teooriate raames, mille järgi on põhilisteks argumentideks oodata kasu ja oodatav kulu. Lisaks on mõjuriteks veel sotsiaalne surve ja muud tegurid (nt usk innovatsiooni 'elujõusse').

E-ID levikut on mõjutanud:

- varem turule tulnud autoriseerimisvahendite (parooli-kaartide) jätkuv toetamine;
- tarkvara kasutajasõbralikkus ja mugavus;
- pangaülekannetele seatud 200-eurone päevane lagi (kasutades paroolikaarte või salasõnu);
- teavituskampaaniad ja mobiil-ID jõulisem turustamine.

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List of Key Institutions and People

AS Cybernetics (Küberneetika AS) was established in 1997. Developed the pilot project of Estonian ID-card, x-road system and e-voting system.

Certification Centre (AS Sertifitseerimiskeskus – SK) was founded in 2001 and is responsible for the certification and time stamping services. In addition, has been contracted to develop the ID-card software since 2002.

Citizenship and Migration Board (CMB; Kodakondsus- ja Migratsiooniamet, KMA) is a part of the Police and Border Guard Board since 2010.

Eesti Telefon was founded in 1993 and was obliged to build up the fixed network based on the agreement with the government. In its early days offered land line phone services. The name was changed to Elion Ettevõttes AS in 2003. See also under Eesti Telekom. Has financed many of the activities relating to the ID-cards.

Eesti Telekom was a holding company. It was founded in 1997 by a government order that turned the state owned company Eesti Telekommunikatsioonid into a public limited company Eesti Telekom AS. It owned two subsidiary companies Eesti Telefon AS (which was renamed Elion Ettevõtted AS in 2003) and AS EMT. In September 2014 the subsidiaries were joined with the holding company and they continued to operate under the name of AS Eesti Telekom. The brands names of EMT and Elion continued in use. In January 2016 the company Eesti Telekom was renamed as Telia Eesti AS and the brands of EMT and Elion were substituted with the brand of Telia.

Eesti Ühispank was founded in 1992. In 1998 it was bought by SEB. In April 2005 its name was changed into SEB Eesti Ühispank and since March 2008 the official name is SEB. Has financed many of the activities relating to the ID-cards.

eID is the electronic identity that is included in the ID-card and mobile-ID. When referring to the eID usage, both – ID-card and mobile-ID usage – is meant.

EMT Estonian mobile telephone operator. It was founded in 1991 as AS Eesti Mobiiltelefon. Was the first to introduce mobile-ID in 2007, today have the most m-ID users. In 2016 was renamed Telia. Has financed many of the activities relating to the ID-cards. See also Eesti Telekom.

Elisa is an Estonian mobile phone operator. It was founded in 1994 as Radiolonja AS. In 2005 it became Elisa. Introduced m-ID in 2009. It is owned by the Finnish Elisa Oyj. Has financed many of the activities relating to the ID-cards.

Estonian Association of Information Technology and Telecommunications (Eesti Infotehnoloogia ja Telekommunikatsiooni Liit, officially abbreviated as ITL) was founded in 2000 by the merger of Estonian Computer Association (founded in 1992) and the Association of Telecommunications Companies (founded in 2000). It is a voluntary organization with the objective to promote the development towards information society. Main activities of the association include popularization of information and communication technology (ICT), promotion of vocational education and amendment of legislation.

Estonian Banking Association (EBA; Eesti Pangaliit) made the decisions to lower the transactions limits in 2007, 2008, and 2009.

Estonian Informatics Centre (Eesti Informaatikakeskus) was a government institution under the jurisdiction of Ministry of Economic Affairs and Communications from 1997 until 2003. Its successor is Infromation System Authority.

Hansapank was founded in 1992, in 2005 Swedbank bought full ownership of the bank and in 2009 the bank's name was changed to Swedbank. Has financed many of the activities relating to the ID-cards.

Information System Authority (Riigi Infosüsteemi Amet – RIA) was created in 2003. Its tasks are coordinating the development and administration of the national information system, to help the state provide the best possible services to citizens. Has been making contracts with the Certification Centre for the continuing development of the ID-card software. Its predecessor was the Estonian Informatics Centre.

Linnar Viik was an adviser to Mart Laar from 1999-2001.

Look@World Foundation (Vaata Maailma SA) was founded in 2001 by banking, telecom and computer companies. Their aim is to popularize and encourage the use of the Internet and ICT by support and education. Has organized and coordinated, but also commissioned and procured many of the activities relating to the ID-cards.

Mart Laar was the Prime Minister from 1999-2002.

Tarvi Martens is an expert in the field of ID-cards in Estonia, he was assigned to lead the ID-card task force in 1999 and later joined the Certification Centre in 2002.

Tele2 is an mobile phone operator. In 1998 the Swedish Tele2 AB bought a share in the company AS Ritabell. In 2001 AS Ritabell was renamed as Tele2 Eesti AS. Was the last mobile operator to introduced m-ID in 2009.

Appendix 1

Timeline of Relevant Events for the Development and Dissemination of the ID-card, and Diffusion of the e-ID

1994-5	Idea emerges but it is not technologically feasible (the RSA-based smart cards are not yet developed) and there is no political support.
1997	Citizenship and Migration Board [28] (CMB) voices the need for electronically readable next generation ID-documents. A working group was formed in the Estonian Informatics Centre to work on the Digital Signatures Act. ID-card project team (AS Küberneetka: Tarvi Martens, Ahto Buldas, Hansapank: Jaan Priisalu) presents a project plan for the implementation of the ID-card to CMB and Estonian Informatics Centre[29] that foresees a development phase of at least 15-months.
1998	Working groups and committees are formed (include people from the public and private sector). Two analyses are commissioned: 1) the requirements and desires of the stakeholders; 2) the available technologies at the time. The idea of public-private partnership and the possibility of attracting private finances is discussed. First articles in the media about the ID-card and digital signature. A public seminar is held at the end of the year to discuss the progress.
1999	New advisory expert-group is created to deal with ID-card pilot projects and standardization. The members of the group included people from the private sector (including banking sector) and public sector.
2000	Digital Signature Act – establishes that digital signatures are equal to handwritten signatures.
2001	EMT, Hansapank, Eesti Ühispank ja Eesti Telefon found the Certification Centre (AS Sertifitseerimiskeskus) to manage the ID-card certificates[30]. In July, the state announces public procurement for purchasing certification service, and in October, the Certification Centre [31] is

[28] Today it is a part of the Police and Border Guard Board because in 2010 the Police Board, Central Criminal Police, Public Order Police, Border Guard Board, and Citizenship and Migration Board were all merged.

[29] It was a government institution under the juristiction of Ministry of Economic Affairs and Communications from 1997 til 2003.

[30] The Digital Signature Act from 2000 created a need for such a certification body who could become a partner to the state and offer the necessary services.

	declared the winner. In September, Eesti Ühispank, Eesti Telefon, and Look@World Foundation and the Ministry of Internal Affairs sign a cooperation agreement for comprehensive implementation of the ID-card. Fierce political debates on the compulsory nature of the ID-card and articles in the media covering the opposition's critical views on the ID-card. The leaders of EMT and Eesti Telefon and two major banks (Ühispank and Hansapank) send a warning letter to the President of the Riigikogu, Prime Minister and Minister of Finance and the Estonian Association of Information Technology and Telecommunications (ITL) sends a public letter to the Prime Minister (Mart Laar). They warn the politicians about the dangers of a voluntary ID-card. In November, political consensus is achieved – ID-card is to become the mandatory identification document in Estonia. On the 26th of November in 2001, over 5000 people in four hours sign up for ID-cards using the portal www.pass.ee. The interest and traffic generated is huge – 250 people manage to register themselves within the first minute of application, and the system went offline at 12:06. CMB expected ten times smaller interest.
2002	TNS Emor publishes survey results that show that 38% of population deems the ID-card necessary, and 27% of them are likely to apply for one in the coming six months. First ID-cards are issued at the end of January, the application for general public begins in February.
2002	In October, the free of charge DigiDoc client-program that enables digital signing, is released. It is developed by the Certification Centre on the commission of Look@World Foundation, and paid for by Eesti Telefon, EMT, Hansapank and Ühispank. Certification Centre opens an information portal id.ee and offers end-user support to ID-card users. Support for web developers in ID-card software to allow its inclusion c-language applications. Based on a cooperation agreement banks (Hansapank and Ühispank) issue ID-cards and passports in their branch offices. About 95 000 Estonian Citizen Passports expire. Approximately 120 000 ID-cards have are issued and on 01.01.2003 104 860 of these are valid. 496 unique electronic users.

[31] Certification Centre is the primary and the only certification authority in Estonia. In addition to certification and time-stamping services they are also responsible for the development and operation of the software to use eID services.

2003	Message portal is opened where one could digitally sign faxes and speeches. Cooperation agreement with the Finnish Population Register to unify the standards, technologies and practices at national level regarding digital documents and signatures. International project OpenXAdES is launched to unify and harmonize the practices regarding digital documents and signatures in different countries. ID-card software support for Java language applications for IT developers. Precedent about the usage of digital signatures appears in court. Tallinn administrative court refuses to accept a digitally sign document. It escalates into a court-case, which results in the ruling that digital signatures have to be considered as equal to hand written signatures. The work on the electronic ticket and payment system for public transportation in the city of Tallinn (the capital of Estonia) begins. About 300 000 Estonian Citizen Passports expire this year. Approximately 250 000 ID-card are issued (the number of valid ID-card holders increases by 223 722 people). 2 354 new unique electronic users (2 850 total).
2004	Tallinn ID ticket system is launched (tickets can be bought online, from any phone, from special ticket machines or from customer service staff). Tartu (the second biggest city) also adopts the ID ticket system. Certification Centre and Ministry of the Interior sign an agreement that makes the ID-card certificates free for the users and the state covers their cost. Ministry of Economic Affairs and Communications made a proposal to all state authorities to change the procurement demands for acquiring hardware. In order to support the use of ID-card, all computers bought by the state have to include ID-card readers in basic equipment. Approximately 228 000 ID-card are issued (the number of valid ID-card holders increases by 298 402 people[32]). 6 045 new unique electronic users (8 895 total).
2005	To promote e-voting, new PIN-codes for ID-cards are given to everyone who wish, free of charge from 20 September until 12 October in service bureaus of Citizenship and Migration Board (CMB) and Certification Centre[33].

[32] There is an error in the data – the increase in valid ID-cards cannot be bigger than the actual number of issued ID-cards. The data for valid ID-s was recieved directly from the PPB this year, the number of issued documents is taken from CMB's book on the institutions history from 1989-2008 (CMB 2008).

[33] The price for PIN-codes in bank-offices was 90 EEK (5,75EUR)

	10 – 12 October, the first electronic vote is held for Local Government elections. 9317 people (1,9% of all voters) vote digitally and 61% of them use their eID for the first time. Apollo Raamatud adopts the ID card as its loyalty card. ML Arvutid (largest computer manufacturer in Estonia) starts pre-installing its computers with the DigiDoc software. During the year in Tallinn, Tartu and Harju County almost a million ID-tickets are bought. 12 675 new unique electronic users (21 570 total).
2006	Hansapank, SEB Eesti Ühispank, Elion and EMT enter into the Computer Protection 2009 agreement with the Ministry of Economic Affairs and Communications with the aim of making Estonia the world's most secure information society by 2009. The ID-ticket system is developed further. Ilves Extra ISC (Estonian sports and outdoor ware manufacturer) introduced ID-card as a client loyalty card. SEB sells cheap ID-card readers (6 EUR)[34]. University of Tartu students can use ID-card based ID tickets to pay for services (printing, scanning and photocopying) without using cash. Complete rollout is achieved, 1 000 000th ID-card is issued in October. By the end of the year there are 910 600 valid ID-cards. 13 837 new unique electronic users (35 407 total).
2007	19 – 28 February, the preliminary e-vote for the Parliament elections takes place. 30 243 people vote electronically (5,5% of all voters). Banks stop issuing ID-cards and passports in spring when the cooperation agreement between the Ministry of Interior and Certification Centre expires. The Look@World Foundation and Omnikey (big smart card producer) provide cheaper ID-card readers (6 EUR) between 2007 and 2009 (600,000 readers are to be provided). As of May 2nd, all online bank transactions above the sum of 10 000 EEK (640 EUR) per day require either an ID-card or pin-calculator. ID card installation software gets a new user-friendly look and becomes available in Estonian, Russian and English. Internal ID card readers for laptops become available as part of the Computer Protection 2009 project. Firefox support for ID card software comes out. EMT launches the mobile-ID service. By the end of the first month, 600

[34] In computer stores the price is usually three times as much.

	people use the service. 50 291 new unique electronic users (85 698 total).
2008	E-Business Register introduces a service to fight company thefts – the system informs all partners, stockholders, board and council members via e-mail about the applications to the registry departments of county courts concerning their enterprise. As of May 2nd, all online bank transactions above the sum of 5 000 EEK (320 EUR) per day require either an ID-card or pin-calculator. 22 May – 30 June, Information System Authority carries out an information campaign about the possibilities of the ID-card. Its aim is to get 50 000 digital signature but in the end the result is 11 126. OÜ Smartlink won the procurement for developing the ID-card and digital signature software further. The software will fall under LGPL license which means that anyone can develop it further and sell that development as a new product. Technicians from Elion are willing to come and give ID-card aid at home or in the workplace for free. The service is offered in by the Look@World Foundation in cooperation with Elion in the frames of the Computer Protection 2009. 11 November, another ID-card campaign by Information System Authority starts with the aim of introducing the different electronic usage opportunities of the card. In December, the Certification Centre starts confirming the validity of foreign certificates (they now confirm Finnish, Belgium and Portuguese certificates). 92 093 new unique electronic users (177 791 total), 127 213 active users[35].
2009	The Certification Centre's root certificate is added to Apple's Safari browser. As of May 18th, all online bank transactions above the sum of 3 000 EEK (191 EUR) per day require either an ID-card or pin-calculator. 28 May – 3 June, e-vote for European Parliament elections. 58 617 people e-vote (14,7% of all voters). 8-14 October, e-vote for Local Government elections. 104 313 people e-vote (15,8% of all voters). Elisa and Tele2 start providing mobile-ID service. European Union starts paying for the ID-card customer support and counseling (only Certification Centre has offered this support). 118 363 new unique electronic users (296 154 total representing almost 28% of total card owners (1 086 702 people have valid ID cards)),

[35] Used eID at least once in previous six months.

	231 712 active users.
2010	31 December 2009 – 21 February 2010, e-Census takes place for the trial Census of the 2011 Census. During the e-Census 18% of the test-regions' population counted themselves online, which is remarkable as the usual share of first time e-Census is below 10%[36]. Information System Authority signs a contract that states Certification Centre is to develop the ID-card software further taking over from where the previous developer (OÜ Smartlink) left off. Certification Centre's root certificate is added to the Mozilla Firefox browser. Linux (Ubuntu 10.04, Open Suse 11.3, Fedora 13) and Mac (10.5, 10.6) support for the ID-card software. 113 280 new unique electronic users (409 434total), 273 234 active users.
2011	Change in the issuing of mobile-ID. From now on it is issued nationally by the Police and Border Guard Board (before the service was issued privately). 24 February – 2 March, the e-vote for Parliament election. For the first time it was possible to use mobile-ID for the e-vote. 140 846 people e-vote (24,3% of all voters). Software version for the Windows platform (XP, Vista, and 7). Ordi (sells, services and puts together computers) Tallinn and Tartu service salons offer ID-card and mobile-ID technical support and install DigiDoc software. Research results on the economic gains of the digital signature were released. It shows that organization leader have limited understanding about the costs that surround the signing of documents and thus the procedures are built around hand written signature. The introduction of digital signatures would help to cut costs at least in printing, paper and postage, but also labor. 73 975 new unique electronic users (483 409 total), 321 375 active users.
2012	31 December 2011 – 2 February 2012, e-Census takes place. 67% of people count themselves electronically online. EMT has a mobile-ID campaign and offers free joining. Mobile-ID gains 3 000 new users per month. By the end of the year, there are almost 35 000 active mobile-ID users. DiciDoc software is included in AppStore's and Microsoft's automatic updates. In December, the 100 millionth digital signature is issued.

[36] E-Census refers to online-census, and one can be identified with eID but also via bank links.

	64 306 new unique electronic users (547 715 total), 351 228 active users.
2013	End-user ID-card software update, transfer of clients to a new Mobile-ID service platform. 10-16 October, e-vote for Local Government elections. 133 662 people vote electronically (21,2% out of all voters). Kick-off of NutiKaitse 2017, the project emphasizes security of use in smart devices and develops mobile-ID improvements. Over 300 000 ID-cards are issued and about 40,000 are renewed. 40 000 mobile-ID users, 68 415 new unique electronic users (616 130 total), 409 056 active users.
2014	15 – 21 May, e-vote for European Parliament elections. 103 105 people vote electronically (31,3% of all voters). OTA (Over The Air) platform within the Mobile-ID service is launched (a messaging system platform that sends secure Mobile-ID messages to the SIM card in a mobile phone). New time-stamping service is launched that supports more digital signatures (foreign ones). Mobil-ID users (about 50 000, every month about 2000 users are added) make about 1,8 million transactions a month, the majority (75%) is bank transactions. About 36 000 m-ID users are the clients on EMT. From the end of October until the end of the year EMT again offers free joining with the m-ID. Technical readiness to deploy new signing formats. Integration for Latvian and Lithuanian ID-cards, which enable offering first cross-border signatures by the end of the year. Mobile-ID gains about 15 000 new users. In December, a new document – the e-resident's card, is issued. 63 730 new unique electronic users (679 860 total), 437 387 active users.
2015	19-25 February, e-vote for the Parliament elections. 176 329 people vote electronically (30,5% of all voters). In March, the 200 millionth digital signature is given. It took ten years to reach the first 100 million, and only three years to reach the second 100 million. Mobile-ID user numbers grow by 40% on annual basis (about 75 000 total users). This is the result of project NutiKaitse 2017, but also service updates. Mobile-ID transactions increased 42%. Busiest year in customer support (over 80,000 requests) due to several software updates which demanded additional work on user's or service provider's side.

	More than 7 000 e-resident's cards are issued. 83 322 new unique electronic users (763 182 total), 501 696 active users.
2016	Lithuanian company Estina starts to manage the DigiDoc portal. Until now it was done by Certification Centre.

Sources: id.ee (Uudised, ID-kaardi projekt), sk.ee (Ajalugu, Uudised), ria.ee (Uudiste arhiiv)

Appendix 2

The Change in the Absolute Number of People with and without a Valid ID-card (Includes Citizen's IDs, Alien's IDs, EU Citizen's IDs and Residence Cards), Population and the Share of Population in Percentages Owning a Valid ID-card from 01.01.2003-01.01.2016

Year (January 1st)	No ID-card, only a valid passport	Total nr of valid ID-cards (citizens, aliens, EU citizens and residence cards)	Population of Estonia	Share of people with an ID-card (%)
2003	868 697	104 850	1 375 190	8%
2004	686 026	328 572	1 366 250	24%
2005	476 639	626 974	1 358 850	46%
2006	408 408	812 773	1 350 700	60%
2007	371 429	910 600	1 342 920	68%
2008	330 026	977 885	1 338 440	73%
2009	280 019	1 040 506	1 335 740	78%
2010	236 927	1 086 702	1 333 290	82%
2011	194 477	1 140 231	1 329 660	86%
2012	165 885	1 157 395	1 325 217	87%
2013	146 805	1 143 807	1 320 174	87%
2014	132 011	1 132 470	1 315 819	86%
2015	125 602	1 105 142	1 313 271	84%
2016	114 790	1 078 909	1 315 944	82%

Note: As of 2012 EU citizens are issued an EU citizen's ID-card and the citizens of third countries (aliens) are issued a residence card instead of an alien's ID-card (the identity cards issued to aliens earlier are valid until the expiry date).

Source: Police and Border Guard Board, Statistics Estonia

Appendix 3

Statistics on the Number of Valid ID-cards (Citizen and Alien) and Relationship to Population Statistics in 01.01.2003

Table 1
The Number of Valid ID-cards (Citizen and Alien) and the Share of valid ID-cards by Gender in Total of Valid ID-cards on 01.01.2003

	Valid ID-cards (citizen and alien) (01.01.2003)			Share of ID-cards out of total valid ID-cards by gender		
Age	Total	Men	Women	Total	Men	Women
0-5	461	253	208	0,44%	0,52%	0,37%
6-10	743	370	373	0,71%	0,76%	0,66%
11-15	3 163	1 663	1 500	3,02%	3,42%	2,67%
16-20	8 913	4 656	4 257	**8,50%**	**9,58%**	7,57%
21-25	4 590	2 229	2 361	4,38%	4,59%	4,20%
26-30	9 854	5 216	4 638	**9,40%**	**10,73%**	**8,25%**
31-35	8 748	4 842	3 906	8,34%	**9,96%**	6,94%
36-40	8 465	4 440	4 025	8,07%	9,14%	7,16%
41-45	8 859	4 305	4 554	**8,45%**	8,86%	8,10%
46-50	8 644	4 056	4 588	8,24%	8,35%	**8,16%**
51-55	8 332	3 825	4 507	7,95%	7,87%	8,01%
56-60	6 881	2 793	4 088	6,56%	5,75%	7,27%
61-65	8 718	3 346	5 372	8,31%	6,88%	**9,55%**
66-70	7 272	2 749	4 523	6,94%	5,66%	8,04%
71-75	6 070	2 267	3 803	5,79%	4,66%	6,76%
76-80	3 466	1 122	2 344	3,31%	2,31%	4,17%
81+	1 671	467	1 204	1,59%	0,96%	2,14%
All ages	104 850	48 599	56 251	100%	100%	100%
%	100%	46,35%	53,65%			

Table 2
The Share of Valid ID-cards (Citizen and Alien) in Population and the Share of Valid ID-cards in Age Group by Gender on 01.01.2003

	Share of valid ID-card owners in population (01.01.2003)			Share of valid ID-card owners in population in age group by gender*		
Age	Total	Men	Women	Total	Men	Women
0-5	0,03%	0,02%	0,02%	0,61%	0,65%	0,57%
6-10	0,05%	0,03%	0,03%	1,05%	1,02%	1,08%
11-15	0,23%	0,12%	0,11%	3,16%	3,20%	3,10%
16-20	0,65%	0,34%	0,31%	8,79%	8,94%	8,64%
21-25	0,33%	0,16%	0,17%	4,72%	4,45%	5,00%
26-30	0,72%	0,38%	0,34%	10,14%	10,52%	9,74%
31-35	0,64%	0,35%	0,28%	9,16%	10,13%	8,19%
36-40	0,62%	0,32%	0,29%	9,01%	9,54%	8,49%
41-45	0,64%	0,31%	0,33%	8,74%	8,77%	8,71%
46-50	0,63%	0,29%	0,33%	8,92%	8,89%	8,95%

51-55	0,61%	0,28%	0,33%	9,09%	9,14%	9,04%
56-60	0,50%	0,20%	0,30%	9,95%	9,18%	10,57%
61-65	0,63%	0,24%	0,39%	10,48%	9,71%	11,02%
66-70	0,53%	0,20%	0,33%	10,81%	10,59%	10,94%
71-75	0,44%	0,16%	0,28%	10,01%	10,64%	9,67%
76-80	0,25%	0,08%	0,17%	8,50%	10,34%	7,83%
81+	0,12%	0,03%	0,09%	5,14%	6,41%	4,78%
All ages	8%	4%	4%	7,62%	7,59%	7,65%

Table 3
The Population of Estonia by Gender and the Share of Age Groups in Population on 01.01.2003

	Population of Estonia (01.01.2003)			Size of that age group in population (%)*		
Age	Total	Men	Women	Total	Men	Women
0-5	75 310	38 770	36 540	5,48%	2,82%	2,66%
6-10	70 870	36 390	34 480	5,15%	2,65%	2,51%
11-15	100 240	51 910	48 330	7,29%	3,77%	3,51%
16-20	101 360	52 100	49 260	7,37%	3,79%	3,58%
21-25	97 330	50 090	47 240	7,08%	3,64%	3,44%
26-30	97 190	49 560	47 630	7,07%	3,60%	3,46%
31-35	95 470	47 790	47 680	6,94%	3,48%	3,47%
36-40	93 960	46 550	47 410	6,83%	3,38%	3,45%
41-45	101 340	49 070	52 270	7,37%	3,57%	3,80%
46-50	96 870	45 620	51 250	7,04%	3,32%	3,73%
51-55	91 700	41 850	49 850	6,67%	3,04%	3,62%
56-60	69 130	30 440	38 690	5,03%	2,21%	2,81%
61-65	83 210	34 450	48 760	6,05%	2,51%	3,55%
66-70	67 300	25 960	41 340	4,89%	1,89%	3,01%
71-75	60 620	21 300	39 320	4,41%	1,55%	2,86%
76-80	40 790	10 850	29 940	2,97%	0,79%	2,18%
81+	32 500	7 290	25 210	2,36%	0,53%	1,83%
All ages	1 375 190	639 990	735 200	100%	47%	53%

Note: * The data on population does not cover the potential recipients of the ID-cards (Estonian citizen, EU citizen, alien and residency card) fully. For one, the Estonian citizens who are issued an ID-card can also permanently reside outside of Estonia. Two, in 2003 the population data was based on Census data updated only with Population Register's data, but it is very low quality because it does not adequately record migration data (Estonians and aliens were not obliged to (and did not) register their place of residence, which led to the poor quality of migration data) (Statistics Estonia 2016a).

Source: Police and Border Guard Board, Statistics Estonia

Appendix 4

Statistics on the Number of Valid IDcards (Citizen, Alien, EU Citizen and Residence Cards) and Relationship to Population Statustics in 01.01.2016

Table 4
The Number of Valid ID-cards (Citizen, Alien and EU citizen ID-card, and residency card) and the Share of valid ID-cards by Gender in Total of Valid ID-cards on 01.01.2016

	Valid ID-cards (including citizen's, alien's, EU citizen's ID)			Share of ID cards out of total valid ID-cards by gender		
Age	Total	Men	Women	Total	Men	Women
0-5	38593	18865	19728	3,15%	2,83%	3,54%
6-10	45278	21997	23281	3,70%	3,30%	4,18%
11-15	47773	23553	24220	3,90%	3,53%	4,35%
16-20	60710	29808	30902	4,96%	4,47%	5,55%
21-25	89191	44385	44806	7,29%	6,65%	**8,05%**
26-30	102858	53195	49663	**8,40%**	**7,97%**	**8,92%**
31-35	96986	50099	46887	**7,92%**	**7,51%**	**8,42%**
36-40	92813	48314	44499	**7,58%**	7,24%	7,99%
41-45	92674	49118	43556	7,57%	7,36%	7,82%
46-50	86255	46431	39824	7,05%	6,96%	7,15%
51-55	91657	50233	41424	7,49%	**7,53%**	7,44%
56-60	86974	49135	37839	7,10%	7,36%	6,80%
61-65	77124	44523	32601	6,30%	6,67%	5,86%
66-70	60347	36163	24184	4,93%	5,42%	4,34%
71-75	57636	35908	21728	4,71%	5,38%	3,90%
76-80	46415	30004	16411	3,79%	4,50%	2,95%
81+	50939	35742	15197	4,16%	5,35%	2,73%
All ages	1224223	667473	556750	100%	100%	100%
%	100%	54,52%	45,48%			

Table 5
The Share of Valid ID-cards (Citizen, Alien, and EU citizen ID-card, and residency card) in Population and the Share of Valid ID-cards in Age Group by Gender on 01.01.2016

	Share of valid ID-card owners in population*			Share of valid ID-card owners in age group by gender*		
Age	Total	Men	Women	Total	Men	Women
0-5	2,93%	1,43%	1,50%	45%	43%	47%
6-10	3,44%	1,67%	1,77%	61%	57%	64%
11-15	3,63%	1,79%	1,84%	76%	73%	79%
16-20	4,61%	2,27%	2,35%	101%	96%	105%
21-25	6,78%	3,37%	3,40%	110%	106%	115%
26-30	7,82%	4,04%	3,77%	104%	103%	105%
31-35	7,37%	3,81%	3,56%	104%	104%	104%
36-40	7,05%	3,67%	3,38%	103%	105%	101%

41-45	7,04%	3,73%	3,31%	101%	107%	96%
46-50	6,55%	3,53%	3,03%	103%	113%	93%
51-55	6,97%	3,82%	3,15%	103%	118%	89%
56-60	6,61%	3,73%	2,88%	99%	122%	79%
61-65	5,86%	3,38%	2,48%	95%	127%	70%
66-70	4,59%	2,75%	1,84%	88%	132%	59%
71-75	4,38%	2,73%	1,65%	104%	178%	61%
76-80	3,53%	2,28%	1,25%	89%	182%	46%
81+	3,87%	2,72%	1,15%	87%	251%	34%
All ages	93,03%	50,72%	42,31%	93%	108%	80%

Table 6
The Population of Estonia by Gender and the Share of Age Groups in Population on 01.01.2016

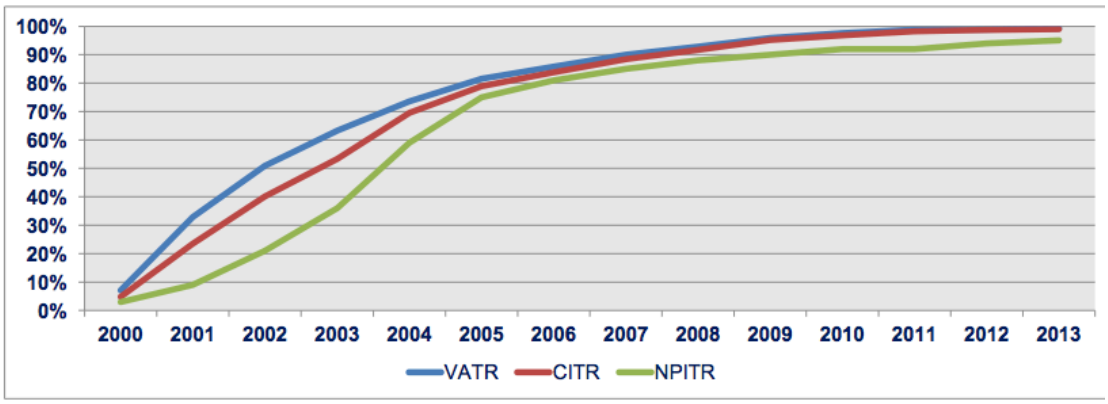
	Population of Estonia (01.01.2016)			Size of that age group in population (%) by gender		
Age	Total	Men	Women	Total	Men	Women
0-5	86355	44322	42033	6,56%	3,37%	3,19%
6-10	74704	38430	36274	5,68%	2,92%	2,76%
11-15	62734	32153	30581	4,77%	2,44%	2,32%
16-20	60389	30938	29451	4,59%	2,35%	2,24%
21-25	80776	41723	39053	6,14%	3,17%	2,97%
26-30	99061	51580	47481	7,53%	3,92%	3,61%
31-35	93343	48046	45297	7,09%	3,65%	3,44%
36-40	89935	46045	43890	6,83%	3,50%	3,34%
41-45	91353	46058	45295	6,94%	3,50%	3,44%
46-50	84019	41209	42810	6,38%	3,13%	3,25%
51-55	89152	42684	46468	6,77%	3,24%	3,53%
56-60	87892	40185	47707	6,68%	3,05%	3,63%
61-65	81349	34990	46359	6,18%	2,66%	3,52%
66-70	68550	27472	41078	5,21%	2,09%	3,12%
71-75	55469	20131	35338	4,22%	1,53%	2,69%
76-80	52338	16490	35848	3,98%	1,25%	2,72%
81+	58525	14252	44273	4,45%	1,08%	3,36%
All ages	1315944	616708	699236	100%	47%	53%

Note: * The data on population does not cover the potential recipients of the ID-cards (Estonian citizen, EU citizen, alien and residency card) fully. For one, the Estonian citizens who are issued an ID-card can also permanently reside outside of Estonia. Two, in 2003 the population data was based on Census data updated only with Population Register's data, but it is very low quality because it does not adequately record migration data (Estonians and aliens were not obliged to (and did not) register their place of residence, which led to the poor quality of migration data) (Statistics Estonia 2016a).

Source: Police and Border Guard Board, Statistics Estonia

Appendix 5

Statistics of Electronically Files Tax Returns from 2000-2013



Statistics of the electronically filed tax returns	
VAT Returns	99,3%
Natural Person Income Tax Returns	95,4%
Customs Declarations	99,8%
Corporate Income Tax and Employer Tax Returns	99,0%

Source: Karin Aleksandrov (2014)