Master's thesis

Technology Acceptance Model: A Case of Electronic Health Record in Estonia

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ABSTRACT

The goal of this master's thesis is to understand key motivators and activities supporting high levels of national Electronic Health Record (EHR) usage by healthcare professionals in Estonia and relate them to findings from Technology Acceptance Model (TAM) research. This thesis aims at contributing both, to better understanding of Estonian EHR implementation case, and TAM application in national public healthcare settings.

In this thesis, I found out that the key motivator for the high levels of usage of the system was legal act making it mandatory for healthcare professionals to send data to the national EHR. Despite that, I discovered that TAM variables perceived usefulness, perceived ease of use and psychological ownership played a role in Estonian EHR implementation case in positively influencing attitude towards the system. In this thesis, I argue that attitude towards the system is an important predictor of success for public systems, even if their usage is mandated by the law. I also argue that importance of psychological ownership may be especially important in the mandatory use cases.

Furthermore, I discovered that in this particular case, information quality and job relevance influenced perceived usefulness, and that compatibility, self-efficacy and support influenced perceived ease of use. In Estonia, compatibility however had controversial effect on perceived ease of use and I argue that in this case, it may have influenced it negatively rather than positively.

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INTRODUCTION

Currently, public health services in Europe face numerous challenges; from rising occurrence of diseases such as diabetes, cancer or cardiovascular diseases, through significant difference in life expectancy and healthcare opportunities both between different European countries and population groups; to ageing population, increasing costs of care and restrictions in public funding. (Koppel, Leventhal, & Sedgley, 2009) As a consequence, doctors are expected to deal with daunting patient loads and expectations for short office visits. (McAlearney, Song, Jorina, Hirsch, Kowalczyk, & Chisolm, 2010)

Electronic health records (EHR) are deemed to be an important part of the solution to these challenges, as they are expected to help improve quality, safety, efficiency and coordination of care (McAlearney, Song, Jorina, Hirsch, Kowalczyk, & Chisolm, 2010), to improve the quality of patient care by increasing care coordination, eliminating errors, and reducing costs (Moores, 2012), to improve patient care and outcomes, increase efficiency, lower costs, improve billing processes, reduce of the frequency of lost records, data and medication errors and improve access to patient histories (Emmanouilidou & Burke, 2013), to enhance the safety, quality and efficiency of healthcare (Cresswell, Worth, & Sheikh, 2012) etc.

Therefore, many countries are now investing substantial sums of money in EHR system. (Cresswell, Worth, & Sheikh, 2012) However, despite the long history of EHR, the progress on EHR deployment remains below expectations. (Emmanouilidou & Burke, 2013) There seems to be numerous failure examples across the countries, institutions and types of EHR (Ellingsen & Monteiro, 2012) (Cresswell, Worth, & Sheikh, 2012) (Berg, 2001), as only handful of EHR implementation process were successfully carried out. (Tavakoli, Jahanbakhsh, Mokhtari, & Tadayon, 2011)

One of the most common reasons for failure is rejection of the system by the users, as the system is not perceived as being fit-for-purpose. (Cresswell, Worth, & Sheikh, 2012) McAlearney et al. confirm that gaining physician buy-in has proved extremely difficult. (McAlearney, Song, Jorina, Hirsch, Kowalczyk, & Chisolm, 2010) Moores observes that the introduction of health IT can often generate resistance from healthcare workers, especially if the system is seen as a threat or incompatible with the way they like to work. (Moores, 2012)

Yet, the improvements to healthcare mentioned above will only occur if clinicians access the key functions and use them regularly. (Simon, et al., 2007) In addition, Simon et al. also note that the benefits will only be realized when clinicians use "higher level" functions supporting advanced clinical decision-making. (Simon, et al., 2007)

Estonia seems to be one of the rare examples of a country, which achieved to implement a national EHR system that is used by 95 % of healthcare professionals and includes a medical record of more than 75 % of Estonian population. (Tiik, 2012) This seems to be an advanced level of usage compared to other countries striving to implement such a system, as most of the countries had to abandon long-planned initiatives (Great Britain and the Czech Republic), are at the beginning of the process (Australia, Austria etc.) or deal with interoperability issues of different local or regionals solutions (Canada, Denmark etc.). According to an OECD and the European Commission report on ICT implementation and adoption in healthcare, Estonia took the top spot among 30 countries included in the study, ahead of Denmark and Sweden. (Nortal, 2013) The Estonian Health Information System is a globally unique e-health solution as it encompasses the whole country, registers virtually all residents' medical history from birth to death, and is based on the comprehensive state-developed basic IT infrastructure. (Tiik & Ross, 2010)

Estonia thus seems like a good case to study in order to understand dynamics that allowed this country to achieve such a high usage levels of the system.

Aim of the master's thesis

In this master's thesis, I am going to focus on uncovering reasons that lead to high usage levels of Estonian EHR. I am going to answer questions such as, why Estonian healthcare professionals use the system, what motivates their behavior and what activities were undertaken in order to support this motivation. I am going to use Technology Acceptance Model (TAM) as an analytical framework allowing me to describe and theoretically support different usage drivers. The goal is to understand key motivators of the EHR usage by healthcare professionals that occurred in Estonia and to relate them to findings from the TAM research. This thesis aims at contributing both, to better understanding of Estonian EHR implementation case, and TAM application in national public healthcare settings.

METHODOLOGY

This chapter of the master's thesis describes the methods used to write the thesis. It includes reasoning on type of research used, research design and analysis of this master's thesis.

1.1 Qualitative research

This is a qualitative research study. Up until the mid-1990s, for a significant proportion of mainstream IS scholars, scientific research meant a quantitative research, and studies not using the so-called "scientific methods" were excluded from the definition of research itself. (Sarker, Xiao, & Beaulieu, 2013) The same applies to the TAM research. Most of the TAM studies found were quantitative studies measuring effects of different TAM variables on user acceptance, or they were a qualitative meta-analysis of the TAM research literature.

Measurements tell us how often or how many people behave in a certain way but they do not adequately answer the question "why". Research which attempts to increase our understanding of why things are the way they are in our social world and why people act the ways they do is the qualitative research. (Hancock, 1998)

As TAM in this master's thesis is mainly used to answer a "why" question and to analyze human behavior and the activities that affected the behavior, it seems to be more appropriate to use qualitative research methods in this case. Qualitative approach also fits aim of this study better, as it is focused on explaining certain aspects of the particular subject of study. (Cormack, 1991) It is also more appropriate to use qualitative research method, as the aim is to gain detailed understanding about implementation of national Electronic Health Record in Estonia, discover what the main usage motivators for healthcare professionals were and analyze them using Technology Acceptance Model (TAM) and its extensions. As the aim of the thesis is to obtain in depth understanding of the phenomenon, the qualitative approach offers better toolset. It also allows flexibility and the attainment of deeper, more valid understanding of the subject than could be achieved with more rigid approach (Duffy, 1986)

1.2 Case study approach

The case study approach is an empirical research method, which investigates a case in a given context. It is desired to investigate the case in its richness and depth. (Eriksson & Kovalainen, 2008) This master's thesis is a single case study. It focuses on Estonian EHR implementation case. By describing and analyzing this case in its depth, this master's thesis should uncover complexities and contradictions present in this case. (Flyvbjerg, 2006)

1.2.1 Case selection and scope

My first interaction with Estonian EHR happened in February 2013 at Vitalis, a healthcare IT conference in Gothenburg, Sweden. English track of the conference comprised, among others, of four lectures on national EHR systems in Finland, Denmark, Norway and Estonia. Dr. Peeter Ross was presenting the Estonian system. From the presentations, it was apparent that among afore mentioned four countries, Estonia is furthest ahead in implementing the system in terms of levels of system usage.

By selecting Estonian EHR implementation case for this master's thesis, I intended to select an extreme case – a case that would especially well describe a successful implementation of an EHR system. (Flyvbjerg, 2006) Originally, I wanted to describe all the different factors facilitating a successful implementation of the Estonian EHR using ANT theory. However, preliminary research showed that this task would be too broad for the purposes of master's thesis at Copenhagen Business School. Firstly, the definition of "a successful implementation" is a tricky one and it would take a whole master's thesis to assess if and under which conditions it is possible to call the Estonian EHR implementation a successful one. Secondly, the whole implementation process was a complex process, mapping of which would require substantially more space and time. Therefore, after careful considerations, I chose to focus on uncovering reasons for high usage levels of the system by Estonian healthcare professionals. This seemed to be an appropriate delimitation, as most of the "success" discourse in Estonian EHR case is based on the high usage levels.

1.3 Research design

The research for this master's thesis uses a combination of primary and secondary data collection.

1.3.1 Secondary data collection

There were two types of secondary data used. Firstly, academic research focused on Technology Acceptance Model (TAM) application on healthcare cases were used. Findings of these articles are summarized in the theoretical chapter of this master's thesis. These findings were used to structure and analyze information obtained in primary data research to enrich the case narrative with relevant theoretical background. Furthermore, reflections of the case on these findings were also commented on in the analytical chapter and summarized in the conclusions.

Secondly, various reports and online data were used to inform description of Estonian EHR. These served to gain understanding of the case by presenting official accounts of events as they occurred for the author and the reader. Most of the findings drawn from these documents are presented in chapter 0. Amount of data accessible on Estonian EHR in English was limited and they were mostly coming from the official website of Estonian e-Health Foundation (EEHF).

1.3.2 Primary data collection

Semi-structured interview was the key method of collecting primary data. Semi-structured interview is performed based on an interview guide, which contains key areas of interest for the interviewer to follow, but gives enough space to venture to areas of interest of the interviewee, if the interviewer considers to be interesting for the particular study.

This approach was appropriate for this study, as it enabled me to uncover specificities of this case. For example, using structured interviews would only allow me to focus on predefined set of variables.

Seven oral interviews were conducted for the purpose of this master's thesis between April and October 2014. Interviewees were people involved in the implementation process of the Estonian national EHR in the role of administrators or policy bearers.

I have selected to focus on the administrators of the process as it was my believe that these people should have the overview over the process and should provide rather aggregated account based on their observations and experience, as compared to for example healthcare professionals, who would have most probably provided a subjective account only based on their own feelings. The administrators were primarily from EEHF, the organization responsible for the implementation of the system. One person from the Ministry of Social Affaires, the political patron of EHR, and one from Estonian Health Insurance Fund were interviewed as well based on suggestion of the EEHF interviewees.

First, I contacted Peeter Ross, whom I had met at Vitalis 2013 conference in Gothenburg, Sweden, February 2013. Dr. Ross was for a long time an active member of EEHF's board, where he represented East Tallinn Central Hospital and he has published several articles on the Estonian EHR. I held my first interview with him in April 2014. This interview served as an expert interview as well, uncovering EHR system features. Following interviewees were approached based on Dr. Ross's recommendations, as well as based on list of employees of EEHF published on the EEHF website.

Overview of interviewees is in Figure 1. As there was a limited number of players in the whole process, only limited number of information can be provided while keeping their anonymity. Reader should also note that Dr. Ross is not interviewee 1 in this master's thesis.

No.	Qualification / Education	Role in the process
Interviewee 1	Business	EEHF employee, Ministry of Social Affaires
Interviewee 2	IT	EEHF employee
Interviewee 3	MD	Ministry of Social Affaires
Interviewee 4	MD	EEHF board, a hospital representative
Interviewee 5	MD	EEHF board, a healthcare providers representative
Interviewee 6	IT	Estonian Health Insurance Fund employee
Interviewee 7	MD	EEHF employee

Figure 1: Interviewees, source: author

Timing and topics

First two interviews were performed in April 2014, another five interviews in September and early October 2014. The later interviews were shorter; they took 45 minutes on average; compared to the earlier ones that took more than 1 hour each. This was caused by narrowing the scope of the master's thesis during the research process as described above. Narrowing the scope down allowed me to leave out general questions about the whole implementation process. In addition, the first interviews also served as expert interviews, describing the features of the Estonian EHR. The interviews performed in Autumn 2014 focused almost exclusively on the activities meant to promote usage among the physicians.

Performing the interviews

The interviews were semi-structured interviews. For each participant, I prepared adjusted set of areas to cover. The set was informed by the role of the interviewee in the implementation process, as well as on learnings gained from previous interviews. In order to give the interviewees an opportunity to warm up,

each interview started with question asking them to describe their role in the system. Subsequent questions focused on the reasons each interviewees identified influencing levels of usage of the EHR by healthcare professionals. Each interview was concluded with giving the interviewees a chance to add whatever they thought they hadn't had chance to say in the interviewee. None of them added anything. Interviews were performed by the author of this thesis.

The interviews were performed online, via Skype technology. For most of the interviews, camera couldn't have been used in order not to disturb quality of the sound by overloading the internet connection. Advantage of the technology usage was that scheduling of the interviews could have been very flexible. If I wanted to perform interviews in person, I would have to manage to fit all of them into defined time slots when visiting Estonia. This could potentially mean more difficult access to primary data. In addition, it conducting interviews via Skype also allowed me to phase the interviews, and thus to be able to revise interview guide each time. If I performed interviews personally in Estonia, I would have several interviews back to back in one day, not giving me a chance to adjust. Lastly, performing several interviews in row in person, I could be tired and influenced by the previous interview. This was eliminated as I had maximum one interviewee per day.

On the other hand, this setup made it harder for me to read body language and facial expressions of the interviewee and react appropriately to them. It was difficult to recognize when the interviewee is taking pause to think and formulate his or her answer and when they are simply waiting for another question. This type of communication could have also negatively impacted personal connection with the interviewees, who might open more in case we were having interviews face to face.

Interviews were recorded and transcribed in order to provide material for analysis.

Language

The interviews were held in English. The original assumption was that the English language wouldn't be a problem as Estonians were assumed to be fluent in the language. While all of the interviewees were indeed fluent in English, it sometimes appeared as if they had some difficulties expressing their ideas in as much detail and as much nuance, as they would have liked to.

For the purpose of better legibility, the final quotes presented in this master's thesis were adapted. They were condensed and grammatically corrected to more clearly and concisely represent what the interviewees wanted to say. This was done by the author of this thesis based on transcripts.

Validity and reliability of information from interviews

The whole process of implementation of EHR in Estonia started twelve years ago, in 2002. This means that memories of interviewees concerning such a long and past period may have been obscured. They may not remember all the details anymore and their time perception may be distorted. Therefore, I tried to compare each factual piece of information provided by interviewees with secondary documents. On the other hand, such a long time timeframe gave the interviewees opportunity to perceive the process from a perspective, filtering unimportant events out, and highlighting only the important ones. If the experiences were more recent, interviewees might have felt urge to share more details, obscuring the importance of the key events.

Interview analysis

Interviews were transcribed and analyzed by the author of this thesis. In the analysis, I identified several large usage motivation topics. Each of these topics was further supported by several smaller arguments or examples. These are presented in chapter 0. The argumentation line in the analytical chapter 0 is built with support of theoretical findings derived from the TAM research.

These theoretical findings are summarized in the following chapter.

TECHNOLOGY ACCEPTANCE MODEL

In this master's thesis, I am going to use Technology Acceptance Model (TAM) to structure analysis of elements that led to high acceptance and usage of the Estonian national EHR. In this chapter, I am going to outline key concepts presented in literature on Technology Acceptance Model, focusing specifically on Technology Acceptance Model research from healthcare settings. The information provided here should give enough background to be able to identify key elements for acceptance and usage of Estonian EHR in the analytical chapter.

This chapter therefore represents meta-analysis of the basic TAM model article as described by Davis (Davis, 1989) and TAM2 extended model as described by Venkatesh & Davis (Venkatesh & Davis, 2000), as well as nine other studies relevant to healthcare settings. The list of studies I go through is not exhaustive. Some of them were generated using search functions for TAM + healthcare in CBS Library article search engine. However, this engine does not reveal all the existing articles, so additional articles were researched based on Holden's and Karsh's meta-analysis. (Holden & Karsh, 2010)

1.4 Importance of Technology Acceptance Model

The prevailing model used in the literature evaluating user acceptance and usage of technologies is Technology Acceptance Model introduced by Fred D. Davis in 1989. (Davis, 1989) Holden and Karsch noted that TAM is "somewhat a gold standard" and they also estimated that 10 % of IS publications space is allocated to TAM. (Holden & Karsh, 2010, s. 159) On the same note, Ketikidis et al. acknowledge that TAM "figures prominently among the key theoretical approaches used to understand people's intentions to accept various forms of information technology". (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012, s. 125) Moores confirms that TAM is one of the most influential theories in IT adoption and acceptance research. (Moores, 2012) The prevalence of TAM in the IS literature is also acknowledged by Pai and Huang in their study from 2011. (Pai & Huang, 2011)

Originally, the TAM was developed by Davis to assess IBM employees' acceptance of new software. IBM employees may be fundamentally different to healthcare professionals. Firstly, they are working in a corporate world, which is, compared to healthcare world tied by less regulations and more open to innovation, and secondly, IBM as such is a technology company, so it is possible to argue that its employees have more positive approach to technology than healthcare professionals. Therefore, many

scholars worried it might not be appropriate to apply the TAM developed on managers, who tend to be early adopters, to professional workers, such as healthcare providers. (Liang, Xue, & Byrd, 2003)

These worries didn't prove to be justified, as after research, it is also considered that TAM is fitting to healthcare settings. (Holden & Karsh, 2010) For example, Holden and Karsh (2010) performed a meta-analysis of over 20 studies focusing on clinicians using health IT applications for patient care. They concluded that many of the relationships specified in TAM were repeatedly validated in healthcare settings and fairly large proportions of variance explained in the dependent variable. Van Shaik et al. found that original TAM model significantly predicted acceptance of a prototype system for postural assessment by physiologists. (Van Schaik, Bettany-Saltikov, & Warren, 2002) Chau and Hu found out that TAM is more appropriate model to understand physicians' acceptance of technology compared to the theory of planned behavior (Chau & Hu, 2001) Yi et al. found that perceived usefulness (PU), a core TAM variable, played an important role in predicting PDA usage intentions by healthcare professionals. (Yi, Jackson, Park, & Probst, 2006)

1.5 Original Technology Acceptance Model

Fred D. Davis introduced Technology Acceptance Model in 1989 in the research paper called "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology".

In his basic model, Davis starts with the assumption that actual use of the technology, defined as "one specific behavior of interest performed by individuals with regard to some information technology system" (Holden & Karsh, 2010) is influenced directly by behavioral intention to use, which he also calls "acceptance". Behavioral intention is defined as "an individual's motivation or willingness to exert effort to perform the targeted behavior". (Holden & Karsh, 2010) Behavioral intention, and not the actual use, is used in the TAM.

The acceptance is influenced by attitude and by perceived usefulness (PU). Attitude is defined as "individual's evaluative judgment of the target behavior on some dimensions (e.g. good/bad, harmful/beneficial, pleasant/unpleasant)". (Holden & Karsh, 2010)

Attitude is influenced by the two key TAM variables – perceived usefulness, defined as "an individual's perception that using an IT system will enhance job performance" and perceived ease of use, defined as "an individual's perception that using an IT system will be free of effort". (Holden & Karsh, 2010)

Perceived ease of use also directly influences perceived usefulness. The model is illustrated in the following figure.

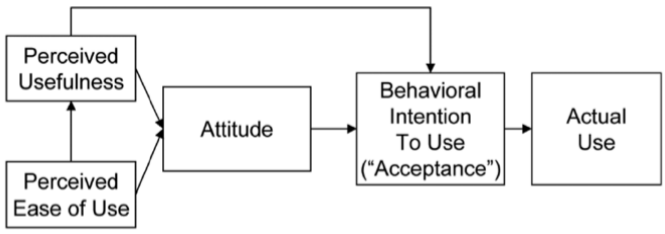

Figure 2: TAM. Source: Holden & Karsh, 2010

1.5.1 Underlying research

TAM didn't become widely used concept in the IS by accident. It's core concept and relevancy of core concepts of perceived usefulness and perceived used are supported by both, theoretical findings and academic research.

The importance of perceived ease of use and perceived usefulness, that are the corner stones of the TAM, is supported by several other researchers and studies, that identify similar concepts having influence on human behavior.

The first research is the self-efficacy theory by Bandura (Bandura, 1982). Bandura concludes that "in any given instance, behavior would be best predicted by considering both self-efficacy and outcome beliefs". (Davis, 1989, s. 329) Bandura's self-efficacy is similar to perceived ease of use and the outcome judgment is similar to perceived usefulness.

The next one is the cost-benefit paradigm from behavioral decision theory by Beach and Mitchell (Beach & Mitchell, 1978) and Johnson and Payne. (Johnson & Payne, 1985) Cost-benefit paradigm explains how people choose among different options by comparing the effort required (similar to perceived ease of use) and the quality (accuracy) of the resulting decision (similar to perceived usefulness).

In research of adoption of innovations, Tornatzky and Klein (Tornatzky & Klein, 1982) found out that compatibility, relative advantage and complexity have significant relationships across a broad range of innovation types. While compatibility and relative advantage have been used broadly and inconsistently in the literature, it is difficult to define them more exactly, complexity is defined by Rogers and Shoemaker (Rogers & Shoemaker, 1971) as "the degree to which an innovation is perceived as

relatively difficult to understand and use". (Davis, 1989, s. 322) This definition of complexity is similar to definition of perceived ease of use.

Swanson (Swanson, 1982) hypothesized that users select and use information reports based on their attributed information quality and attributed access quality, or associated cost of access, trade-off. Based on their load factors and definitions in Swanson's studies, these correspond to perceived usefulness and perceived ease of use.

The four theories mentioned above support Davis' TAM built on perceived usefulness and perceived use. In addition to this theoretical support, TAM was also confirmed in further research. King and He performed a meta-analysis of 88 TAM studies including more than 12 000 observations and concluded that TAM measures - perceived ease of use, perceived usefulness and behavioral intention to use a system are highly reliable and may be used in a variety of contexts. (King & He, 2006) However, they also noted that the correlations reported, while strong, were rather variable, so further research for moderator or external variables is recommended. This gave birth to multiple TAM extensions and variations that will be discussed further in this chapter.

1.6 Technology Acceptance Model extensions

Since 1989, a large number of authors revised and extended the model. Several of these extensions took on importance and were confirmed to improve accuracy of the model in explaining the user acceptance of different technologies. In this section, I will have a look at the most prominent extension of TAM, TAM2 proposed by Venkatesh and Davis in 2000 and several extensions applied to healthcare settings to identify variables that were proven to have positive effect on user acceptance in healthcare settings.

1.6.1 TAM2

In 2000, Venkatesh and Davis in their study called "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies" introduced their revised model called TAM2. In TAM2, perceived usefulness and perceived ease of use still play an important role, but attitude is removed from the model, so perceived usefulness and perceived ease of use influence the acceptance directly.

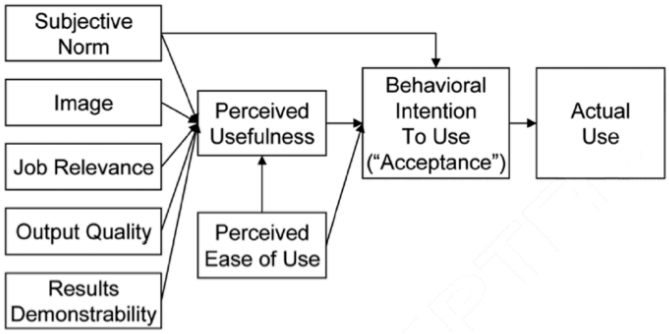

Figure 3: TAM2. Source: Holden & Karsch, 2010

Furthermore, TAM2 adds more factors influencing perceived usefulness. These new indirect factors are image, job relevance, output quality, results demonstrability and subjective norm. Out of the new factors, subjective norm is the most influential one, as it is the only one from the new factors that not only influences perceived usefulness, but also behavioral intention to use, or the acceptance, directly.

1.6.2 Technology Acceptance Model extensions in healthcare setting

It has already been established at the beginning of the theory chapter that TAM has relevancy in healthcare settings as well as other settings. However, researchers also proposed many other variables that should extend the TAM in order for it to become more accurate and fit healthcare settings further.

Both Ketikidis et al. (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012) and Holden & Karsh (Holden & Karsh, 2010) arrived to conclusions calling for extending TAM for healthcare settings to achieve standardization, better reporting data, exploration of additional motivations and relationships that might even increase TAM's ability to explain variance in the acceptance.

Pai and Huang, 2011: Adding quality variables into the model

In 2010, Pai and Huang tested a model including perceived usefulness and perceived ease of use and their effect on intention to use an information system among healthcare professionals in Taiwan. They also tested effect of information quality on perceived usefulness, service quality on perceived usefulness and perceived ease of use and system quality on perceived ease of use. (Pai & Huang, 2011)

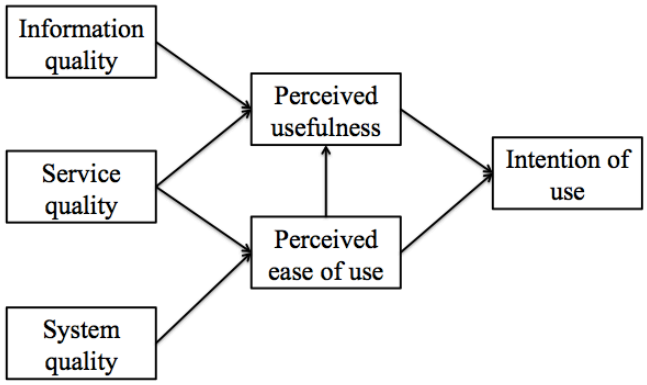

Figure 4: Pai & Huang's research model. Source: author

In the research findings, they conclude that all the relations as indicated in the Figure 4 in their proposed model are confirmed by their research:

- Information quality positively affects perceived usefulness,
- Service quality positively influences users' perceived usefulness as well as perceived ease of use,
- System quality positively affects perceived ease of use,
- Perceived ease of use and perceived usefulness significantly affect users' intention to use,
- Perceived ease of use has significant positive impact on perceived usefulness. (Pai & Huang, 2011)

Moores, 2012: Mandatory use of systems

Moores is testing effect of independent variables on three dependent variables – actual system use, attitude towards using the system and compatibility. He considers actual system use and attitude towards using as poor surrogates for acceptance of the system, and therefore defines compatibility with the way end-users like to work as a better measure. (Moores, 2012)

Apart from using perceived usefulness and perceived ease of use, Moores defines two antecedent variables to those constructs. Information quality means information accuracy, format being easy to understand, and timeliness of information and completeness of content of information. Enabling factors are computing support and self-efficacy, meaning the extent to which the system user believes they have the capability to use the system. (Moores, 2012)

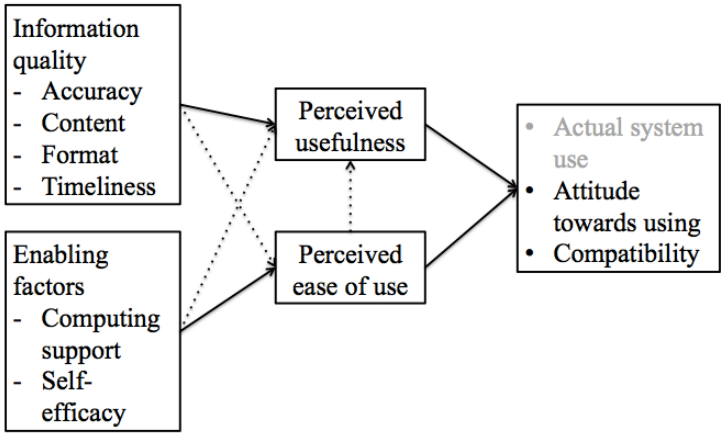

Figure 5: Moores' research model and conclusions. Source: author

After his analysis, he concluded that information quality positively influences perceived usefulness, but does not influence perceived ease of use, and that enabling factors positively influences perceived ease of use, but does not influence perceived usefulness. He also didn't find any influential effects of perceived ease of use on perceived usefulness. Finally, he concluded that perceived ease of use and perceived usefulness have positive influence on attitude towards using and compatibility, but he didn't find a proof that these two elements affect actual use. (Moores, 2012)

Furthermore, Moores makes an important statement: "For a system that is mandatory the level of system use was not significantly determined by attitude towards using, compatibility, perceived usefulness or ease of use." (Moores, 2012)

As usage of healthcare IT systems is very often bound to be mandatory, either on institutional level in hospitals, or even national levels by law, he concludes that compatibility as the measure of IT acceptance can better resolve the problem of how to overcome resistance towards the adoption of IT. Focus on increasing compatibility in order to increase IT acceptance can, according to Moores, better avoid low levels of use, feelings of frustrations, and potential aggressive resistance to the system. (Moores, 2012)

Liang, Xue and Byrd, 2003: Personal innovativeness along side perceived usefulness and perceived ease of use

One of the extensions was proposed by Liang, Xue and Byrd in their research of acceptance of PDA technologies by healthcare providers. Their model is in the Figure 6. They leave out both attitude and behavioral intention as direct determinants of actual use, and only focus on effects on actual use.

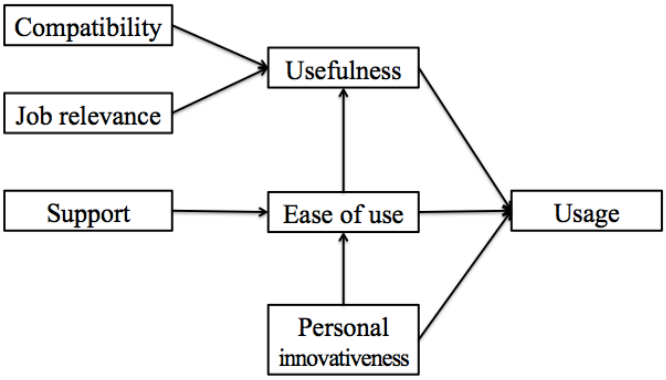

Figure 6: Liang, Xue and Byrd's research model. Source: author

In addition, they extend users' beliefs: perceived ease of use and perceived usefulness, with a third element, users' trait: personal innovativeness. They also introduce new external variables: support as antecedent of perceived ease of use, and job relevance and compatibility as antecedents of perceived usefulness.

Liang, Xue and Byrd (2003) proposed an extended Technology Acceptance Model to predict actual PDA usage by healthcare professionals. They found out that perceived usefulness and perceived ease of use determined the PDA usage. They also found out that personal innovativeness influences usage directly and indirectly via perceived ease of use. Perceived usefulness mediates the effects of job relevance, compatibility, and perceived ease of use. Support affects usage through perceived ease of use.

Tung, Chang, Chou, 2008: Adding negative variables to the model

In 2008, Tung, Chang and Chou proposed a hybrid Technology Acceptance Model and tested its validity on a sample of Taiwanese hospital nurses. Their model included negative effect of perceived financial cost on behavioral intention to use, and positive effect of compatibility, perceived usefulness, perceived ease of use and trust on behavioral intention to use. In addition, they also proposed that compatibility, perceived ease of use and trust affect perceived usefulness and that perceived ease of use affects trust. (Tung, Chang, & Chou, 2008)

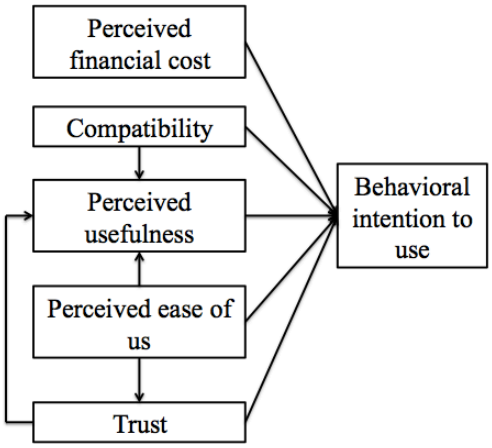

Figure 7: Tung, Chang and Chou model. Source: author

Liu & Ma, 2006: Perceived system performance replacing perceived ease of use

The research paper of Liu & Ma from 2006 focused on examining user behavioral intention to use electronic medical record by healthcare workers using questionnaires method. They tested model presented in Figure 8. Their study concludes that perceived ease of use and perceived usefulness are affecting behavioral intention to use. However, they also found out that perceived system performance positively influenced perceived ease of use and improved understanding of perceived ease of use. Nonetheless, in the case perceived system performance is in the picture; influence of perceived use on behavioral intention becomes insignificant. Therefore, they conclude that it is perceived system performance that is more direct predictor of behavioral intention than perceived ease of use. (Liu & Ma, 2006)

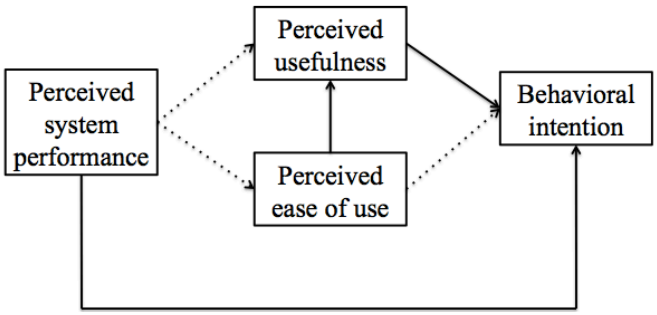

Figure 8: Liu & Ma's model. Source: Author

Wu, Wang & Lin, 2006: Effects of compatibility and self-efficacy on perceived usefulness and perceived ease of use

In 2006, Wu, Wang & Lin published a research article that presented a revised Technology Acceptance Model explaining intention to use a mobile healthcare system (MHS) by healthcare professionals.

Their research supported perceived usefulness and perceived ease of use influencing behavioral intention to use. In addition, they also found evidence supporting compatibility and MHS self-efficacy having positive influence on both, perceived usefulness and perceived ease of use. Moreover, they found that compatibility influenced positively both MHS self-efficacy and behavioral intention to use. Furthermore, they found out that compatibility has strongest total effect on the intention to use. (Wu, Wang, & Lin, 2007)

Their research did not find sufficient evidence that technical support and training would influence perceived ease of use and perceived usefulness; however, the evidence supported it positively influencing MHS self-efficacy. (Wu, Wang, & Lin, 2007)

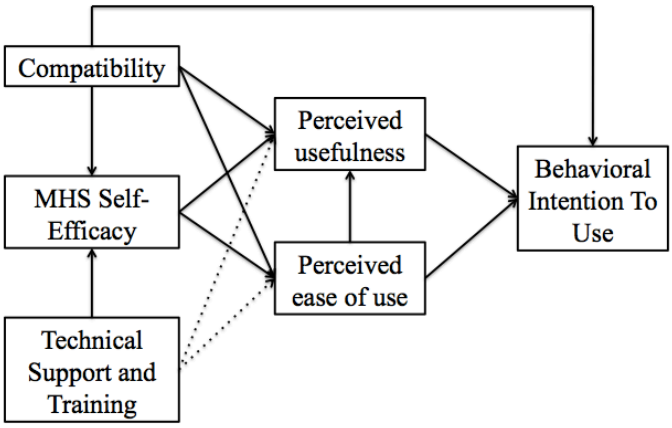

Figure 9: Wu, Wang & Lin's model. Source: Author

Paré, Sicotte & Jacques, 2006: Introducing psychological ownership

In 2006, Paré, Sicotte and Jacques researched acceptance of clinical information systems by physicians. They enrich the TAM construct with psychological ownership. While they proved the relationships indicated in Figure 10, their research also indicated much stronger relationship between perceived usefulness and attitude to use than between perceived ease of use and attitude to use. They found out that feelings of ownership positively affect perceived ease of use and perceived usefulness. However, compared to the model proposed in Figure 10, they found out that it is only communication and overall responsibility that are important antecedents of psychological ownership, while hands-on activities did

not have significant effect on the development of feelings of ownership. (Paré, Sicotte, & Jacques, 2006)

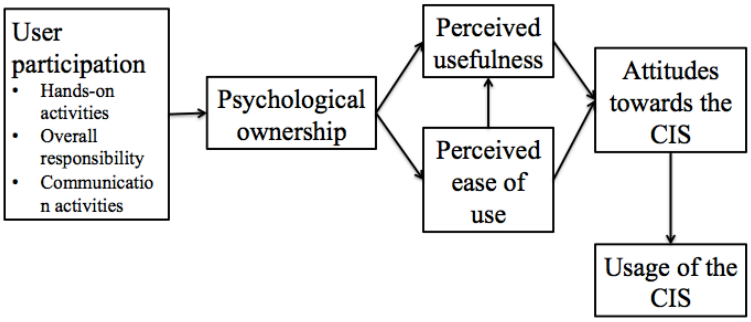

Figure 10: Paré, Sicotte, Jacques TAM extension model. Source: Author

Chau & Hu, 2002: Highlighting effect of compatibility on perceived usefulness

Chau and Hu published a research paper about acceptance of telemedicine by individual healthcare professionals in 2002. Their study highlighted importance of perceived usefulness, and only limited effect of perceived ease of use on attitude. They also found out that compatibility was a significant determinant of perceived usefulness. The concept of peer influence they tested seemed to have no effect on the attitude or behavioral intention to use. (Chau & Hu, 2002)

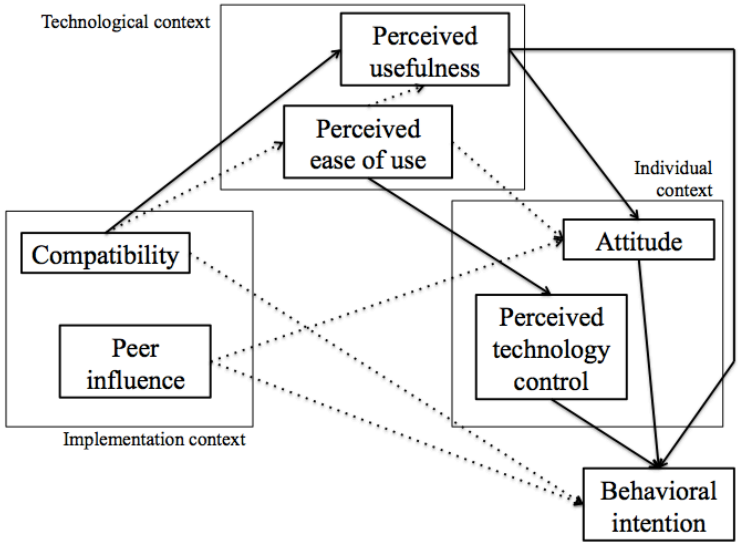

Figure 11: Chau and Hu's TAM extension model. Source: Author

Ketikidis et al., 2012: Effect of subjective norm on behavioral intention to use

In their study, Ketikidis et al. tested updated TAM2 model. However, the specific model they tested seems to be quite far from TAM2. In their hypothesis, they claim to focus on testing perceived usefulness and perceived ease of use and their ability to predict healthcare professionals' intentions to use HIT and subjective norm, descriptive norm, relevance and computer anxiety to have influence on usage intentions over and above the effects of perceived usefulness and perceived use. The author's idea of their model is depicted in Figure 12.

Results of their study didn't confirm perceived usefulness' role in the intention to use HIT, as they only found proof for perceived ease of use to have positive effect on intention to use. In addition, they confirmed relevancy of job relevance and subjective norm for intention to use HIT in healthcare professionals. Computer anxiety and descriptive norms didn't play a significant role in predicting healthcare professionals' intention to use. (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012)

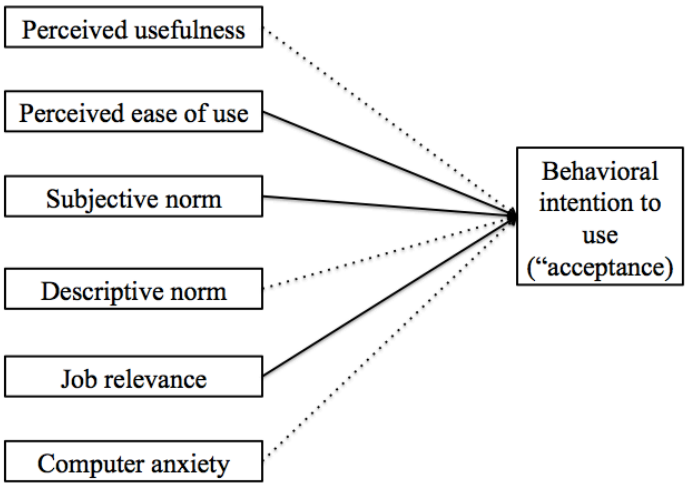

Figure 12: Ketikidis et al. model. Source: Author

1.7 TAM theory application in this thesis

It is clear that there is many different variations of TAM used both inside and outside the healthcare settings and that some of the variables have been both confirmed and found insignificant by different studies. In this section, I am going to summarize main findings from the previous paragraphs to identify most prominent variables in the existing TAM research. These variables should help to analyze interviews and formulate conclusions based on the analytical research in done on the case of Estonian EHR.

1.7.1 Level of use vs. intention to use vs. attitude to a system

The most visible difference between different model variations is in the way they define "acceptance" or rather, in the dependent variable that should reflect the acceptance of the technology by users. While in the original TAM model, Davis defined three variables indicating the acceptance of the technology and used them in the model:

- use of technology - "specific behavior of interest performed by individuals with regard to some information technology system" (Holden & Karsh, 2010),
- behavioral intention to use (which he calls "acceptance") - "an individual's motivation or willingness to exert effort to perform the targeted behavior" (Holden & Karsh, 2010)
- attitude to the technology - "individual's evaluative judgment of the target behavior on some dimensions (e.g. good/bad, harmful/beneficial, pleasant/unpleasant)". (Holden & Karsh, 2010).

Davis claimed that actual use is influenced by behavioral intention and behavioral intention is influenced by attitude and perceived usefulness. (Davis, 1989)

However, following TAM extensions often leave one of those variables out of the model. For example, Venkatesh & Davis in TAM2 (Venkatesh & Davis, 2000) remove attitude from the dependent variables and only keeps behavioral intention to use and level of use. Pai and Huang (Pai & Huang, 2011) and Tung et al. (Tung, Chang, & Chou, 2008) only study effects of independent variables on the intention to use the system. Liang et al. (Liang, Xue, & Byrd, 2003) leave both. attitude and behavioral intention to use out and only study effects on actual use levels.

Despite that the results on independent variables does not seem to be influenced by this in the eleven studies used, Moores makes an important statement: "For a system that is mandatory the level of system use was not significantly determined by attitude towards using, compatibility, perceived usefulness or ease of use."(Moores, 2012) Moores concluded that compatibility as the measure of IT acceptance can better resolve the problem of how to overcome resistance towards the adoption of IT. It also seems that in the case of mandatory systems, TAM independent variables such as perceived ease of use and perceived usefulness may explain "attitude" to the system, while they cannot explain level of use. From that perspective, I will be considering "attitude" as well as level of use and intention to use as parts of the TAM model in this thesis.

1.7.2 TAM variables summary

In Figure 13, I have summarized all the different variables presented in the studied research on Technology Acceptance Model. Each tick in the Figure 13 represents a variable confirmed in the respective research. In this part of theoretical chapter, I am going to describe the variables that were repeatedly confirmed in the TAM research as they are the ones most probably appearing as significant also in the case of Estonian EHR, so their detailed knowledge will help analyzing the case in hand.

	TAM	TAM2	Pai & Huang	Moores	Liang, Xue & Byrd	Tung, Chang & Chou	Lia & Ma	Wu, Wang & Liu	Paré, Sicotte & Jacques	Chau & Hu	Ketikidis et al.	Occurrences
Perceived usefulness	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		10
Perceived ease of use	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	10
Subjective norm		✓									✓	2
Image		✓										1
Job relevance		✓			✓						✓	3
Output quality / Information quality		✓	✓	✓								3
Results demonstrability		✓										1
Service quality / Support			✓	✓	✓			(✓)				3 (4)
System quality / Perceived sys performance			✓				✓					2
Self-efficacy				✓				✓				2
Compatibility					✓	✓		✓		✓		4
Financial costs						✓						1
Trust						✓						1
User participation									✓			1
Technology control										✓		1

Figure 13: Occurrences of different variables in different TAM variations used in this thesis. Source: Author

Perceived usefulness and perceived ease of use

The most often confirmed was effect of perceived usefulness and ease of use. Each variable was confirmed in 10 out of 11 studies selected for theoretical research for this master's thesis. In the overall research, scientists have often argued about relative importance of perceived ease of use and perceived usefulness. For example, Davis found out that usefulness was more strongly correlated with usage than ease of use. (Davis, 1989) Furthermore, importance of perceived usefulness has been consistently supported by number of studies, results supporting perceived ease of use were less consistent as some studies failed to show the link between perceived ease of use and usage.

Also Holden and Karsch (2010) found the relationship between perceived usefulness and intention to use or the actual use of health IT significant. They also concluded that perceived ease of use is not that

likely to affect acceptance, but it appears to correlate with usefulness. It thus seems that an IT system that is perceived as difficult to use cannot possibly be perceived as useful.

However, for the purpose of this thesis, based on the eleven studies research, it seems that both perceived ease of use and perceived usefulness play significant roles in the healthcare settings and they are expected to play a role in acceptance and usage of Estonian EHR system.

Perceived usefulness is defined as "an individual's perception that using an IT system will enhance job performance". It means that users will positively reply to questions such as: (1) 'the technology' enables me to accomplish tasks more quickly, (2) using 'the technology' increases my productivity, (3) using 'the technology' improves my job performance, (4) using 'the technology' enhances my effectiveness on the job, (5) using 'the technology' makes it easier to do my job, and (6) overall, I find 'the technology' useful in my job. (Davis, 1989)

Perceived ease of use is defined as "an individual's perception that using an IT system will be free of effort". (Holden & Karsh, 2010) As he did for perceived usefulness, based on extensive meta-research of concepts similar to perceived ease of use, Davis defined 6 items that load concept of perceived ease of use: (1) learning to operate 'the technology' is easy to me, (2) I find it easy to get 'the technology' to do what I want it to do, (3) 'the technology' is rigid and inflexible to interact with, (4) my interaction with 'the technology' is easy for me to understand, (5) I find it takes a lot of effort to become skillful at use 'the technology' and (6) overall, I find 'the technology' easy to use. (Davis, 1989)

Compatibility

Out of the eleven studies researched for the purpose of this thesis, four confirmed importance of compatibility for acceptance and levels of use of the system.

Compatibility is one of the key variables in diffusion of innovation theory. Rogers first described it in the book Diffusion of Innovations as one of five major constructs that determine innovation acceptance. Innovation diffusion theory greatly complements Technology Acceptance Model theory and these two theories have been often combined together to improve predictability of TAM. Diverse studies have shown that compatibility may be a significant determinant of perceived ease of use.

Compatibility is defined as "the degree to which an IT is perceived as being consistent with the existing values, needs and past experiences of potential adopters". (Liang, Xue, & Byrd, 2003, s. 377) Or in other words: "Compatibility is the extent to which the value of the innovation, its experience in the past,

and users' needs are consistent with each other." (Tung, Chang, & Chou, 2008, s. 326) It means that if users think that using of an IT will not affect their current working style, or will only require insignificant changes, they are more open to use that IT. (Chau & Hu, 2002)

Furthermore, also Moores (Moores, 2012) concluded that to overcome resistance towards the system, the system must be designed to fit with current work practices.

Support and service quality

Three studies confirmed that support or service quality connected to the system have important effect on either perceived ease of use or perceived usefulness of the system. One study showed that trainings and support positively influence self-efficacy, which in turn positively affects perceived ease of use.

Support is defined as "objective factors, 'out there' in the environment, that several judges or observers can agree will make an act easy to do." (Liang, Xue, & Byrd, 2003, s. 377) Support includes training, consulting, IT support, hardware and software availability etc. This kind of support is likely to increase users' confidence in using the technology in question.

Pai & Huang (Pai & Huang, 2011) also highlighted importance and ability of service quality that goes together with a system to improve its perceived ease of use and usefulness. The quality service is considered to be on time, professional and personalized.

Wu et al. studied influence of technical support and training on perceived ease of use. They found no significant influence of training and technical support on perceived ease of use, however they found out that these elements have positive effect on self-efficacy. (Wu, Wang, & Lin, 2007)

The training needs to be built to match existing levels of knowledge and it was suggested that also general computer training, not only system-specific one, improved self-efficacy. However, in their discussion, Wu et al. concluded that as the systems are designed in a more user-friendly way, importance of training and technical support decreases. (Wu, Wang, & Lin, 2007)

Job relevance

Job relevance was found significant variable in several TAM extensions, such as in TAM2 by Venkatesh & Davis (Venkatesh & Davis, 2000), Liang et al. (Liang, Xue, & Byrd, 2003) and Ketikidis et al. (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012). Job relevance is defined as "a user's perception regarding the degree to which the target IT is applicable to his or her job". (Liang, Xue, & Byrd, 2003)

Job relevance means that IT users compare important work goals and the consequences of using it. Based on this comparison, they make a judgment about whether the technology is useful or not.

Assumption that job relevance is influencing IT usage is based on motivation theory, action theory and behavioral decision theory, which state that human behavior is driven by a mental representation linking high-level goals to specific actions. In this logic, IT users compare important work goals and the consequences of using it. Based on this comparison, they make a judgment about whether the technology is useful or not. (Liang, Xue, & Byrd, 2003)

Also Ketikidis et al. in their conclusions confirmed that job relevance has an effect on intention to use a system by healthcare professionals. They concluded that the more healthcare professionals know about the applicability of the system on their daily work routines, the more likely they are to accept those systems. (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012)

Information and output quality

In his study, Moores proved that information quality significantly positively affects perceived usefulness of the system and thus plays a role in TAM. (Moores, 2012) Information quality was defined by Moores to be based on accuracy, content, format and timeliness of the information provided by the system. (Moores, 2012) This means, to achieve high information quality, the system must be free of errors, provide information needed for the user to finish their work, in an easy to read format and at the time needed. (Moores, 2012)

Information quality was assumed to positively affect perceived usefulness of a system also by Pai & Huang. (Pai & Huang, 2011) According to them, information quality reflected in ability of the system to provide correct information and knowledge.

Subjective norm

Subjective norm was found to have positive effects in terms of TAM research in TAM2 by Venkatesh & Davis (Venkatesh & Davis, 2000) and by Ketikidis et al. (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012) Subjective norm is an indicator of social influence. It is theorized in the TAM2 that subjective norm is an effect that opinions of important others, such as colleagues, family, friends etc. have on intention to use the technology. In TAM2, subjective form is deemed to influence perceived usefulness. (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012) This concept is different from a descriptive norm, which also evaluates social influence on usage and intention to use, but this time rather then opinions of

others, it is behaviors of others (i.e. if they do or do not use the system) that would play a role in the acceptance of the systems. Ketikidis et al. studied effects of descriptive norms, but didn't find any significant impact of descriptive norms on intention to use a system.

Self-efficacy and personal innovativeness

Self-efficacy and personal innovativeness were each confirmed by one of the studies research, by Moores (Moores, 2012) and by Liang et al. (Liang, Xue, & Byrd, 2003). However, the concepts are overlapping, so they were grouped into one category for the purpose of this thesis.

Personal innovativeness is defined as "the willingness of an individual to try out any information technology." It is also considered to be relatively stable across time and environment. (Liang, Xue, & Byrd, 2003) It is assumed that personal innovativeness has a strong relationship with computer self-efficacy, which is defined as the judgment of ones capability to use an IT, which determines individuals' IT using behavior. It is also stated that there will be a relationship between computer self-efficacy and perceived ease of use.

In summary, it can be said that the more users consider themselves capable of using an IT, the higher their degree of personal innovativeness, which in turn has a positive effect on perceived ease of use of a technology.

Self-efficacy reflects "the extent to which the system user believes they have capability to use the system. " (Moores, 2012, s. 509) This can be measured by comfort, ease or confidence using the system without external help.

It is however interesting, that also Ketikidis et al. studies effects of computer anxiety on intention to use a technology in healthcare setting, but their study didn't manage to find significant negative connection between computer anxiety and intention to use a system. (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012)

In this theoretical chapter, I have analyzed eleven TAM research articles in order to identify key trends and variables used in the TAM research in healthcare settings. Information from this chapter are further used in the analytical chapters in order to identify specific activities and elements that lead to high usage

of the Estonian EHR system by healthcare professionals. However, I will also focus on activities and elements that helped improve attitude of healthcare professionals towards the system.

ANALYSIS – ESTONIAN EHR DESCRIPTION

The analysis is divided into two chapters. In this chapter, I focus on describing the Estonian Electronic Health Record system and its implementation process based mostly on secondary data sources, such as reports, presentations and online presentations. This chapter should allow the reader to form an overview about the scope and the implementation process of the system, allowing him to better navigate through the following chapter.

In the following chapter, I focus on analyzing information collected during the interviews to identify the main conditions and activities that led to a high acceptance of the system by healthcare professionals in Estonia.

1.8 EHR in Estonian: system features, goals and vision

"The Estonian Health Information System is a globally unique e-health solution as it encompasses the whole country, registers virtually all residents' medical history from birth to death, and is based on the comprehensive state-developed basic IT infrastructure." (Tiik & Ross, 2010)

The Estonian Health Information System includes four e-health projects: Electronic Healthcare Record, Digital prescription, E-registration and Digital Images. The main goals for starting the e-health projects were: (1) decreasing the level of bureaucracy in the doctors' work process, (2) increasing the efficiency of the health care system, (3) making the time-critical information accessible for the attending physician, (4) developing health care services that are more patient friendly and have higher quality. (Estonian e-Health Foundation, 2010)

This master's thesis focuses primarily on Electronic Health Record system. EHR registers the medical history of Estonian citizens. Its main goal is to enable the exchange of information between doctors by connecting IT systems for health services. (ProeHealth)

Apart from patients' primary data, such as the contact information, insurance information, allergies, important drug information etc., the EHR contains the following eleven categories of data: medical files, time critical data (allergy, chronic diseases), GP and hospital visits, summary of ambulatory and stationary cases, link to medical images, prescribed and dispensed medication, expressions of

will/preferences, closing medical records (opt out), names of trusties, donation of organs and overview of logs. (ProeHealth)

Apart from storing the data, EHR provides additional services to healthcare professionals and other stakeholders in order to simplify their way through the healthcare systems. These services include for example:

- EHR gives the doctors possibility to see the patient's entire health history when they need it.
- EHR provides time critical information to ambulances staff (for example if patient has any allergies or if there are any drugs that are dangerous to the patient).
- EHR gives doctors the possibility to receive consultation from colleagues as they can exchange patient's medical information through the EHR system.
- EHR reduced the need to use paper forms carried by patient from one stakeholder to another; for example, (a) the GP can send patient's medical information through the EHR system to the specialist who treats the patient. The patient does not have to carry any papers himself; (b) the patient can receive medical certificates through EHR without having to deal with any additional paperwork. These certificates can also be sent to employers or state authorities through EHR system in electronic form. (ProeHealth)

1.9 Technical solution

The HIE (healthcare information exchange) platform that is the basis for the Estonian EHR utilizes already existing state infrastructure such as electronic ID cards, X-Road security and communications and existing ICT systems of healthcare providers. (ProeHealth) This means that Estonian national EHR does not replace the in-house information system of healthcare providers - these must be updated and modified to enable data update according to the technical specifications set by the system administrator. (ProeHealth)

The existing in-house information systems and communication infrastructure were integrated ("linked") by special system modules. The module for message exchange enables data exchange and interoperability of all integrated users and delivers all messages, which conform to the standard message type. (Estonian e-Health Foundation, 2010)

However, unfortunately in spite of a more than ten years history of digital collection of medical data by doctors prior to the national EHR implementation, the medical data collected prior to 1st of January

2009 were not transferred to the EHR due to their poor quality and insufficient standardization. (ProeHealth)

1.10 Estonian healthcare system

The Ministry of Social Affaires manages the healthcare system in Estonia. The Estonian Health Insurance Fund is the single payor in the system. Its revenues consist of public financing (73,7 % in 2006) which comes from the compulsory solidarity-based public insurance system and social taxes, and private expenditures (25,6 % in 2006). All Estonian citizens, including those unemployed, children, or retired people, have equal access to healthcare services regardless of their financial contribution through insurance or taxes. (Koppel, Leventhal, & Sedgley, 2009)

The system is further characterized by the purchaser (EHIF) and provider split (healthcare providers), free choice of healthcare provider and a high level of autonomy. The system is built around countrywide primary care with family doctors as the main providers, supported by ambulatory services. Specialized care is being provided mostly in outpatient settings and advanced technology is centralized to fewer institutions. (Doupi, Renko, Giest, Heywood , & Dumortier, 2010)

1.11 EHR - Institutional organization

Ministry of Social Affaires is the main healthcare policy developer, including the Estonian Electronic Health Record project. The projects are developed according to the Ministry of Finance's guidelines, discussed and approved by the Government, and may receive financing from the state budget. (Doupi, Renko, Giest, Heywood , & Dumortier, 2010) In addition, the involvement of the Ministry of Social Affaires is important, as the e-health projects involve multiple stakeholders and social development activities. Additionally, they include other aspects such as medical standardization, ethics and legislation. (Estonian e-Health Foundation, 2010)

Estonian Health Insurance Fund is the main funding agency of the project together with the EU Structural Funds. Estonian e-Health Foundation is the main administrative body ensuring the implementation of the system.

1.11.1 Estonian e-Health Foundation

In 2005, Ministry of Social Affaires together with other stakeholders established an administrative body to deliver most of the e-health projects – the Estonian e-Health Foundation (EEHF). Its goal was to "effectively manage the process of developing these projects". (Tiik, 2012)

The main purpose of EEH is summarized as follows: *"The Estonian e-Health Foundation promotes and develops national e-solutions within the health care system – we create solutions and offer services with the goal to assist in providing high-quality and accessible health care services. Our broader goal is to promote the development of a patient-centered health care system that has well-informed patients."* (Estonian e-Health Foundation)

The e-solutions that are part of the EEHF's responsibility include three out of four HIE projects: Electronic Health Record, Digital Image, and Digital Registration. The fourth e-solution, Digital Prescription, was put into responsibility of Estonian Health Insurance Fund.

The founders of the EEHF were: Ministry of Social Affairs of Estonia, North Estonia Medical Centre, Tartu University Hospital Foundation, East Tallinn Central Hospital, Estonian Hospitals Association, The Estonian Society of Family Doctors and Union of Estonian Emergency Medical Services.

Each of these stakeholders is represented in the EEHF Board. There are 11 members of the Board – Ministry of Social Affaires has 5 members and each of the remaining professional organizations or healthcare providers holds 1 seat. The members are appointed by the founding organizations according to the criteria described in the Statute of the Foundation. The Board members are appointed for a 3-year term. (Estonian e-Health Foundation)

The evaluation and perception of EEHF in Estonia are both positive and negative. The defenders of EEHF argument that EEHF had an accurate overview of the project's progress and that it was staffed with experts. (ProeHealth) Another argument in favor of the positive role of EEHF in the process is that it unified various stakeholders to ensure compliance and cooperation in developing the four projects. (Tiik, 2012)

However, there are also arguments that represent negative attitude towards EEHF. One of them is that not all the stakeholders are equally represented - health professionals are only represented to a small degree, including GPs, radiologists, doctors interested in telemedicine. Many crucial partners – Estonian Health Insurance Fund, Estonian Medical Association, University of Tartu, and the patients – are not actively engaged in development process and there is no clear strategy for communicating and

establishing the added value for each one of them. (Doupi, Renko, Giest, Heywood , & Dumortier, 2010) Mostly, it is also just professional associations and their representatives that participate in the dialogue and in planning committees, so not all the doctors had the opportunity to be actively involved in the communication. (Doupi, Renko, Giest, Heywood , & Dumortier, 2010)

1.12 Timeline

The first idea to improve and extend health services for patients and citizens started in 2000 in the form of Estonian National Health Information System (NHIS) and was introduced in the Estonian Health Project 2015 document for the World Bank. (ProeHealth) This project was then terminated in 2002, when the Health Division of the Ministry of Social Affairs took fully over the responsibilities for the entire process. At the same time, in 2000, all primary care practices were obliged to procure computers and Internet connection. (Doupi, Renko, Giest, Heywood , & Dumortier, 2010)

The ideas of e-health and electronic health record already emerged in 2002. The purpose was to develop a nationwide framework (database) to facilitate the exchange of digital medical documents and diffuse health information available so far only in local databases and information systems that were not able to communicate with each other. (Estonian e-Health Foundation, 2010)

In 2003, the Department of Health Information and Analysis was established for the practical development of the project's strategy. (Doupi, Renko, Giest, Heywood , & Dumortier, 2010)

In 2004, the Estonian Health Information System Development Plan 2005-2008 was published. It included targets such as improving interoperability of data exchange between different parties within the healthcare system. In November 2014, the Estonian Digital Health Record Vision document was published. It contained series of feasibility studies undertaken in the first years of the NHIS project). (Doupi, Renko, Giest, Heywood , & Dumortier, 2010)

In 2005, Estonian Ministry of Social Affaires obtained funding from the EU Structural Funds to develop and launch e-health projects in 2005 – 2008. These included:

- Electronic Health Record (1,6 mil EUR),
- Digital images (0,2 mil EUR),
- Digital Registration (0,2 mil EUR) and
- Digital Prescription (0,24 mil EUR). (ProeHealth)

The funding in total amounted to 1,8 EUR per capita from the EU Structural Funds, but increased to 7 EUR per capita from Estonia's own resources. (ProeHealth) It was planned to include approximately 1500 participants to interfere with the EHR system. The budget for drafting the e-health bill and implementing the four e-health projects is 36 million EEK. (Estonian e-Health Foundation, 2008)

As was also mentioned above, in chapter 1.11 EHR - Institutional organization, in 2005, EEHF was founded by the Ministry of Social Affaires and other stakeholders.

In 2006, the Estonian government initiated the development process of the Electronic Health Record System as a part of the Estonian Information Society strategy 2013. (Tiik, 2012)

In December 2007, the Estonian Parliament ratified an amendment act that established the legal basis for implementing the e-health projects called The Health Services Organization Act and Associated Acts Amendment Act. The goal of these accepted changes is to unify all information systems created for a specific health care organization into one central health information system. (Estonian e-Health Foundation)

The basic idea of this Act is to create a basis to enable the electronic processing of different medical documents. (Doupi, Renko, Giest, Heywood , & Dumortier, 2010)

In 2008, The Health Information Act was ratified by Parliament. It specified the content of information stored centrally and their usage by the law. (ProeHealth)

From January to June 2008, EEHF arranged Information Days at thirteen Estonian hospitals, discussing the current status of e-health projects, information security and upcoming implementation of the information systems in healthcare. (Estonian e-Health Foundation)

In August 2008, TNS Emor carried out two surveys that showed that doctors and patients were mostly in favor of EHR. 97 % of doctors and 57 % of residents had heard about the EHR. 77 % doctors that had heard of the system were in favor of it. The main benefit they considered was that all information on patients' exams and consultations are available from one location regardless of the health care facility where a patient saw a doctor, whereas the main disadvantage perceived was that initially it can be too time consuming to enter and retrieve information from the system as well as the reliability of the system during power failure, for instance. Overall, out of those that had heard about the system 71 % were in favor of it. (Estonian e-Health Foundation, 2008)

On 17th December 2008, the national Electronic Health Record was launched and data collections started. (Estonian e-Health Foundation, 2010)

Since 1st January 2009, all the healthcare providers were obligated to send an agreed number of standardized documents to EHR. (ProeHealth) In October 2009, the Patient Portal was launched. (Estonian e-Health Foundation, 2010)

By March 2010 the EHR contains over a million medical documents. For the moment the agreed amount of data is sent to the system, containing discharge letters (inpatients and outpatients), referrals and links to digital images. (Estonian e-Health Foundation, 2010)

In the following chapter, I focus on describing motivations and activities that led to high usage levels of the system by healthcare professionals.

ANALYSIS – ADOPTION OF ESTONIAN EHR BY HEALTHCARE PROFESSIONALS

In this chapter, I am going to describe the reasons that led to the usage of the EHR system by healthcare professional. The reasons were identified based on analysis of interviews as described in the methodology chapter. The analysis was structured based on the TAM variables presented in the theoretical chapter of this thesis. The aim of this chapter is to describe the case of Estonian EHR implementation and the activities that lead to high usage of the system in the country based on TAM theory.

Firstly, I discuss appropriateness of the TAM for this particular case. During the interviews, it occurred that the main usage-driving factor was a law that made using the system mandatory. In the TAM research, mandatory usage was not vastly explored; therefore, the first section of this chapter explains why TAM is still relevant even in the case of mandatory usage. Subsequently, I focus on describing further elements that played role in creating positive attitude towards the system and assess their fit into the TAM theory.

1.13 Mandatory system usage and TAM

The Estonian EHR was selected as a case for this master's thesis because it is promoted as one of the most successful national implementation of an EHR system in terms of high levels of usage of the system by healthcare professionals and amount of information uploaded to the system. It seems like such a scenario could be rich in acceptance building elements, and thus would be a good case to illustrate different variables found in TAM theory. However, during the interviews, it became apparent that mandatory usage of the system anchored in Estonian legal system was cited as the most important reason for the high usage number by all the interviewees. This mandatory usage of the system has not been deeply described in the TAM theory articles selected in the theoretical research for this thesis.

When asked about their opinion, what are the main reasons why so many healthcare professionals are using the system, all the interviewees agreed that the most important decision was that it is obligatory by law to send medical case summaries into the system as of September 1, 2008. The law was ratified in December 2007, which gave healthcare providers eight months to make arrangements to comply with the law.

The law included these provisions:

- As of September 1, 2008, healthcare providers are obligated to forward medical data to the national EHR,
- Only healthcare employees currently associated with patient's treatment have the right to make enquiries about patient's data. Enquiries outside of treatment process are not allowed. The data will only be issued to healthcare employees registered with Healthcare Board,
- Patients can exercise their right to set restrictions (incl. situations such as emergency situations) of access to their health data using Patient Portal. (Estonian e-Health Foundation, 2010)

The law became a powerful motivator for usage, despite the fact that interviewee 1 from the EEHF revealed that, especially at the beginning, there was no real penalty to healthcare providers who didn't follow the rule.

> *"Yes, there were some punishments defined, for example to take away their medical licenses. But we never did it, because there is never enough of doctors." (Interviewee 1)*

The fact that the law was executed despite the lack of punishments may have several reasons. Firstly, it is tendency of (most of the) citizens to follow the law even if the probability of punishment is low. Secondly, EEHF made agreement with the Estonian Health Insurance Fund to only sign contracts with healthcare providers who proved they have made usage agreements of the system with EEHF. While this is not specifically a punishment, it was an effective pre-emptive measure to ensure healthcare providers did not break the law. (Interviewee 1, EEHF)

A controversial decision

It was clear from the interviews that passing this law was a controversial decision. The controversy is apparent from following quote of an EEHF employee:

> *"I think that the law that says that it's mandatory to use the system has been the first driving force. The other one is that Estonian Health Insurance Fund, which is funding all the healthcare services, has put it to the agreements with the healthcare service providers. But these are not really good examples to give."(Interviewee 1)*

Other interviewees had a similar attitude to the law that made uploading the documents to the system obligatory. Interviewee 4 from EEHF called it *"the most undiplomatic decision we took"* despite that,

he also agreed that this decision had caused the high usage of the system by healthcare professionals in the first place.

1.13.1 What made it possible to put the mandatory usage into the law?

That the ratification of the law was a rather extreme solution was admitted only with hesitation by the interviewees. The question therefore is, what made it possible to ratify this law in parliament, by politicians who are traditionally very careful about passing controversial laws, as they strive to be re-elected. There were two possible reasons for passing the law identified while researching information for this thesis. First was a strong commitment of the Estonian politicians to e-services and second was financing of the EHR system.

Governmental commitment to e-services

Since its independence, Estonia departed on the path of fast development of a society based on information technology. In 2000, it offered its citizens opportunity to file their tax declaration online, and today, 94 % of declarations are done online. In 2003 electronic ID bus tickets were introduced in Estonia. In 2005, they organized first i-voting and in 2011, 24 % of votes were cast online. (Tiik, 2011) These activities were launched by document called the Estonian Information Policy, which was approved in Parliament in 1998. In 2006, Electronic Health Record became part of Estonian Information Society Strategy 2013 initiated by Estonian government. (Tiik, 2012) These facts show that there was pretty strong and continuous commitment of the politicians to implement various e-services in the country.

In addition, in order to enable the emergence of these various e-service, Estonia had to invest into a nation wide infrastructure ensuring secure access to these services. The first part of the infrastructure is a national electronic ID card that includes a certificate for authentication and a certificate of digital signature. The card was introduced in 2002. The second part of the infrastructure is X-Road, the Estonian countrywide data exchange platform. Usage of both is free of charge for both institutions and citizens. (ProeHealth)

Having these two elements already in existence and free to use significantly decreased procurement costs of the EHR system, thus decreasing political resistance as the investment was lower. In addition, finding new additional usages for this infrastructure would improve ROI of the investment into the infrastructure, which is also beneficial for the political image of the government.

EHR system financing structure

In 2005, Estonian Ministry of Social Affaires obtained funding from EU Structural Funds to develop and launch e-health projects in 2005 – 2008 for a total amount of 2.8 million €. This money had to be spent and billed by end of 2008. The total investment into the e-health services between 2006 and 2008 was 6.3 million €. (ProeHealth) This means that the EU investment represented large proportion of the budget. It is therefore clear that it was crucial to use the funds in compliance with the conditions and the timeline imposed.

This pressure was also expressed by the respondent no. 5 who sat on the advisory board of EEHF:

> *"And I also understand the Ministry [that they pressured the HCPs to use the system], because they have applied money from European funds and their timetable was quite strict and they had to spend the money and show the results in very short notice." (Interviewee 5)*

It therefore seems that another reason for the political pressure and willingness to use unpopular, top-down solutions, such as enforcing usage by law was also external pressure from the EU Structural Funds.

1.13.2 How does mandatory usage influences TAM?

The theoretical research shows that if a system is mandatory to use, then the usage level of system is not significantly determined by attitude, compatibility, perceived usefulness or perceived ease of use. (Moores, 2012) Adams et al. made similar conclusions. They concluded that if a system is used on a compulsory basis as part of person's job description, factors such as usefulness and ease of use may have little influence on overall levels of use, though they may influence measures such as user satisfaction. (Adams, Nelson, & Todd, 1992)

However, as it was described in the theoretical chapter, in the original Technology Acceptance Model (Figure 2, p. 13), the variables such as perceived ease of use and perceived usefulness influence usage levels through attitude and behavioral intention to use (acceptance). The acceptance (intention to use) is defined as "an individual's motivation or willingness to exert effort to perform the targeted behavior" (Holden & Karsh, 2010) and it is directly influenced by attitude, which is defined as "individual's evaluative judgment of the target behavior on some dimensions (e.g. good/bad, harmful/beneficial, pleasant/unpleasant)". (Holden & Karsh, 2010) This distinction between usage, intention to use and attitude towards the system was part of the original model constructed by Davis, but abandoned in later

extensions, such as in TAM2 (Venkatesh & Davis, 2000), Pai & Huang (Pai & Huang, 2011), Tung et al. (Tung, Chang, & Chou, 2008) or Liang et al. (Liang, Xue, & Byrd, 2003).

In the case of Estonian EHR, intention to use (acceptance) and usage were highly influenced by the law that mandated the use of EHR system and to send medical data into the system. Therefore these two dependent variables, the independent TAM variables such as perceived usefulness and perceived ease of use, were not crucial.

However, in this thesis, it will be described how these basic TAM independent variables played a role in building positive attitude towards the system. Before I move onto that, it is crucial to understand why attitude is important in the case of mandatory healthcare systems.

Importance of attitude for mandatory public systems

I found three main reasons that justify importance of attitude. The first reason is that public systems require public support. This is a basic implication derived from the way these systems are being decided about and funded – by politicians seeking public support in the next elections. Second reason why a positive attitude is important for mandatory healthcare systems is that it minimizes attempts to find loopholes in the law. This reason is based on the interview analysis of the Estonian EHR case. Thirdly, a positive attitude also maximizes the usage of the system for tasks that are not mandated in the law. This reason is based on three stages of launching new technology by Scarborough & Zimmerer. (Scarborough & Zimmerer, 2000) All three reasons are described more in depth in the following paragraphs.

1) Publicly funded projects require public satisfaction

In the publicly funded sectors, such as healthcare, the systems are paid from public resources and their implementation usually derives from a political decision to invest money into them, as compared to investing into a different initiative. If the system is vastly unpopular, the healthcare professionals and public can create enough pressure on politicians to discontinue the system, or to dismiss or not to re-elect those in charge of implementing it. The success of such system is therefore not only determined by levels of usage, but also by the attitude towards the system.

2) Positive attitude minimizes trials to find loop holes in the law

In Estonia, while it is obligatory to "forward medical data to the national EHR", it may be difficult to create clear and specific enough definitions of what "medical data" means to make it easy to understand and enforce the law; and when such data should be forwarded to the system.

In Estonia, there are two different key documents that are to be sent to the national EHR – the hospital case summaries issued whenever a patient leaves hospital, and ambulatory case summaries, which are issued whenever a patient's condition for which he visited a doctor ambulatory is terminated. While it is estimated that more than 90 % of hospital summaries are submitted to the system, this number is only around 50 % for ambulatory summaries. (Interviewee 1,2)

Interviewees 1 and 2 agreed that the main difference between these two types of documents is that while the hospital summaries are well defined, the ambulatory summaries are not. It is hard to determine when does an ambulatory case ends, in some cases patients do not report when they are cured, and in the case of chronic diseases, the case never ends, thus there is no final statement and no ambulatory case summary.

> *"The ambulatory part is pretty problematic because there are some tricky regulations and the definitions are not clear enough. And many doctors do think they do not have to send all the information to the central system. Let's say when they found out the person is not ill; they decide they won't say it. But according to the law, they have to say it." (Interviewee 1)*

> *"But ambulatory it is actually hard to guess the right number because there is not clear rule when the summary should be sent. Is it after every visit or is it after the patient does not come often, after 2 – 3 visits? Is the person well or do they just don't come? Ambulatory visits are not very well established as a tool where to send documents. " (Interviewee 2)*

This example well illustrates that attitude towards a system is important. If attitude is positive, then healthcare professionals will want to forward data to the system, so they will not question the accurateness of the definitions provided and will behave according to "spirit" of the law or the system and they may even try to proactively understand foggy definitions. However, if attitude is negative, healthcare professionals will not proactively try to understand foggy definitions and they may even try to search for loopholes in the definitions in order to avoid using the system. Therefore, cultivating a positive attitude towards the system positively influences usage of the system.

3) Positive attitude maximizes usage above the mandatory usage

In Estonia, while it is obligatory to "forward" medical data, it is not obligatory to read data from the system. Simon et al. suggested that the benefits will only be realized when clinicians use "higher level" functions supporting advanced clinical decision-making. (Simon, et al., 2007) So in order to realize the full benefits of the system, it is crucial that healthcare professional access patient data in the system and use them in their clinical work. Before existence of national EHR, they could only read data from their

own systems. For numerous specialists and hospital visit, that meant only accessing referral report from a GP. With the national system, it needs to become doctors' routine to check data in the system, for example measuring blood sugar for a diabetes patient. Scarborough & Zimmerer define three stages of launching new technology. They claim that first, new technology only substitutes old appliances to perform the same tasks. In the second stage, users ascertain they can do new things with the new technology. And in the third stage, they revolutionize way they worked to fully fit all the opportunities of the new technology. (Scarborough & Zimmerer, 2000)

In order to realize full benefits of the system, the users need to move into the third stage. However, this can be realized by law only with extreme difficulties (if it is even possible), as it requires changes in process and routines, which are extremely personal and difficult to track and enforce. In addition, it is the best if each and every user finds the ways the system fits their style. But for users to be willing to do so, they need to have a positive attitude towards the system.

As was shown in this section, in the mandatory healthcare systems implementation, it is not only level of usage that matters, but also the attitude. In non-mandatory usage, it may be assumed that attitude and acceptance are identical, as positive attitude translates into intention to use. However, in the case of mandatory healthcare systems, the law drives intention to use and usage, and they both differ from attitude. This implies that for mandatory healthcare settings, the distinction made between attitude, acceptance and level of use suggested in the original TAM by Davis (Davis, 1989) should be made.

By selecting this case for this master's thesis, I intended to select an extreme case – a case that would especially well described motivations and activities leading up to the high usage levels. (Flyvbjerg, 2006) However, it seems that in terms of TAM theory, I have unintentionally chosen a so-called critical case. (Flyvbjerg, 2006) If the TAM model works for this case, where the motivations may be obscured by the mandatory usage, than it might be working for all the other cases.

In the following sections, I will investigate if TAM variables appear as influencers of attitude towards the Estonian EHR.

1.14 Role of perceived usefulness in Estonian EHR implementation

In the TAM theory, perceived usefulness is one of the most important elements influencing usage and acceptance of the technology by users. In the research articles studied in theoretical part, only one study didn't find connection between perceived usefulness and usage, intention to use or attitude to using a system.

For a system to be useful, TAM theory says that it needs to enhance job performance by enabling users to accomplish their tasks more quickly, increasing productivity and effectiveness on the job and making it easier to do the job. (Davis, 1989) Several other independent variables were found to positively influence perceived usefulness. These are for example job relevance, output or information quality etc.

In the case of electronic health record in Estonia, perceived usefulness was reflected in two main topics. One of them was information availability in the system, and another theme was providing services based on the information available in the system.

1.14.1 Information availability critical for perceived usefulness

The vision and purpose of the Estonian national EHR was to facilitate an easy exchange of information about patients between healthcare providers. It is therefore no surprise that during the interviews, availability and quality of information appeared as a key theme influencing perceived usefulness of the system.

The system is only perceived useful for healthcare professionals if they think they can access information about their patients that they couldn't access otherwise, or it if they can access it easier or faster than without the system. This perception is expressed in number of search queries they perform in order to access this information. The development of search queries can be seen in the Figure 14. It is apparent that in 2009, the number of queries was extremely low and that is has increased exponentially since then until 2013.

The feeling of interviewees was that the reasons behind the low usage at the beginning and the subsequent growth was the lack of sufficient information in the system at the beginning. But the amount of information was rapidly increasing thus explaining the growth thereafter. Interviewees 1 and 4 expressed it in similar terms. Interviewee 4 said:

"So I would say that it takes off gradually. It is there, and it is big system, so the benefits are coming quite slowly. But now physicians have accepted it and the usage is growing very rapidly" (Interviewee 4)

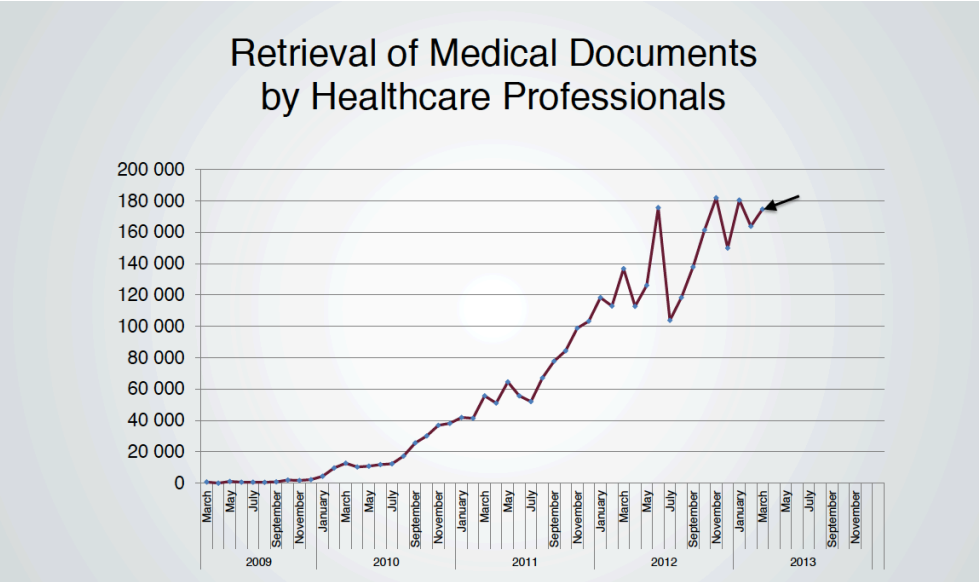

Figure 14: Development of queries to access data in EHR in Estonia between 2009-2013. Source: Artur Novek, 2013

Apart from motivating using the information in the system, interviewee 2, an IT expert from EEHF assumed that this motivates uploading information to the system as well: *"Getting information motivates also putting the information there."(Interviewee 2)*

The case shows a potential challenge in assuring usefulness of systems based on the sharing information. In order to be useful, these systems need to have large amount of information available, so that when users search for something, it is there. But there will never be enough information, if they do not start uploading the information to the system first. It becomes a vicious circle. Tension between administrators, who claim that users need to upload information first for system to become useful, and users, who require the system to be useful first before starting to use it, increases.

This tension was illustrated by interviewee 3 from the Ministry of Social Affaires:

"If you want to get something back, you have to provide something." (Interviewee 3)

This conflict can be further deepened by users attempting to input information in the easiest way possible, preferably in open text fields, on one hand, and the need of users receiving data from their colleagues in a structured, complete and correct format on the other hand. This is how the conflict is illustrated by the Estonian EHR case:

"Doctors don´t like to click too many times. It means they like to write down everything in plain text fields. But if you have all information in plain text it´s not very standardized, not very usable in order to use in other documents so we have to find balance also here." (Interviewee 3)

The interviewee 1 mentioned in her interview that to break the vicious circle (or not to even enter it), a fast roll out pushed from top down was important, because only by forcing the healthcare professionals to upload the information, they could manage to fill in the system with data as soon as possible and thus start bringing benefits to the users as well.

"It may have been too much of pressure from the governmental side. But if there are no laws, it's much harder to get that kind level of usability that we have in Estonia". (Interviewee 1)

As was mentioned earlier, this was achieved in Estonia by passing the law that made sending medical data into national EHR compulsory for all healthcare providers.

This gave Estonians opportunity to shorten and overcome the period when there were not data in the system and to force healthcare professionals to use the system anyway in order to achieve critical mass of data that eventually would make the system useful. Importance of achieving critical mass of users or critical mass of data was also mentioned by Adams et al. in their work. They considered it the key ingredients in implementation success. (Adams, Nelson, & Todd, 1992)

The fast, strong, top-down implementation also had another positive effect from the point of view of interviewee 2, EEHF employee and a medical doctor:

"At the beginning, no one knows what is going on, but later on as the knowledge is there, then the management boards [of the hospitals] will start to consider the system like a competitive solution which will somehow limit their possibilities in the existing markets.

And many countries have failed because of that. We were lucky because we built and launched the system really fast, and it was very strongly guided from the top down so there was political support to make it ready and pass the legislation to make it compulsory to send medical data to the system, which is really important." (Interviewee 7)

This quote illustrates that without the strong, top-down push, the critical mass may have never been achieved, because before it is achieved, healthcare providers realize they are loosing their power and they will increase the resistance against the system.

One of the key issues affecting perceived usefulness of the system was amount of data available. In the TAM theory, amount of data in the system is closely similar to information and output quality mentioned by several authors, such as Venkatesh & Davis (Venkatesh & Davis, 2000), Pai & Huang (Pai & Huang, 2011) or Moores. (Moores, 2012) These authors relate this variable to perceived usefulness of the system.

Pai & Huang (Pai & Huang, 2011) define information quality as the ability of a system to provide correct information. If there is no or very little information in the system, the system obviously does not have this quality. This was the case of Estonian EHR at the beginning of its existence.

Moores (Moores, 2012) defined information quality by accuracy, content, format and timeliness. This means that in order to achieve high information quality, the system must be free of the errors, provide information needed for the users to finish their work, in an easy to read format and at the time needed. In the case there is little information in the system, users perform lot of queries with zero results, which they may consider as an error of the system, and they have hard time finding information they need to finish their work.

Right after the introduction of the system, based on these definitions by Pai & Huang and Moores, Estonian EHR was not providing quality data to healthcare professionals, which resulted in the low levels of usage of the system to retrieve the data from the system. As time went by, the system became filled in with data and thus healthcare professionals started to perform more and more queries. Increasing amount of information available made the system more useful for healthcare professionals, resulting in higher usage levels.

Estonian EHR system was able to augment the number of queries to the system by increasing perceived usefulness over the time. This was achieved by increasing the amount of information available in a steady pace thanks to a fast, strong, top-down implementation approach represented mainly by legislation making the uploading the medical data into the system mandatory.

Here, the Estonian EHR case supports the importance of information quality for perceived usefulness and levels of usage of systems as indicated in the existing research by Moores, Pai & Huang and Venkatesh & Davis.

In addition, since the amount of information available had visible effects on accessing information from the system (Figure 14) by healthcare professionals, a type of usage not mandated by law, I can conclude

that perceived usefulness probably positively influenced attitude to the system, which in turn positively influenced acceptance and usage of it.

1.14.2 Improving perceived usefulness by introducing e-services

Apart from the amount of information available in the system, the interviews with administrators of the national EHR in Estonia revealed that it was also specific additional functionalities enabled by this information that improved perceived usefulness of the system. These functionalities are for example decision-making support for disability classification, and digitalization of the process to issue medical certificates for driver's licenses. The interviewees called these additional functionalities "secondary usage of EHR" or "e-services".

Interviewee 3 from the Ministry of Social Affaires seemed satisfied with the effect that introducing such additional services had on the perceived usefulness:

> *"It promotes the system well, because then people see that they can get something back. Especially for family doctors, life became much easier, because earlier they had to go through all this paper record to see, what is history of the patient." (Interviewee 3)*

These additional e-services introduced on the top of the data structure improved the relevance of the system for doctors and their daily activities. This corresponds to independent TAM variable called job relevance. It was proved by Liang et al. (Liang, Xue, & Byrd, 2003) and Ketikidis et al. (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012) in their research. Ketikidis et al. specifically concluded that the more healthcare professionals know about the applicability of the system on their daily work routines, the more likely they are to accept those systems. (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012) The two e-services mentioned as examples at the beginning of this section simplify specific tasks that healthcare professionals have to perform as part of their daily routines. Providing specific functionalities for these tasks increases the relevancy of EHR for the existing daily work of the professionals, which increases perceived usefulness of the system.

The introduction of e-services seems to be important in the case of Estonian national EHR, because Estonian national EHR is a document-based system. This means that queries about a patient returns a list of summary documents that a healthcare professional needs to read through in order to get to know the information they need. This means that primary usage to access patients' data is rather time-

consuming. Interviewee 6 from the Estonian Health Insurance Fund expressed frustration over this type of data sets:

> *"Doctors want practical information and that is a big difference. The system only gives back the doctors the documents, but the doctors want information aggregated from lot of different documents. If the system gives to the doctor lot of documents they do not have any time to read it." (Interviewee 6 from Estonian Health Insurance Fund)*

Interviewee 3 from the Ministry of Social Affaires also highlighted that sifting through all the documents and all the data is time consuming:

> *"So it depends on how much time the doctor has and how big is the problem, if the problem is very big then of course the doctor finds this time but if you have quite minor problem there is no time to dig into."(Interviewee 3)*

In the healthcare settings, speed is often crucial in treating patients and healthcare providers struggle with ever increasing expectations about number of patients seen and decreasing time needed to see one patient. Therefore, anything that takes too much time to use won't be perceived as useful by healthcare professional. In this context, the e-services made it easier to achieve positive impact of the EHR on everyday actions and goals of healthcare professionals, increasing the perceived usefulness of the system.

In the case of Estonian EHR implementation, two of the aspects highlighted in the interviews as aspects improving acceptance of the system can be tied to the TAM's perceived usefulness key variable. First one, amount of information available, can be further identified with information or output quality as defined by Ketikidis et al. (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012), Pai & Huang (Pai & Huang, 2011) and Moores. (Moores, 2012) The case describes that low information quantity at the beginning of the implementation process caused low usage levels, as the system was perceived not to provide useful information to the healthcare professionals. Second aspect, associated e-services, can be tied to job relevancy as defined by Liang et al. (Liang, Xue, & Byrd, 2003) and Ketikidis et al. (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012) In the minds of interviewees, the introduction of e-services improved perceived usefulness of the system, which in turn should influence attitude, acceptance and usage levels. These findings support general TAM claims that perceived usefulness positively influences attitude, acceptance and usage levels of healthcare IT systems did reflect in the Estonian EHR implementation case.

In the next section, I will analyze Estonian EHR implementation aspects that influenced perceived ease of use of the system.

1.15 Role of perceived ease of use in Estonian EHR implementation

Perceived ease of use is another key variable presented in TAM theory that influences the usage of the system by healthcare professionals by influencing attitude and acceptance of the system. From the studies researched for this master's thesis, only one out of eleven didn't support influence of perceived ease of use on either attitude, acceptance or level of usage.

System is perceived to be an easy one to use if the users think it will be free of effort to use it. (Holden & Karsh, 2010) More specifically, it needs to be easy to learn to operate the system and it cannot take too much effort to become skillful at using it, it needs to be easy to get it to do what the user wants and it needs to be easy to interact with the system. (Davis, 1989) Furthermore, additional supporting variables were found to influence perceived ease of use, such as support (Pai & Huang, 2011), (Moores, 2012) and (Liang, Xue, & Byrd, 2003), system quality (Liu & Ma, 2006) and (Pai & Huang, 2011) and self-efficacy (Moores, 2012) and (Wu, Wang, & Lin, 2007).

Very strong evidence of perceived ease of use playing an important role in the Estonian healthcare setting emerged in interview 3. Interviewee 3 from the Ministry of Social Affaires, when asked what she thinks makes the e-prescription system much more appreciated and used compared to EHR answered:

> *"It´s easier actually. (laughs) Because in E-prescription you just have to select the drug or the brand name and how many packages you want so for doctors it means its not so much writing or typing. But of course this central health record it´s more complicated. You have to type more, you have to have more time to look at the data etc."*

This quote suggests that Estonian healthcare professionals had a more positive attitude towards a system that is less complicated (meaning it should be easier to learn to operate it and to do it what the user wants) and faster to use (meaning it is easy to interact with it). This places perceived ease of use at the focus of this section of analytical chapter.

In Estonia, there were two basic strategies that could be classified as improving perceived ease of use. Firstly, local electronic medical records used in the hospitals and by doctors at the time of

implementation were not centrally changed. Healthcare providers did not have to exchange their existing EMR systems; instead they only had to update them in order to be able to send medical data into the national system. Existing technology was also used for logging into the system. In the TAM theory, this variable was described as compatibility.

Secondly, focus was also put on improving general computer skills, but also specific EMR and EHR skills of physicians. This corresponds to support, training and self-efficacy variables described in the TAM theory.

These two themes are analyzed and described in more detail in the following paragraphs.

1.15.1 Compatibility with existing processes and systems

Before the implementation of national EHR in Estonia, usage of computers by healthcare professionals was rather high. Data from 2007 presented by Doupi et al. suggest that 95 % of doctors were using some kind of electronic medical record before implementation of national EHR. Doupi et al. reported that 95 % of doctors stored patient diagnoses and 84 % stored medications information electronically. (Doupi, Renko, Giest, Heywood , & Dumortier, 2010) These data suggest that prior to national EHR system implementation, healthcare providers were using their own electronic patient record systems.

As a consequence, it was decided that in Estonia, EEHF was only responsible for introducing the national part of the system. It did not take care of the local systems. Healthcare providers were responsible for ensuring that their own systems worked properly together with the national system.

> *"One of the important issues or items we should recognize that we did not change the hospitals neither GPs workflows nor process by implementing central system but we just added connect the central system to existing ones." (Interviewee 4 from EEHF)*

> *"So if the local system is well developed, it is not so hard to put the information together, give it signature and send it to the central system." (Interviewee 2 from EEHF)*

This was a result of EEHF trying to make the new system as compatible as possible with the existing practices. TAM researchers such as Liang et al. (Liang, Xue, & Byrd, 2003), Tung et al. (Tung, Chang, & Chou, 2008), Wu et al. (Wu, Wang, & Lin, 2007) and Chau & Hu (Chau & Hu, 2002) identified compatibility as one of the variables influencing perceived ease of use. Compatibility variable reflects that if users think that usage of an IT will not affect their current working style, or will only require

insignificant changes, they are more open to use that IT. (Chau & Hu, 2002) Keeping existing systems positively influenced perceived ease of use as it eliminates need to learn to operate a new system.

However, in contradiction to what the aggregated data from Doupi et al. presented above and interviews 2 and 4 suggested, interviews 1 and 5 uncovered that real state of usage of IT systems in the Estonian healthcare may have not been so high. This would questions the level of compatibility achieved by not replacing existing systems.

> *"The work processes in the hospital had to be changed. There were hospitals when the coverage of the electronic documentation was higher than in the other ones. The biggest problem was that the older doctors were not used to use computers daily." (Interviewee 1 from EEHF)*

> *"But in this moment, in 2008, […] doctors documented their work in paper form and then they opened their computers and copy it manually. They called it "every day making of e-Health" and it takes lot of work from the doctors." (Interviewee 5 from EEHF)*

Apparently, there is a discrepancy between statements of different interviewees. From some interviewees, it seems that level of compatibility was not as high as there were massive changes in daily routines of healthcare professionals, as the usage of local systems was not as widely spread as could be understood from the interviews 2 and 4 and data presented above.

Introducing ID card login

In addition, there was one specific change to processes that healthcare professionals needed to submit to even if they kept using their existing local electronic patient records. As access to the national system meant access to much larger quantity of data both for a particular patient, but also for more patients, it was necessary to increase login security. Previously, healthcare professionals usually used only their own login and password to access local systems. With more data present in the system, it was decided that healthcare professionals needed to use their ID cards to login into the system. This meant that they had to carry the card with them all day long. This was not accepted happily among doctors. Interviewee 4 says:

> *"We started to used ID cards which is a pretty big change in habits and other is procedures what were implemented to really secure the access and have control who access what. This was a big issue to explain why it is needed." (Interviewee 4 from EEHF)*

The decision needed to be communicated clearly to healthcare professionals. Interviewee 4 explained that this explanation was much easier as there were all stakeholders' representatives present on the supervisory board of EEHF so they had interest to explain this issue well to their peers. The effect of having users' representatives seated on the EEHF board is further discussed in section 1.16.2 Role of EEHF in building psychological ownership on the page 61.

The example of ID cards login introduction clearly shows that if a new system is not compatible with existing procedures, it can increase negative response and attitude from the users and extra activities need to be done in order to overcome the issue.

In the following paragraphs, further problems with local systems are discussed.

Problems with local systems

It was discussed in the previous paragraphs that the intention was to keep processes unchanged after implementation of the national system by keeping local electronic patient records in place. However, further problems occurred as the local systems were not user friendly and updating them to communicate with national system proved costly for healthcare providers. In her interview, interviewee 1 from EEHF expressed that lack of control of the development of local electronic patient records hindered the usage of the system:

> *"So the biggest problem is the EEHF who is responsible for the central system couldn't give the exact recommendations to the local IT developers how to make the systems user-friendly. So today, [one of the] the main reason why the doctors are not sending the information to the central system is that their own systems are not good enough." (Interviewee 1)*

It is now visible that in this particular case, maximizing "compatibility" may have actually hindered ease of use of the system. Despite the fact it eliminated the need to actually learn how to use a new system, it kept systems that took too much effort to operate; or it wasn't easy to get them to do what the users wanted; or it was not easy to interact with them. Negative effects on perceived ease of use of maximizing compatibility may have exceeded positive effect on the perceived ease of use.

Improving processes

When EEHF realized the low ease of use of the existing systems and their connection to national system, they started to identify most crucial issues and address them. Interviewee 2 from EEHF

indicated that EEHF is right now trying to gain more influence on how the local systems are going to look like:

> *"Now we are trying to do this, putting standards how it should look like in the local system … It would be something very important I think and it would get faster acceptance actually." (Interviewee 2)*

In order to improve perceived ease of use, EEHF introduced several small developments, such as introducing electronic stamps for family doctors. Interviewee 4 from EEHF described that before introduction of electronic stamps for family doctors in 2013 probably less than 15-20 % of them were using the system. GPs complained it took too much time to send data into the national system for every single visit. In 2013, EEHF introduced an electronic stamp family doctors can use to sign a several documents at once at the end of the day. In the Figure 15, you can see how the number of documents sent by GPs to the system increased after introducing the digital stamp. This shows that making a system easier to use can significantly improve usage levels. Since in this specific example we are talking about ambulatory summaries, which as was mentioned previously, were not clearly defined in the law, and thus very difficult to enforce, this would suggest that ease of use improved attitude towards the system and its acceptance, not only the usage levels.

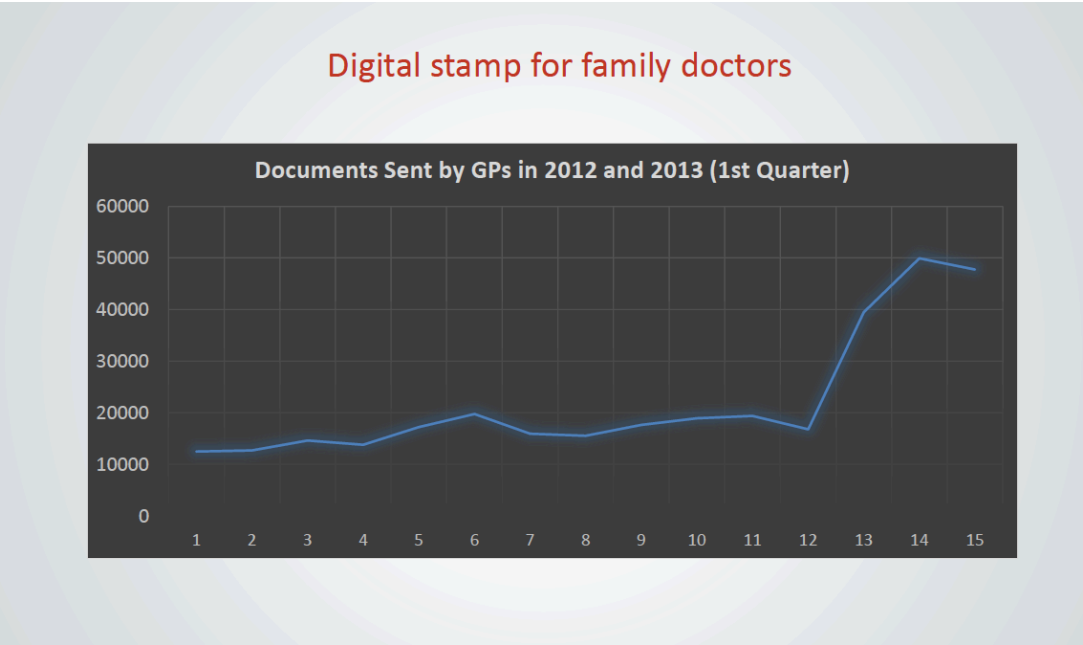

Figure 15: Development of number of documents sent by GPs before and after introduction of electronic stamp NOTE: Numbers 1-12 represent months of 2012, number 13-15 represent January, February and March of 2013. Source: Artur Novek

It seems like the original intention was to keep processes in healthcare institutions unchanged by not introducing new system they need to use locally, however unexpected changes to local process occurred anyway, delivering negative impact on perceived ease of use. This corresponds to findings from TAM theory, more particularly the importance of compatibility variable.

However, further findings showed that compatibility variable may have actually hindered perceived ease of use, as local systems were not perceived as easy to use and they were not well integrated to allow for easy updating of information into the national system.

This particular study raised the issue that compatibility on its own may not be a good predicting variable of perceived ease of use.

Perceived ease of use is not only determined by the system itself, but also by its users. More skilled users may perceive a system easier to use compared to their less skilled peers. This is discussed in the following paragraphs.

1.15.2 Effect of computer skills on perceived ease of use

TAM research shows that perceived ease of use is influenced by self-efficacy. Self-efficacy reflects "the extent to which the system user believes they have capability to use the system. " (Moores, 2012, s. 509) This can be measured by comfort, ease or confidence using the system without external help. Self-efficacy reflects both, the subjective opinion about one's skills and objective ability to actually use the system. The more skills and experience with technology people have, the more they believe they are able to operate such system. The less skills and experience they have, the less they believe they can handle the technology.

This is reflected in a quote from interview 3, where interviewee from the Ministry of Social Affaires revealed that older doctors with less computer skills had more negative attitude to the system:

> *"Doctors who are a bit older and who still don´t like to use computers, they think that it´s bullshit actually (laughs). But younger doctors who grew up with computers see it as a quite normal part of their work. If computer skills of doctor are good then he can type and orient much easier way in the system and earlier. It depends on skills." (Interviewee 3)*

Despite the data showing 100 % Estonian GPs using computers in their practices or 95 % of doctors storing diagnoses electronically (Doupi, Renko, Giest, Heywood , & Dumortier, 2010), the perception of administrators was that computer skills of doctors were not high:

> *"When we started the system, […] some doctors didn´t know anything about computers or their computer skills were quite limited" (Interviewee 3 from Ministry of Social Affaires)*

In order to improve perceived ease of use, interviewees 1, 2, 4 and 7 revealed that EEHF organized training sessions to improve computer and EHR literacy among healthcare professionals.

Interviewee 7 estimated that around 70 % of the healthcare professionals went through the trainings and interviewee 4 estimated 10-15 % of budget was allocated for this educational project. The relatively high percentage of the budget allocated would indicate that a high importance was placed on their role in the implementation process by EEHF. The trainings were voluntary and mainly family doctors went through the centrally organized trainings, as doctors working in hospitals were trained by the hospitals. (Interviewee 1) Trainings were not only in-class lessons, but also e-learning. There were 24 e-learning courses including 12 courses in Estonian and 12 in Russian because there are many Russians in Estonia. E-learning courses included guidelines and demos.

Trainings performed had several levels to fit level of knowledge of different groups. From basic computer literacy trainings, through training on secure access and privacy and what were the user rights. There were also training sessions to show how to build new documents, what standards and classification to use etc. This training structure corresponds to the suggestions of Wu et al. that the trainings need to be built to match existing levels of knowledge and it was suggested that also general computer training, not only system-specific one, improved self-efficacy. (Wu, Wang, & Lin, 2007)

The TAM research found out that trainings have an effect on perceived ease of use. Trainings are usually part of a larger variable called support, which usually includes trainings, user support and other activities aimed at helping users. Support was found important for either perceived ease of use or self-efficacy by Moores (Moores, 2012), Wu et al. (Wu, Wang, & Lin, 2007), Liang et al. (Liang, Xue, & Byrd, 2003) and Pai & Huang (Pai & Huang, 2011). The trainings have the power to improve both, the objective ability and the subjective idea about ones ability to operate a technology, both important for usage of the system.

Personal innovativeness

In addition to personal computer self-efficacy, TAM theory also defines personal innovativeness to have an effect on acceptance of the technology. Personal innovativeness is defined as "the willingness of an individual to try out any information technology." It is also considered to be relatively stable across time and environment. (Liang, Xue, & Byrd, 2003) It is assumed that personal innovativeness has a strong relationship with computer self-efficacy, which is defined as the judgment of ones capability to use an IT, which determines individuals' IT using behavior. It is assumed trainings cannot change personal innovativeness in short term.

This would be confirmed by interviewee 1 from EEHF who considered personal innovativeness to be embedded in the national culture:

> *"Estonians are pretty innovative and they are not scare of failing (…) and I think that was also one of the reasons for success of the system." (Interviewee 1)*

Altogether, the interviews indicated that self-efficacy and personal innovativeness played role in perceived ease of use of the system. While computer usage numbers and general opinion about Estonian nature would suggest self-efficacy and personal innovativeness were rather high, EEHF decided to devote significant time to provide trainings to make sure that the healthcare professionals have the skills they need to use the system, but also that their computer self-efficacy increases. These factors would have positively influence perceived ease of use of the system, improving attitude, acceptance and usage levels.

Perceived ease of use played a role in implementation of Estonian EHR system. EEHF attempted to keep ease of use as high as possible by not changing local electronic patient records (EPR). This corresponds to compatibility variable mentioned in several TAM extensions. However, further information showed that the existing EPRs features and design and their integration to the system, as well as unexpected changes to the system, such as need to use ID cards to login, hindered the ease of use of the system.

Significant effort was devoted to train healthcare professionals to be able to use the system. This was done to make sure that healthcare professionals have the skills they need to operate the system and to

create and search for documents in it. However, the TAM theory also shows trainings improve personal computer self-efficacy, which improved perceived ease of use by the individuals.

In the next section, I am going to describe process organization aimed at building psychological ownership of the system among healthcare professionals. This was highlighted as another important aspect leading up to positive attitude, acceptance and high levels of usage of the system by healthcare professionals.

1.16 Role of psychological ownership in Estonian EHR implementation

The last element that emerged strongly from the interviews is psychological ownership. From the studies researched for this thesis, only Paré et al. (Paré, Sicotte, & Jacques, 2006) mentioned psychological ownership as an important variable in the TAM. That is why psychological ownership wasn't further dealt with in the theoretical chapter, as it was assumed that primarily variables mentioned repeatedly by researches would play an important role in the Estonian EHR. However, in different ways, importance of psychological ownership and activities leading to build the ownership among the interested parties was mentioned in most of the interviews.

Paré et al. defined psychological ownership as a state of the mind in which individuals feel as though the target of ownership or a piece of it is "theirs". (Paré, Sicotte, & Jacques, 2006) In their research, Paré et al. found out that support exists for the fact that psychological ownership leads to positive or negative orientation towards change. The individuals will promote changes that they feel ownership towards. Finally, they proposed and confirmed that user participation had significant and positive effect on psychological ownership, as well as communication and overall responsibility. (Paré, Sicotte, & Jacques, 2006) In their research, they confirmed that psychological ownership positively influencers both, perceived ease of use and perceived usefulness.

In Estonian EHR implementation case, user participation played an important role in the whole process. This was in one or another form highlighted by all the interviewees. For example, when asked what were the specific strategies and activities that EEHF used to get healthcare providers on board to use the system, interviewee 1 from EEHF started describing the process of making a vision of EHR. She described that the Ministry of Social Affaires created a work group of approximately 100 members including different stakeholders that met several times and talked about how the system should look like

and how it should work. In this way, she was highlighting the process of involving all the different stakeholders into the process in order to build their ownership towards the system's vision.

Another example was mentioned in interview 4, where the interviewee, MD and a board member himself, highlighted that the fact that most of the stakeholders were seated on the EEHF's board helped overcome resistance towards the system. This was also highlighted as important by interviewee 3 from Ministry of Social Affaires:

> *"And of course EEHF has itself a board, supervisory board. And this supervisory board consists of representatives of different interest groups - from ministry, from health insurance fund, from hospitals, from family doctors, from ambulance - so all these stakeholders can see that their interests are represented and of course sometimes if there is something they don´t like, they can protest as well (laughs)." (Interviewee 3)*

Interviewee 3 further explained that recently, EEHF created "Medical Advisory Committee"[1] in which around 20 doctors discuss how to improve the system, what kind of features they would like to see etc. She said: *"This is now very well perceived that we have moved this way forward."*

In addition, interviewee 7 mentioned that an important change towards perception of the system occurred when a person with MD title was appointed CEO of EEHF in 2007:

> *"The first thing – most of the doctors don't want to listen to IT guys to tell them how to change their working processes." (Interviewee 7)*

All of the above mentioned are different ways EEHF and the Ministry of Social Affaires tried to involved users in the implementation process. They did so because they believed it was important for long-term success of the system:

> *"Because maybe alone you can move much quicker than with anybody but if you have to be successful in longer time then you have to involve everybody." (Interviewee 3 from Ministry of Social Affaires)*

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[1] Medical Advisory Board was created in 2012 by EEHF and it is created by 17 doctors-experts. The objective of the Advisory Committee is to advise the Foundation and to give evaluations from the medical aspect, mediating the proposals of treatment institutions for the development of the health information system. (Estonian e-Health Foundation, 2012)

All of these examples clearly illustrate the notion of user participation, which leads to psychological ownership of the system, which in turn supports both, perceived ease of use and perceived usefulness.

In the following paragraphs, I am going to go in depth describing different strategies used to increase user participation in the Estonian EHR, as well as some of the challenges that appeared.

1.16.1 Involving healthcare professionals

While there are more users to the EHR system, it is the healthcare professionals that are the most important ones to involve in the process to build their psychological ownership.

Interviewee 3 from the Ministry of Social Affaires admitted that at the beginning, doctors were not involved much, however as time went on, EEHF realized they needed to involve them. But also doctors themselves became more interested in the system and their IT skills became more advanced so they could have had valuable input for the process. Interviewee 3 from the Ministry of Social Affaires said:

> *"Doctors are always so overwhelmed [by work], so they don´t find time to think about something which is five ten years away. And if we think about ourselves ten year back, we were very much paper based, and you think that if you make paper based things computer based it´s the best solution." (Interviewee 3)*

As this quote implies, finding healthcare professionals that would like to be involved in the implementation process and had the right skills to be able to do so was difficult at the beginning.

Another challenge in involving users in Estonia might have been to actually involve all the users – it is virtually impossible to involve every single doctor in such a process. In Estonia, the decision was taken that different healthcare professionals' organization will find and nominate pioneers that will represent the specialty or the organization in the process. It was convenient as interviewee 7 from EEHF noted:

> *"It was convenient for us. When the organizations' representatives accepted something, then if something went wrong and healthcare professionals were complaining, we just could say: 'Your umbrella organization has accepted it after internal discussion and they agreed'" (Interviewee 7)*

The agreements on different issues were searched for using mainly discussions and searching for a compromise. Interviewee 7, a medical doctor and an important player in EEHF, confirms the importance of these discussions to gain acceptance of the system:

"We had lot of round table discussions. Firstly, inside every specialty and then all specialties together. This was very crucial process making this acceptance and we found pioneers in each field of healthcare who were ready to join this kind of discussion and they were like advocates inside their own specialty." (Interviewee 7)

When negotiating different agreements, for example definitions of ambulatory case studies, there were several rounds of discussions as described by interviewee 3 from the Ministry of Social Affaires. Firstly, the representatives of each relevant professional group met and discussed the specific topic. Then EEHF created consolidated document based on their discussion arguments and sent the document to each of them for approval. Afterwards, representatives discussed the issue with their peers and sent their comments. Based on their comments, EEHF created new version of the document and called for another meeting. This process was repeated several times until everyone was satisfied with the final version of the document. This process could take quite a long time. Interviewee 3 noted:

"As people are doing it besides their regular job, people are quite occupied with other activities, we can´t set very short and very strict deadlines." (Interviewee 3)

It is therefore visible that ensuring user participation in the implementation process was not an easy task, and that it can prolong the whole process. However, it was a necessary task to do in order to achieve psychological ownership of the system by Estonian doctors.

1.16.2 Role of EEHF in building psychological ownership

Interviewees 1 and 4 highlighted that EEHF played an important role in involving users in the decision-making and implementation process. Most of the stakeholders of the EHR were seated on the supervisory board of the organization, which made them one of those making decisions about EHR design, rules and implementation process. At the same time, being part of the EEHF made them accountable for the organization's goals. And since one of the goals was implementation of the EHR system, they were accountable for it. At the same time, they were still doctors, hospital directors and members of doctors' unions and professional organizations' leaders, so they were accountable to the healthcare professionals as well and these healthcare professionals were respecting them, because they were 'one of them'. This combination gave those seated on the EEHF board responsibility to search for solutions and compromise, rather then to search for what's wrong with the system, and to communicate these decisions positively towards their peers. Interviewee 4 described it this way:

> *"So we in the board where I was sitting, we were fighting extensively … but we had to agree because it was our organization as well and we couldn't not to make the decision, we had to find the compromise. And once we agreed, then the execution process was very straightforward."(Interviewee 4)*

However, interviewee 5 who was also sitting on the EEHF supervisory board on behalf of one of the healthcare organizations disagreed and when asked if EEHF did anything to make hospitals and clinicians happier about the national system, he replied:

> *"No, let's say the main message was that you have to send these messages or we cancel your certificate or license to act as medical institution." (Interviewee 5)*

This quote implies that, despite all of the afore mentioned activities, there might still have been some healthcare professionals that didn't feel involved enough in the process to own the project, despite the fact they were sitting on the EEHF board.

The quote may also indicate that conditions such as making the system mandatory by law may negatively influence psychological ownership of the system among the users, as they may feel it is forced to use the system from the top. In addition, another condition negatively influencing psychological ownership may be the strict implementation timeline that may not leave sufficient time to overcome controversial issues and agree on a compromise. Here, we find a clash between positively influencing levels of usage by the mandatory usage provision and psychological ownership.

The second reason why the decision to establish EEHF was evaluated positively in the interviews was that the organization had clean start. That was explained by interviewee 6 from Estonian Health Insurance Fund:

> *"Decision the Minister of social affaires took (to establish EEHF, rather then charging Estonian Health Insurance Fund with the task) was made because ten years ago, our organization did not have very good relations with hospitals and doctors. We would like to tell them exactly, you have to do that and you have to go there, we would not negotiate. We were too tough for that and the Ministry and hospitals have discussed that they need a little bit softer organization who can make cooperation with the hospitals to make all this work."*

This would have positive impact on psychological ownership as well, at least in comparison with charging Estonian Health Insurance Fund with the implementation process. Healthcare professionals

would be more likely to accept the system from an organization with a clean record, rather than from an organization they have negative experience with, and that they feel is too pushy.

In Estonia, establishing EEHF had a positive effect on psychological ownership of the system, which in turn positively influenced perceived usefulness and perceived ease of use, which in turn positively influence attitude, acceptance and usage level.

Despite the fact that the Estonian EHR system was enforced by law, it is possible that psychological ownership building activities played an important role in its acceptance. In other words, even though the users were not able to decide if they could use the system or not, they could help shape the systems user interface/functionality etc. leading to a greater level of acceptance.

In the voluntary systems, users can 'evaluate' perceived ease of use and perceived usefulness by either using or not using the system, so the administrators and developers can observe usage levels and determine if they are going the right direction or not. In the mandatory systems, this 'feedback' is missing, as no matter what, usage levels should be almost 100 %. Therefore, if the administrators want to make sure their system as accepted, they need put extra focus on involving the users in the decision making and evaluation processes.

1.17 Summary: Elements influencing high attitude, acceptance or usage levels of Estonian national EHR

In this chapter, I have analyzed information gathered by interviews to identify key elements that led to high usage levels of the national EHR in Estonia and explain their importance using TAM research. I found out that enforcing the system by law was one of the key elements behind the high usage levels. However, activities increasing perceived usefulness and perceived ease of use also appeared across the interviews as important elements that enabled high usage levels. Lastly, activities building psychological ownership formed another important group identified by interviewees as increasing usage of EHR. The conclusions are in more detail summarized in the following chapter.

CONCLUSIONS

The case of Estonian EHR was selected to be studied in this master's thesis based on numbers showing high usage of the system by healthcare professionals. The assumption was that if the usage numbers are so high, and they were achieved over such a short period of time, the whole process of implementation must have been very smooth and thus represents a best-case practice of national EHR implementation. Subsequently, Technology Acceptance Model was selected as an analytical tool to uncover and explain different elements contributing to high usage numbers.

However, during the analysis, it became apparent that while the usage numbers are high, the attitude towards the system is not as positive as one would expect from such a high usage numbers. There were many opinion differences and problems registered and described in the interviews. It also came to light that the e-prescription system implemented in Estonia a year after EHR is much more popular and accepted by the healthcare professionals and public compared to the EHR system.

This case study indicates that for analytical purposes, distinction should be kept between attitude, intention to use (acceptance) and usage level of the system. This difference has been theorized in the original TAM model proposes by Davis in 1989, however, one or more of these dependent variables were later left out in TAM extensions, such as in TAM2 (Venkatesh & Davis, 2000), by Pai & Huang (Pai & Huang, 2011), Tung et al. (Tung, Chang, & Chou, 2008) or Liang et al. (Liang, Xue, & Byrd, 2003). It has been shown that while intention to use and usage levels were caused by the law that said it was mandatory to use the system, the effect of the law on the attitude towards the system was rather negative. Several TAM variables were identified in this case to influence attitude towards the system positively.

It was shown that positive attitude is an important condition for long term success of public systems, as it allows for continuous political support, limits trials to avoid using system through loop holes in the law, and supports usage of the system beyond mandatory usage, which may be important in order to realize full benefits of the system.

The findings of this thesis suggest that building a positive attitude may play an important role in implementation of publicly funded, mandatory systems.

Next, elements increasing positive attitude towards the Estonian EHR were studied. They were identified to be perceived usefulness, perceived ease of use and psychological ownership of the system.

Perceived usefulness

In the case of Estonian EHR, perceived usefulness was largely dependent on the amount of information available in the system. At the beginning, the amount of information available in the system was low, and so was the usage of the system to retrieve the documents. As the amount of information in the system grew, so did the usage for retrieval of documents, which reflected increased perceived usefulness of the system. At the beginning, the growth of the information available in the system was enabled by the law mandating forwarding medical data to the system.

Here, the Estonian EHR case provides support for importance of information quality for perceived usefulness and arguably also attitude towards the system, as the increasing amount of information increased type of usage not mandated by law. This example shows how perceived usefulness influences usage of the system as well as attitude towards the system.

Another important factor increasing perceived usefulness defined in the analysis was introduction of so called "secondary usage of EHR" or "e-services". This concept corresponds to independent TAM variable called job relevance identified by Liang et al. (Liang, Xue, & Byrd, 2003) and Ketikidis et al. (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012) in their research.

The two e-services mentioned as examples in the analytical chapter simplify specific tasks that healthcare professionals have to perform as part of their daily routines. Providing specific functionalities for these tasks makes relevancy of EHR higher for existing daily work of the healthcare professionals, which increases perceived usefulness of the system. It should then further influence positive attitude towards the system and increase usage levels as well.

This case supports perceived usefulness to have impact on attitude, and consequently, acceptance and usage levels in the Estonian EHR case. Furthermore, output/information quality was found to be related to the perceived usefulness of this system, which is designed to facilitate exchange of information between users. Another variable related to perceived usefulness identified in this case was job relevance.

Perceived ease of use

In Estonia, there were two basic activities designed to support perceived ease of use of the system. First, at the beginning, in order to maximize compatibility with existing processes, it was decided that healthcare providers should keep their existing electronic patient records and only update them to be

able to send medical data to the national system. Compatibility is one of the variables defined in the existing TAM research to have positive effect on perceived ease of use.

However, in this case, several complications appeared. It was the fact that as the security had to be increased to protect patient data, the way healthcare professionals login into the system had to change, which was not compatible with the existing process. Furthermore, it also appeared that existing systems were not as common as described, they were not easy to use or they were not updated to connect to the national system in an ease-to-use way. Consequently, this potentially hindered perceived ease of use of the Estonian EHR. As a result, EEHF had to become more active and apply corrective actions to improve perceived ease of use of the locally used systems.

Secondly, general computer skills and specific EHR skills seemed to play an important role in the perceived ease of use of the system. Healthcare professionals with limited skills were not in favor of the system, so EEHF designed an extensive training project to increase both, general computer and specific EHR skills of all healthcare professionals. This supports the TAM statements that self-efficacy and training are important variables related to perceived ease of use.

In this thesis, I found out that perceived ease of use played a role in influencing the attitude towards the system; and usage of the system. The case also shows that compatibility might be difficult to achieve when introducing a new system, and that it does not have to necessarily have positive effect on perceived ease of use. Furthermore, this case shows that perceived ease of use may not only be dependent on system features, but also the users' IT skills, which reflect in IT self-efficacy, and can be improved by trainings.

Psychological ownership

Third element emerging strongly from the interviews to influence attitude towards the Estonian EHR was psychological ownership of the system as defined by Paré et al. (Paré, Sicotte, & Jacques, 2006) In fact, only Paré et al. found support for this variable to have influence on perceived usefulness and perceived ease of use and consequently on attitude towards a system and its usage. However, the Estonian EHR case provided rather frequent reference to strategies and activities leading to increasing psychological ownership of the system by the users - healthcare professionals.

It might be possible that focusing on psychological ownership is especially important in cases where systems are enforced by law (or similar institution). Mandatory usage as such decreases psychological ownership of the system by users, as users might feel the system usage is pushed upon them, creating

perception “them – administrators” vs. “us – users”, where the system is “theirs”, not “ours”. In this thesis, numerous ways of involving users into the designing, decision making, implementing, promoting and improving the system were illustrated. Users’ involvement in the process is found to be one of the key building blocks of psychological ownership. In addition, it was proposed that in case of mandatory systems, users’ involvement is crucial to receiving feedback on the system, as the feedback cannot be derived from usage.

In this thesis, it was discovered that psychological ownership played an important role in building positive attitude toward the Estonian EHR system. It was also proposed that ownership-building activities might be specifically important in cases where the system’s usage is mandated by law.

DISCUSSION

In this chapter, I am going to outline possible theoretical and practical contributions of this master's thesis, as well as indicate limitations to keep in mind and suggest possible directions for further research.

Theoretical contributions

In the theoretical chapter, eleven academic articles were studied to identify most common Technology Acceptance Model variables supported by research in the healthcare field. They are summarized in the Figure 13 on the page 24.

This thesis shows that Technology Acceptance Model may be a relevant model for acceptance of a mandatory technology in public healthcare settings, as long as attitude is kept in the equation. This thesis also showed that in the case of such systems, attitude is an important variable that needs to be considered in order to achieve long term success of the system. This presents contrasts to tendency of other TAM extension researchers to abandon concept of attitude from their models.

In addition, the thesis supports importance of perceived usefulness and perceived ease of use in TAM. The thesis highlights information or output quality as an important variable influencing perceived usefulness. This is probably caused by the fact the system is aimed at exchanging information between users. Furthermore, in this particular case, job relevance emerged as an important variable for perceived usefulness; self-efficacy and trainings played an important role for perceived ease of use; and compatibility was attempted to keep perceived ease of use high. However, compatibility was not entirely preserved as certain changes had to be made to achieve security of the system. Even where the compatibility was preserved, it had controversial effects on perceived ease of use as the preexisting systems were not perceived as easy to use.

Psychological ownership emerged as the third important variable playing role in the Estonian EHR implementation. The thesis proposes that it is to counteract negative effects of mandatory usage that makes the psychological ownership activities important in this case.

Overall, based on both theoretical research and the case analysis, it seems that the original Technology Acceptance Model proposed by Davis in 1989 that included only perceived ease of use and perceived usefulness as independent variable is valid even for mandatory public systems. However, it seems like it

is not possible to define a fixed set of variables supporting either perceived ease of use, or perceived usefulness, or being on the same level as perceived usefulness and perceived ease of use in order to achieve more accuracy of the model. The additional variables seem to differ greatly from case to case. In the eleven studies research in the theoretical chapter, I found thirteen different supporting variables, each re-appearing in max 4 studies.

However, it might be possible to define the sets of supporting variables for different types of the systems being introduced in healthcare (national vs. local, mandatory vs. voluntary, information based vs. function based etc.). After such classification, the struggle registered throughout the existing TAM research to "refine" the model might be more successful in finding common denominators for specific types of systems.

Practical implications

The findings presented throughout the analytical chapter might be an inspiration for countries (or regional organizations such as EU) when creating EHR implementation strategies. Such usage is proposed also by Van Shaik et al. (Van Schaik, Bettany-Saltikov, & Warren, 2002) or Adams et al. (Adams, Nelson, & Todd, 1992)

It was not aim of this thesis to provide practical implications, so I will only present couple of examples here:

1. Lack of information in the system at the beginning is key turn off for the healthcare professional. It needs to be addressed in the plan.
2. For fast implementation, political support across political spectrum is necessary for success and should be translated into mandatory usage of the system anchored in the law.
3. Despite the mandatory usage provisions, administrators and politicians must strive to build psychological ownership of the system by healthcare providers.
4. It seems to be a good idea to establish an independent organization charged with implementing and administering the system. It gives the organization needed focus and clean start.
5. It seems to be important to make key stakeholders parts of this organization.
6. The process needs to be driven by people trained in medicine in order to gain respect of other healthcare professionals, to be able to talk to them in their own language and to understand the process that they go through daily.

7. In case of obsolete electronic patient record systems used locally, it might be better to design new, user-friendly system for the healthcare professionals to interact with the national platform rather than insist on keeping the old system hoping to leverage compatibility variable.

Limitations

Most critical limitations of this thesis were time limits imposed on Master's thesis project and relative lack of knowledge of the author about the case before departing on the thesis journey.

Time limit imposed led to focusing on the point of view of administrators. Despite the fact that I believe that they are the ones to have an overview about the whole process, their answers may be biased by the fact they are the ones responsible for the system. Conducting interviews with users might uncover more controversies and acceptance elements.

Before the project started, I had only limited knowledge of the Estonian EHR gained from a conference speech and couple of additional articles. This brought about complications such as relatively large portion of interview time spent on the system description and understanding, continuous development of research scope, as well as the fact that TAM model was selected as the analytical framework before it was revealed the system usage was mandatory. Fortunately, deeper analysis showed that TAM is relevant also for mandatory systems; however, this was something that could have potentially had serious effects on the whole project. However, this ignorance also brought about positive aspects, such as bird view on the case and ability to analyze the interviews without having preconceptions.

Further research

As was suggested before, further research might include deeper dive into Estonian case to discover views of users on the elements that motivated them to use the system.

From theoretical perspective, further research might also study other similar systems (public, national, mandatory, information focused systems) to determine if the variables that were highlighted in this case correspond. In such a case case an extended TAM model for this type of system might be built.

TABLE OF FIGURES

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