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Designing a User Interface for a Public Transportation On-Board Self-Service Ticketing System

Master Thesis

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Tallinn
May 2013

Author’s declaration

I declare that, apart from work whose authors are clearly acknowledged, this document is the result of my own and original work.

This thesis has not and is not being submitted for any other comparable academic award.

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Abstract

This thesis studies the possibility of creating an effective solution to be used in Estonian mass-transit on-board ticket-sales interface solutions in terms of the speed of usage processes and the ease of use, while also focusing on the demands for the interface based on the theories of user accessibility and usability principles.

The work aims at creating a suitable self-service on-board ticketing system for a mass-transit public transportation company in the case of an Estonian company Elektriraudtee Ltd. Case studies of 5 different on-board self-service ticketing systems around the Baltic Sea region were carried through in that aim. The case studies are supported by expert interviews carried through with expert from Tallinn's self-service on-board ticketing system developer and from Elektriraudtee.

The purpose of the study is to give analytically constructed criteria for a public transportation company (in this case Elektriraudtee Ltd.) for the user interface and service design (usage logic) for one's on-board ticketing system.

As a result of the thesis, a list of demands for Elektriraudtee' self-service on-board ticketing system was proposed. These were based on expert interviews, case studies of 5 different on-board self-service ticketing systems and academic reviews.

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Chapter 1. Introduction

Estonian public transportation sector is currently going through a period of extensive investments - whether it is in the field of rolling stock (new trains[1], new trams[2], new buses[3]) or infrastructure (railway renovations[4], tramway renovation[5]), the Government and the European Union are seeing great effort to bring more people to public transport in Estonia.

As the investments made in the sector are unprecedented (23 million euros for bus procurements[6], about 280 million euros for train procurements[7] etc.), a leap of quality and quantity of travels made is expected in return from the public transportation sector in Estonia.

As the author of the thesis is an employee of Elektriraudtee Ltd (the company active in the business sector into which the largest amounts of public transportation related investments are made by the government), responsible for sales and marketing in the company, than the author wished to apply the knowledge gained from the master studies in Tallinn University to

[1] ERR News. (December 13, 2012) Uued rongid võivad muutuda Eesti ühistranspordi selgrooks. http://uudised.err.ee/index.php?06268130
[2] E24 News (November 6, 2012) Tallinna uute trammide suurhanke võitis Hispaania firma CAF http://www.e24.ee/1031136/tallinna-uute-trammide-suurhanke-voitis-hispaania-firma-caf/
[3] Postimees News (January 31, 2013) Homsest sõidavad Harjumaal uued bussid http://www.tallinnapostimees.ee/1122596/homsest-soidavad-harjumaal-uued-bussid/
[4] Estonian Railways Ltd, Raudtee rekonstrueerimine Rail Baltic trassil (Tallinn-Tartu lõik), Retreaved March 2013, http://www.evr.ee/?id=31298
[5] Environmental Investment Centre, Kik toetab tallinna trammiliikluse arendamist ligi 19 miljoni euroga, Reatreaved March 2013, http://www.kik.ee/et/uudised/kik-toetab-tallinna-trammiliikluse-arendamist-ligi-19-miljoni-euroga
[6] Estonian Goverment, Valitsus investeerib kasutamata heitkoguse müügitulu tuuleenergeetika ja ühistranspordi arendamisse, Retreaved March 2013, http://valitsus.ee/et/uudised/istungid/otse-valitsuse-istungilt/7040
[7] Estonian Logistic News (August 4, 2010) Eesti ostab enam kui nelja miljardi eest uusi ronge http://logistikauudised.net/Default.aspx?PublicationId=62e62ecd-652f-4c1f-a4f5-621f1cf0e5d6

support the leap of quality and quantity in the field of sales at Estonian passenger railway business. A self-service on-board ticketing system definitely is a mayor development in such a field, reducing ticket sales costs (self-service) and generating a stream of passage-related information to be used to further develop the public transportation network[8] (lines, schedules, transfers, departure volumes etc.).

Chapter 2 gives an insight to Estonian public transportation sector. Chapter 3 focuses on the users of public transportation, discussing about the reasons behind self-service usage and the demands for such systems' interfaces by the users. Chapter 4 further extends the interface design, describing the requirements set by the Estonian public transportation companies for on-board self-service ticketing systems. Also the chapter concludes the case studies of five different self-service ticketing solutions used around the Baltic Sea area. Chapter 5 outlines the possible solution for a self-service on-board ticketing system for Elektriraudtee Ltd. The solution is based on the expert interviews, informed by the knowledge gained from the case studies and academic input. Finally the study is concluded with the overview and proposed solution for use by Elektriraudtee Ltd in its procurable self-service ticketing system.

1 Purpose of the Study

The purpose of this study is to give analytically constructed criteria for a public transportation company (in this case Elektriraudtee Ltd.) for the user interface and service design (usage logic) for one's on-board ticketing system. Service design or usage logic here is meant in a way, how to interface works – what actions can be done with it and how the customer reaches those actions using the interface.

The author developed the criteria based on the academic research on the field of user interfaces for human-computer interaction; and on the expert-interviews taken with the persons in charge of developing and implementing ticket-sales solutions in Estonia's public transportation field.

1.1 Author's relationship with the case

The author of this thesis has worked in the field of public transportation for more than three years in Estonia. Currently the author holds the head of sales and marketing position in

[8] Tallinn City News (December 22, 2011) Tallinn sõlmis hankelepingu integreeritud piletimüügisüsteemi loomiseks
http://www.tallinn.ee/est/Tallinn-solmis-hankelepingu-integreeritud-piletimuugisusteemi-loomiseks

Elektriraudtee Ltd and is co-preparing the company for a country-wide market overtake starting 1st of January 2014.[9]

Elektriraudtee Ltd sees that with the rise of departures in the electrified lines in Harju County and the overall decrease of trip times due to better train fleet taken into use, the nature of trips made in the trains would be more of metro or inner-city type. This means that the trips made by passengers are so frequent and with short durance, that the current model of ticket sales via an on-board personnel (a ticket conductor) is not viable in the long term.

A fully automatic on-board ticketing system is more suitable for the trips described before; as such solutions are used in near cities around Estonia[10].

This system has nevertheless fit the current sales service design used by the company and has to take account the behaviour peculiarities of Estonian train travellers, while excess in terms of usability and accessibility.

2 Research Questions

The study focuses on the following research questions:

1. What would be an effective solution to be used in an Estonian mass-transit on-board ticket-sales interface solutions in terms of the speed of usage processes and the ease of use;
2. What are the demands for the interface based on the theories of user accessibility and usability principles;

3 Research Methodology

The literature review was chosen as a method for the need of using already existing principles and common understanding of creating user interfaces for human-computer interaction. The author sees that a lot of user interface development is currently being done in Estonia by many in this field (recent procurement in Tallinn[11] and in Tartu county[12], new talks of ticket

[9] Estonian Goverment, Uusi ronge hakkab esialgu opereerima Elektriraudtee, Retreaved March 2013, http://valitsus.ee/et/valitsus/64852/uusi-ronge-hakkab-esialgu-opereerima-elektriraudtee
[10] Helsinki (see Chapter 4 section 3.2), Amsterdam (see Chapter 4 section 3.4)
[11] Estonian Express News (August 14, 2012) Saage tuttavaks: Tallinna uus piletisüsteem http://www.ekspress.ee/news/paevauudised/eestiuudised/saage-tuttavaks-tallinna-uus-piletisusteem.d?id=64822546
[12] Tartu County, Uus piletimüügisüsteem läheb peagi käiku, Retreaved March 2013, http://www.tartumv.ee/?op=body&id=7&prn=1&art=473&cid=

sales systems procurement to Tartu city[13]) and it is good to use the already-gained experience from nearby cities of Northern Europe. This method will give instructions - in amongst other things – for example creating interfaces usable by clients with disabilities regarding sight or hearing.

Expert interview as a method was chosen for collecting specific information regarding the public transportation and its peculiarities in Estonia. As the information gained will be based on the Estonian expertise, the sample for the interviewees was constructed based on project leaders of the mayor modern, smart-card based ticketing systems existing in Estonia.

Kristjan Konks, CEO of United Tickets Ltd. and the head of developers behind Tallinn's ticketing system, was chosen as an expert because United Tickets as a company is the current operator of the biggest public transportation ticketing systems of Estonia (for example Tallinn's and Tartu's). Recent developments in the company have broaden the line of customers of United Tickets Ltd, as there was a merger between them and the Estonia's second largest public transportation ticketing systems developer WebPartner Ltd[14]. This has resulted in United Tickets Ltd becoming a company who operates mayor ticketing systems present in Estonian public transportation network.

Tõnis Tiitsaar, IT-specialist of Elektriraudtee Ltd and the head of Elektriraudtee' new ticketing system, was chosen as an expert because he is responsible for creating a documentation and leading the project for the procurement of an on-board self-service ticketing system for Elektriraudtee Ltd..

Expert interviews will help the author broaden the scope from the needs of Elektriraudtee Ltd to the needs of most of Estonian public transportation companies, while also giving input of the already existing experience regarding the creation and usage of a self-service-like on-board ticket validating systems. Interviews were carried through using a semi-structured questionnaire. (Appendix 1.1)

Case study, supported by qualitative user interviews, as a method was chosen for collecting specific information regarding the already existing on-board self-service ticketing systems in or around Estonia. The addition of expert user interviews will give a more detailed insight from the user's point of view regarding the usage of already existing ticketing systems, while

[13] ERR News (August 21, 2012) Tartu üritab bussiliiklust reisijaile mugavamaks muuta http://uudised.err.ee/index.php?06259574
[14] Postimees News (April 18, 2013) Ühendatud Piletid AS ja WebPartner OÜ viisid läbi aktsiatevahetuse http://uudisvoog.postimees.ee/?DATE=20130422&ID=309465

the method of case study will help to find and describe with detail the already existing solutions in Northern Europe in on-board self-service ticketing systems.

The result of this academic research will also be a usable input for a possible experiment carried through by Elektriraudtee Ltd – this will manifest itself in a way where the author will create in conjoint with Elektriraudtee Ltd the prototype ticket validating system in a particular train and will observe the use of it by a test group. This of course depends whether Elektriraudtee Ltd decides to carry through procurement for a new on-board ticketing solutions. Later on the company can further develop the system by the commentary and proposals based on the observation.

Chapter 2. Estonian Public Transport Systems

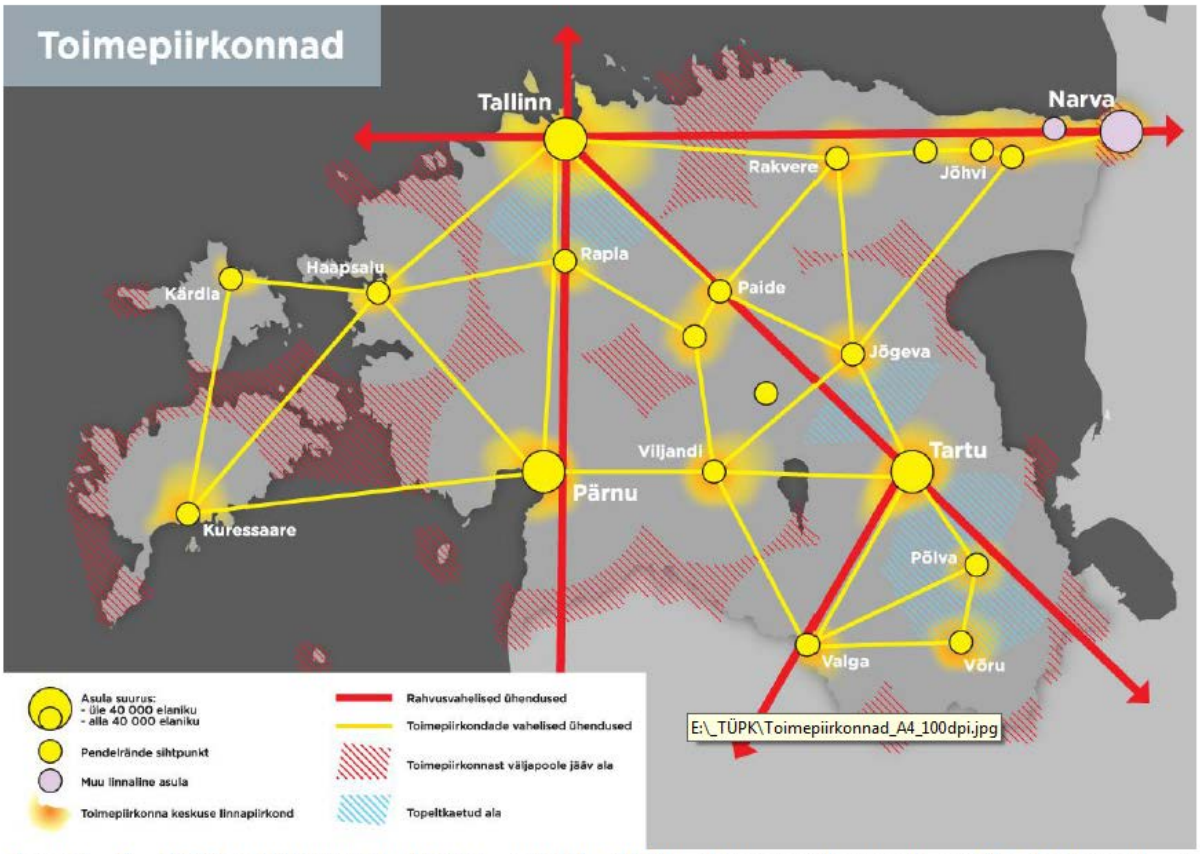
1 Introduction

This chapter gives an overview of the Estonian Public Transportation sector. As one of the results of this study is to generate a list of requirements for an Estonian mass-transit ticketing system, the chapter gives an overview of Estonian mass-transit companies – mayor market shareholders and the volume of passages made. The focus was put to regional and lower-regional inland mass-transit system, as the ticketing system under research will be aimed towards companies active on these markets.

2 Overview of the Sector

Estonia has according to Estonian transport development program nine city-like areas: Tallinn, Tartu, Pärnu, Kuressaare, Viljandi, Jõhvi, Võru, Haapsalu and Paide. These areas are complemented by regional centres like Kärdla, Rapla, Türi, Jõgeva, Sillamäe, Kohtla-Järve, Põltsamaa, Valga and Põlva. (Eesti Vabariigi Siseministeerium, 2012) (Eesti Vabariigi Majandus- ja kommunikatsiooniministeerium, 2010)

These areas are served by a 5-level public transportation system, which consists of the international (Tallinn), national (the latter plus Tartu, Pärnu, Narva), regional (the latter plus Kuressaare, Viljandi, Võru, Valga, Paide, Haapsalu, Rakvere, Jõhvi), lower-regional (the latter plus Kärdla, Paldiski, Keila, Rapla, Türi, Põlva, Jõgeva, Sillamäe, Kunda, Virtsu, Heltermaa) and the local (all other) public transportation centres. (Eesti Vabariigi Majandus- ja kommunikatsiooniministeerium, 2010)



Joonis 5. Toimepiirkonnad Eestis aastal 2030. *Toimepiirkonnad, mille keskused on praegustes maakonnalinnades, suurenevad tulevikus mõnevõrra. Seda mõjutavad kasvav liikuvus ja protsessid töökohtade, haridusasutuste ja teenuste ümberpaigutumisel.*

Figure 1 Overview of Estonian regional centres in the year 2030 (Eesti Vabariigi Majandus- ja kommunikatsiooniministeerium, 2010)

The international centre refers to connections linking to other European countries; the national centre refers to connections reaching to other national centres, the regional centre refers to connections reaching to the nearest national centre and the lower-regional refers to connections reaching to the regional centre.

As the focus of this master study is on the regional and lower-regional level (mass commuter travellers), then the detailed description of the public transportation systems only covers these two classes.

TC1421	**PASSENGER TRAFFIC ON RAILWAYS**
2012, Passengers, thousands	4 416

Table 1 Number of passengers in railway, according to Statistics Estonia

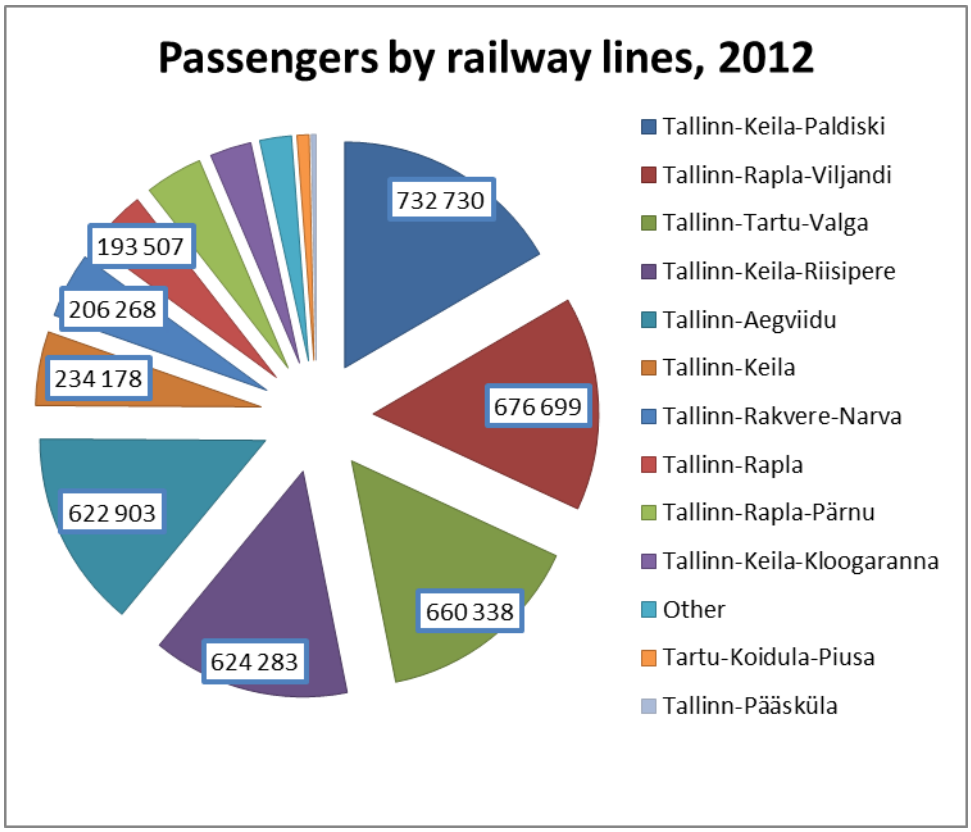


Figure 2 Passengers in 2012, subcategorized to railway lines[15]

TC541	**PASSENGER TRANSPORT BY BUS**
2012, Passengers, thousands	
Scheduled and non-scheduled traffic	119 263.9
County lines	17 901.3
Urban transport	91 052.7
Municipal lines	711.7
Domestic highway lines	4 586.0
International traffic	632.8
National non-scheduled traffic	3 869.0
International non-scheduled traffic	510.0

Table 2 Number of passengers in buses, according to Statistics Estonia

[15] Edelaraudtee Ltd, Edelaraudtee reisijate arv püstitas viimase kümne aasta rekordi, Retreaved March 2013,

The biggest public transportation enterprises based on number of departures[16] active on the regional and lower-regional levels in Estonia are SEBE AS (offers public and private held bus-lines), Edelaraudtee (Go Group) (offers public service via diesel trains in mainland Estonia), Elektriraudtee (a public held company offering service via electric trains in Tallinn and its neighbouring local communities), Väinamere Liinid (Tuule Group) (offers public service via ferries in western Estonia), Go Bus (Go Group) (offers public and private held bus-lines), Mulgi Reisid (Hansabuss Group) (offers public and private held bus-lines).

3 Closing Remarks

To sum it up, Estonia has three largest inland mass-transit companies (SEBE, Go Group and Elektriraudtee) and altogether 73 000 passengers (via scheduled trains, -county-buses and -domestic highway buses) are transported on a daily basis.

http://www.edel.ee/uudised/10/readmore/628/ , Elektriraudtee Ltd, Elektrirongidega sõideti möödunud aastal 2,4 miljonil korral, Retreaved March 2013, http://www.elektriraudtee.ee/ettevottest/uudised/282-elektrirongidega-soideti-moeoedunud-aastal-24-miljonil-korral

[16]information from national public transportation schedule databases www.tpilet.ee (commercial bus lines) and www.peatus.ee (both public and private held bus lines)

Chapter 3. Demands and Requirements for On-Board Ticketing Systems in Public Transportation

1 Introduction

The following chapter gives an overview of the requirements for a user interface, which is to be created for a regional or lower-regional mass-transit on-board self-service ticketing system.

The requirements divide into two sub-categories – demands from the user side and requirements by the system owners (public transportation companies). As online supporting systems were under view also, then the subcategories cover two fields of interest – on-board user interfaces and its' online-supporting systems.

Service design (usage logic) was also looked upon, as one cannot create user interfaces or online supporting systems without developing (or knowing already-existing) design of the service, in the sense of "How the customer uses the computer-based system (user inputs, system outcomes etc.).

User demands were found via the case studies (user interviews, see Appendices 2) and academic reviews (Meuter, Ostrom, Roundtree, & Bitner, 2000), (Blythe, 2004).

System owner set requirements were based on the expert interviews carried through (Konks, 2013) (Tiitsaar, 2013).

2 Demands for User Interface and Usage by the Users

A successful ticketing system does not only meet the requirements set by the procurer, but caters the demands and desires set by the customer as well[17].

2.1.1 Reasons behind the choice of self-service

According to the research done by Meuter et al., the intentions behind self-service usage are mainly of three origins: time saving, easy to use and right on time. (Meuter, Ostrom, Roundtree, & Bitner, 2000)

Satisfying Incidents

Group Number and Name	Illustrative Quotes	Percentage of Total
1. Solved intensified need	"My ride to work didn't show up, and I had no money in my pocket. I had 20 minutes to get to work. I went to the cash machine and got some cash for the cab ride…. I made it to work 10 minutes late instead of not at all."	11%
2. Better than the alternative		68%
2A. Easy to use	"The page's forms were clear and easy to use. I had no difficulty deciding on my purchase and going ahead with the order." (regarding purchasing roses through the 1-800-FLOWERS Internet page)	16%
2B. Avoid service personnel	"I like shopping on the Internet because there is no salesperson to bribe you."	3%
2C. Saved time	"I was on my way to a friend's house and was low on gas. I was in a huge hurry, so using the pay at the pump saved me a lot of time."	30%
2D. When I want	"[I] was having a videotape of a house I was interested in putting an offer [on] and was very anxious to get the tape so I could make my decision. [It was] convenient to be able to check on [the] parcel's whereabouts any time of day or night."	8%
2E. Where I want	"I can check out [library] books by phone without having to drive all the way down to the library to renew them."	5%
2F. Saved money	"I called around to several car agencies and was unable to get a price that was within my range. I decided to try Alamo online. I entered the information and came up with a price that was $20 less per week than when I had called them."	6%
3. Did its job	"I needed gas …[,which involved] inserting the card, selecting credit, pumping the gas, and then asking for a receipt. I received the gas I needed and wanted, and got a receipt."	21%

Figure 3 Satisfying incident categories (Meuter, Ostrom, Roundtree, & Bitner, 2000)

According to Curran et al there are two mayor factors that drive a client to use self-service solutions:

> *"There is evidence from this study that there are at least two forces that can move people to use a technology in the service encounter, one being the consumer's attitude toward employees (both individual and global attitude toward the service firm) and*

[17] Beyond Philisophy, Design Self-Service Experiences With Customers in Mind, Retreaved March 2013, http://www.beyondphilosophy.com/design-self-service-experiences-customers-mind

the second being the attitude toward SSTs (both specific SST of interest and global attitude toward service technologies).” (Curran, Meuter, & Surprenant, 2003)

2.1.2 Desire for seamless and fast transactions

One of the important reasons behind introducing smart-card based self-service systems is the possibility of shortening the time needed for monetary transactions when on the vehicle.

“*The delivery of the interoperable smart-card specification for transport is seen as one of the cornerstones of the [United Kingdom’s] Government’s 10-year transport plan as it facilitates the progressive roll-out of interoperable smart-card schemes across the UK. These schemes, it is hoped will make the prospect of travelling by public transport more attractive to users—as one ticket can be used for several modes, which is both convenient as well as saving time through faster payment, boarding times and ease of purchasing a single ticket*.” (Blythe, 2004)

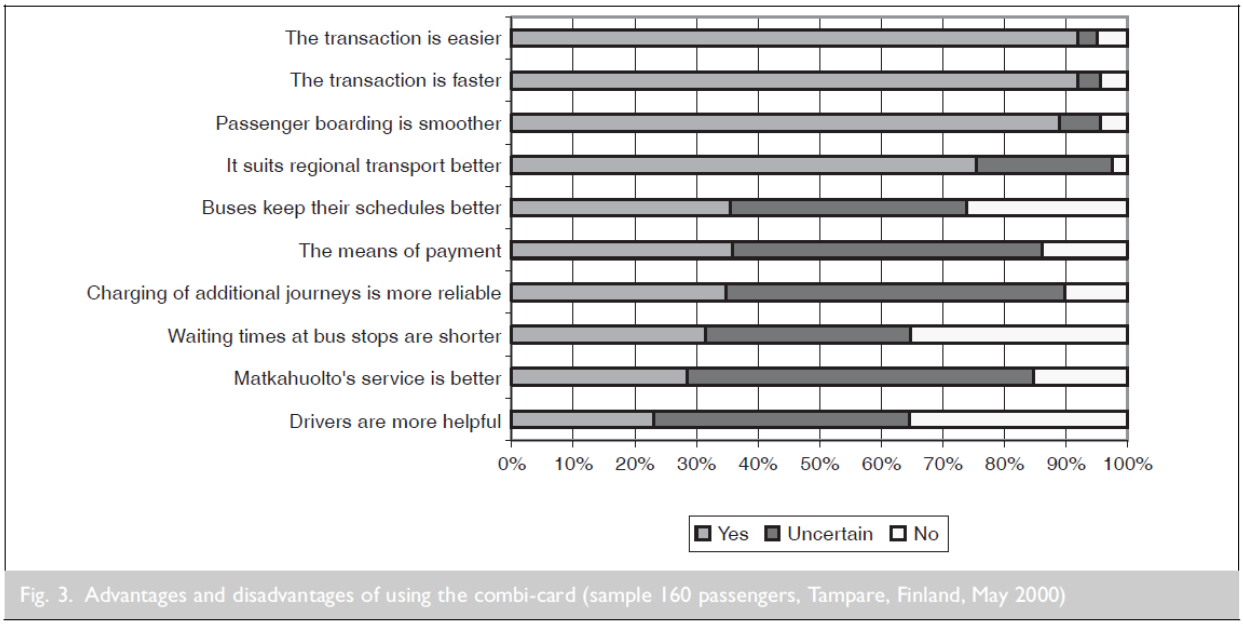


Figure 4 Benefits gained from using a smartcard based ticketing system (Blythe, 2004)

Estonia has seen a rise of non-cash transactions in the last years. According to the mayor bank of Estonia, Swedbank, over 60% of monetary transactions in retail business are made using bank card[18]. The number has doubled with the past two years[19] and banking sector sees that it will continue to grow.

[18] ERR News (November 22, 2012) Kaardimaksete osakaal kaubanduskettides ulatub üle 60% http://m.err.ee/app/android/ee/eesti/52524

[19] Consumer News (November 22, 2012) Kaubanduskettide kliendid eelistavad pangakaarti sularahale http://www.tarbija24.ee/1049894/kaubanduskettide-kliendid-eelistavad-pangakaarti-sularahale/

This tendency supports the idea that customers wish for seamless and easy transactions, which further supports the non-cash based solutions like smart-card based ticketing systems.

2.1.3 Issues of trust and awareness

When Elektriraudtee implemented a smart/card based ticketing system in the September 2010, there were 19 complaints in the first half of 2010 regarding sales by customer service personnel in trains. After the implementation the complaint numbers have risen twice (100 complaints in the first half of 2012). This tendency implicates that the more seamless the purchases made are (no cash/transactions, no receipts etc.) the higher customer dissatisfaction is. (Appendix 5.1)

Of course this should not lead to degeneration of the ticketing systems, rather the possible developers of such systems need to especially address the issues regarding monetary transactions (via additional confirmations, real-time user monitoring etc.). (Appendix 5.1.1)

This means, that in order to support the client's desire to use self-service systems, a significant supporting system (online-based solutions and/or traditional customer service channels) should be used, in an aim to avoid the prevailing of issues of discredit etc. (Tiitsaar, 2013)

3 Demands for Online Supporting Systems by the Users

The significance of online supporting systems in customer service in Estonia is on the rise:

- 96.5% of tax declarations were done online in 2013[20]
- In 2013 Estonian banks had 1.95 million online banking clients[21], compared to the 1,62 million in 2009[22]

The significance of online supporting systems in public transportation sector in Estonia is also on the rise (in the case of Elektriraudtee Ltd.):

- 87% of Elektriraudtee public transportation daily and monthly tickets were purchased via mobile or online. (Appendix 5.3)

[20] Estonian Tax & Customs Board, 2011. aasta eest esitati 16 miljonitulu deklaratsiooni, Retreaved March 2013, http://www.emta.ee/index.php?id=32267&tpl=1026
[21] Delfi News (March 20, 2013) Pankadel on 1,95 miljonit internetipanga klienti http://majandus.delfi.ee/news/tarbija/pankadel-on-195-miljonit-internetipanga-klienti.d?id=65796192
[22] Postimees News (February 5, 2009) Pankadel on ligi 1,62 miljonit internetipanga klienti http://www.postimees.ee/78775/pankadel-on-ligi-1-62-miljonit-internetipanga-klienti/

- Elektriraudtee annual web-based credit upload grew from 109 thousand euros in 2011 to 134 thousand euros in 2012. (Appendix 5.4)

This tendency gives weight to the further investments made to companies' online supporting systems.

3.1.1 Safe and clear transactions

When creating self-service systems where one of the end results is the credit deduction of the user, it is very important to develop easy to use and reliable systems.

Research shows that the main reasons behind the decrease of use - in the self-service area - are technology or process failures and poor service design. (Meuter, Ostrom, Roundtree, & Bitner, 2000)

Dissatisfying Incidents

Group Number and Name	Illustrative Quotes	Percentage of Total
4. Technology failure	"ATM broke down. It kept my card. I had to have the card reissued."	43%
5. Process failure	"After a month passed from placing my original order, I e-mailed the customer service center at Disney with my order confirmation number. They had lost my order. I reordered, only to be sent the incorrect merchandise twice."	17%
6. Poor design		36%
6A. Technology design problem	"I was trying to order books from a book club online. The system was confusing, and I ordered two of the same title without knowing it."	17%
6B. Service design problem	"I did not realize that some (ATM) machines put limits on how much you can get out. The machine did not tell me I went over my limit for the day. It just spit my card back out so I kept trying different amounts until I was able to get some cash out."	19%
7. Customer-driven failure	"I was attempting to get money from an ATM and couldn't remember my [personal identification] number. I was leaving in one hour before the bank opened for mainland Japan, and the machine took my card."	4%

Figure 5 Dissatisfying incidents (Meuter, Ostrom, Roundtree, & Bitner, 2000)

4 Requirements for User Interface by the System Owners

Based on the expert interviews carried through with representatives from Elektriraudtee Ltd. (Tiitsaar, 2013) and from the Tallinn's ticketing system developers team (Konks, 2013), the following categories raised when focusing on the demands set by system owners (public transportation companies).

4.1 Usability & accessibility

As the public transportation systems are created for everybody then the solutions used in the system need to be truly for everybody. Whether the question arises from the language

(customers with different language-skills), motor-skills (handicapped customers), visual performance (older people might not see the output on the system screens etc.), the system needs to meet with positive outcome each of these issues.

4.2 Durability

Public transportation systems are used by everybody, but owned by a private companies or the state itself. This leads in many times to the act of vandalism, which are carried through by certain customers in the public transportation vehicles. Therefore the ticketing systems used in the vehicle need to be durable to outstand potential vandalising by the customers. The acts of vandalising usually consist of physically harming the interfaces of the ticketing systems (by paint, scratching or beating) or systematically harming the ticketing system itself (hacking the system).

4.3 Efficiency

Mentioned by the author before, public transportation is under constant task of self-optimization. Therefore all of the solutions offered in public transportation need to constantly prove themselves as cost-effective ones.

Cost-effectiveness in the case of ticketing systems means low periodic outlays from the system and relatively low emergency fees (reparations of the systems after for example act of vandalism).

4.4 Security

An important issue that arises from a self-service ticketing system, is the security of the system, looked from the company's side. As the costs are based on the behaviour of the customer (for example the use or non-use of ticket validators, compared to manned ticket sales units) and the legal use of the ticket carrier (for example the assumption, that the credit on the ticket carrier hasn't been altered in a customer's favour), it is very important, that the system is built up with high security solutions.

In the case of Amsterdam's ticketing system (based on a ticket carrier OV-chipkaart, used country wide), a widespread of issues related to security have risen[23], which describe the

[23] Webwereld News (January 25, 2011) OV-chipkraak nu voor elke Windows-gebruiker http://webwereld.nl/nieuws/105494/ov-chipkraak-nu-voor-elke-windows-gebruiker.html#utm_source=article_related_news_1&utm_medium=website&utm_campaign=ww;
Webwerel News (January 26, 2011) Hacktools OV-chipkaart gelekt op internet http://webwereld.nl/nieuws/105511/hacktools-ov-chipkaart-gelekt-op-internet.html;
Webwereld News (January 25, 2011) Een paar kliks en je reist vogelvrij http://webwereld.nl/nieuws/105503/een-paar-kliks-en-je-reist-

ticket carrier as a security threat, because it can be hacked in a way, where the total credit on the carrier is bigger than legally applicable (carrier's user hasn't loaded such amounts of money to the carrier).

Another issue that arises from the introduction of self-service based systems is the behavioural threats from the customers – the travel needs to be validated upon entering the vehicle, but the decision to validate is solely made by the traveller. When Riga introduced its e-ticketing system, the following years showed an increase in stowaway passengers[24] who didn't have a ticket or left it un-validated.

According to the research made by (Phillips, Alexander, & Shaw, 2005), there is a significant rise of theft when using self-service based solutions in the case of grocery stores:

> "*Statistical evidence certainly attests to how the rise in recorded incidences of shop theft coincided with the widespread growth of self-service grocery stores.*" (Phillips, Alexander, & Shaw, 2005)

The research shows that the mayor reason behind this is the temptation (ease of theft) - "*Some people say that these shops put temptation in people's way. I do not know about that, but it is your duty to resist temptation (chairman of the John Lewis Partnership, owner of the Waitrose chain of supermarkets)*" (Phillips, Alexander, & Shaw, 2005).

When one develops self-service based ticketing systems, an effort is needed to put into the ticket-units, while making the usage of the ticketing system as seamless as possible, in an effort to not further "tempt" the client from renouncing the validation procedure.

5 Requirements for Usage by the System Owners

In this subject the author gives an overview of the subjects that public transportation companies stress out regarding the ticket sales systems.

These principles are important to point out as the interface one might develop for a public transportation vehicle, has to be able to provide with ease the onward-listed input.

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vogelvrij.html#utm_source=article_related_news_5&utm_medium=website&utm_campaign=ww; Webwereld News (January 27, 2011) Minister onthult nieuwe hack, maar OV-chipkaart blijft http://webwereld.nl/nieuws/105529/minister-onthult-nieuwe-hack--maar-ov-chipkaart-blijft.html

[24] Baltic News Network (January 16, 2013) More stowaways used public transport in 2012 http://bnn-news.com/stowaways-public-transport-2012-85616

5.1 Fast and durable usage

One of the important properties a self/service ticket validator in a public transportation vehicle should have is its speed of action. In the case of Tallinn's ticketing system the aim was to create an user interface, which usage would be faster than a humans average walking speed (Konks, 2013). In that way the system provider further eliminates the possibility of clogging in vehicle entrances (where the ticketing systems usually lie).

The second issue lies with the threat of vandalism. As the interfaces will be for self-service usage in an environment where there is no on-the-spot monitoring of the system by personnel and the systems usage is quite intense (operating hours in Estonian public transportation systems are from 6:00 to 23:00 usually[25]), therefore the types and occurrences of vandalism are quite high. (Konks, 2013)

5.2 Simple and efficient ticket sales systems

Another demand regarding the usage set by the companies is the existence of easy-to operate and efficient (regarding maintenance, expenditure, durability) ticket sales systems.

5.2.1 Ticket price-setting logic

The most common ticket price-setting logic used in Estonian public transportation system is the tariff system.

This usually means that the client pays an entrance fee (a fixed sum) plus an additional fee based on the kilometres he or she drives via the public transportation vehicle.

While this system is good for company (the cost of the service for the passenger is the most objective one; overview of the trips made is available in detail), it is nevertheless uncomfortable for the passenger: usually the ticket prices are inconvenient (x.xx euros); the transport provider offers no multi-ticket like solutions (as the company supports a usage-based ticketing system) therefore making everyday trips inconvenient for the passenger (constant, everyday payment for a long-term service).

The second type of ticket price-setting logic used by companies is a zone-based one. Elektriraudtee and Harju Country have showed a pro-stance towards passengers and have created a system where the stations are gathered into groups and the trip fees are now not station-based (kilometre-based), but group also known as zone-based.

[25] National public transportation schedule database, www.peatus.ee

This greatly simplifies the ticketing system for the passenger, giving more support for the increase in trips made. Zone-based ticketing system is also good as it now allows more multi-ticket types of tickets to be made available for the passengers.

The third type of ticket price-setting logic is a universal one where a passenger only pays a fixed fee every time or day when he or she uses a public transportation vehicle. In Estonia most of the larger towns (Tallinn, Tartu, and Pärnu) use this system, as the service is in a majority supported by the local authority – therefore the cost-effectiveness is not the priority of the system.

5.2.2 Ticket selling logic

The majority of public transportation ticket sales in Estonia are still made by cash in the vehicle itself. While this system was client-friendly (everybody had cash and the payment took place right before the use of the service in the location of the service itself, in short – in the vehicle), it comes with some great difficulties from the company side.

Cash transactions in its nature are time-consuming and with certain risks. Time consumption is a first difficulty, as every cash transaction needs to be verified and transacted ("give back change") with the client.

Regarding the risks the main risks are security related: the possibility of theft, conning by the employee and counterfeit money.

With the adaption of euro Estonian people have greatly started to depend on bankcard-based transactions, which in return have raised the demand to move from cash-based transactions to bankcard-based transactions. This in return has raised another risk which deals with connectivity questions. As the transportation vehicle is in moving operation, therefore the banking systems on-board have to be wireless, in return being open to cyber-security-breaches and connectivity-issues.

5.2.2.1 Ticket selling logic output

Based on the risks described above many of the public transportation companies have created additional ticket sales channels aside the on-board (on-board cash transactions) sales.

Company	**Ticket sales channels**
SEBE AS	on-board[26], online (assisted by phone and mobile phone based solutions), agent-based[27], station-based[28]
Edelaraudtee AS	on-board, online, station-based
Elektriraudtee AS	on-board, partially online (assisted by phone and mobile phone based solutions),
Väinamere Liinid AS	on-board, online, agent-based, station-based
Go Bus AS	on-board

Table 3 Public transportation companies and their ticket sales channels

5.3 Detailed overview of the passenger movement

Public transportation service is a very expensive one and therefore it is under constant pressure for optimization. The most common decisions on terms of optimization are made considering passenger movement – whether the line under question has enough demand.

Nowadays, aside the need for input to optimize transport networks, there is also need for intelligent passenger movement solutions. These solutions offer the company new routes, departure-times or lines, based on the statistics gained from ticket sales or passenger counting systems.

According to the vice-mayor of Tallinn, the main reason for the installation of a new ticketing system was the possibility of better public transportation network planning, based on the information gained via the validations of smart-card based ticket carriers[29].

6 Closing Remarks

To sum it up, user based demands for on-board self-service ticketing systems follow the criteria of seamless and fast usage (Meuter, Ostrom, Roundtree, & Bitner, 2000).

[26] Short term for manned cash ticket sales onboard the vehicle
[27] Short term for agent-based (tertiary) sales channels
[28] Short term for station-based fixed manned and automated sales channels
[29] Postimees News (January 3, 2013) Taavi Aas online-intervjuus: ID-kaardi pilet jäi ajale jalgu http://arvamus.postimees.ee/1091262/taavi-aas-online-intervjuus-id-kaardi-pilet-jai-ajale-jalgu/

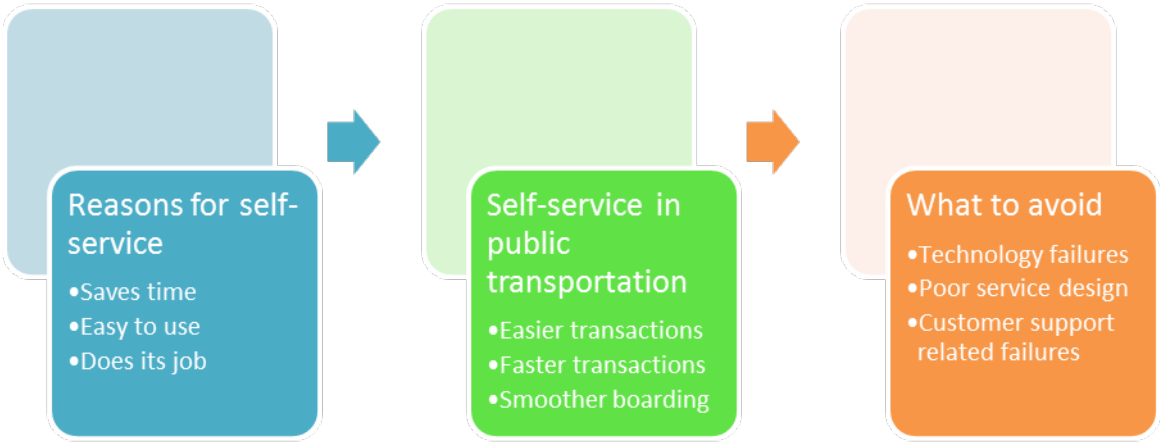

Figure 6 Overview of customer set demands for on-board self-service ticketing systems (blue (Meuter, Ostrom, Roundtree, & Bitner, 2000), green (Blythe, 2004), orange (Meuter, Ostrom, Roundtree, & Bitner, 2000)

From the system owner's side, the following pinpoints were presented by experts:

Figure 7 The main pinpoints of on-board self-service ticketing system development (Konks, 2013) (Tiitsaar, 2013)

Chapter 4. The Overview of Existing Solutions: Case Studies

1 Introduction

This chapter covers the outcomes of different case studies that were conducted in an aim to collect already existing practise of creating user interfaces for on-board self-service mass-transit ticketing systems.

The chapter starts by giving an academic input of different input element categories taxonomy) that can be taken under consideration when creating on-board user interfaces.

It follows by four different case studies which were based on the Baltics Sea area public transportation ticketing systems.

Case studies were conducted in a way where the ticketing system's on-board user interface was examined (via usage practice or photo analysis (Riga's case) in terms of user interface elements used and service design built-up. In an addition, user interviews were carried through with selected everyday users of each public transportation system under study (Appendix 2.1). Finally the author browsed through each system's online supporting systems in an aim to gain knowledge of the solutions and service logic regarding the system's online support.

2 Types of On-board Interfaces

User interfaces depend on the type of user activity that is being carried through via the input device. According to Karray et al (2008) the user activities have three different levels: physical, cognitive and affective.

> *"The physical aspect determines the mechanics of interaction between human and computer while the cognitive aspect deals with ways that users can understand the system and interact with it. The affective aspect is a more recent issue and it tries not only to make the interaction a pleasurable experience for the user but also to affect the user in a way that make user continue to use the machine by changing attitudes and emotions toward the user."* (Karray, Alemzadeh, Saleh, & Arab, 2008)

Karray et al states that the existing physical technologies for HCI basically can be categorized by the relative human sense that the device is designed for. These devices are basically relying on three human senses: vision, audition, and touch. (Karray, Alemzadeh, Saleh, & Arab, 2008)

If one would take into consideration of a typical environment of a public transportation vehicle, vision-based input devices would be switch-based (buttons) or pointing-based (touchscreens). Audition-based input would lie in the field of speech recognition, but as Karray et al point out, such systems are much more difficult to build (Karray, Alemzadeh, Saleh, & Arab, 2008). When considering the noise and background sounds existing in public transportation vehicles, audition-based input methods should be not used.

Touch-based input devices in a public transportation vehicle are one of the most interesting and difficult ones to create. Karray et al states this type of devices to be haptic ones and describe them as following: "These kinds of interfaces generate sensations to the skin and muscles through touch, weight and relative rigidity." (Karray, Alemzadeh, Saleh, & Arab, 2008)

All of the solutions can and usually are assisted by sound-based feedback.

As the ticket sales solutions are becoming more universal (therefore international), the demand for customization from the customer side has lead the ticketing systems vendors to use touch-screen interfaces as it allows relatively easily to customize ticket-validators interfaces by the wishes set by the customer.

3 Existing On-board Interface-solutions Used in Public Transport

The following chapters give an overview of the ticket validator systems interfaces that are currently being used in the Baltic Sea area mayor cities.

An overview is also given regarding a system`s online supporting system. An online system in this case means that a user can access the system via the Internet, using any device capable of Internet access (laptop, mobile phone, tablet etc.). A supporting system in this case means, that the system is an extension of the user interface on-board the vehicle, giving the user the same level or extended level of information than what was received via the on-board self-service ticketing solution.

Total of three sub-categories were looked into:

1. The availability of overall information about the on-board ticketing solution (and instructions for usage) in the cities public transportation.

   The criteria was researched in a way, where a city`s website (in English) was browsed for the words “public transport” > “tickets”.

2. The possibility of overlooking historical transactions made via ticket carrier.

   The criteria was researched in a way, where the ticketing system`s online website was browsed for a section, where overview of the historical transactions were possible.

3.1 Ticket validator solution used in Tallinn City.

The city of Tallinn was the first city in Estonia to use self-service ticketing system in its public transportation vehicles.

3.1.1 The logic of sale

As the city uses a fixed price ticket, regardless of the duration of the trip (in terms of kilometres or time (maximum time-duration is one hour), therefore only one action is needed to be taken by the passenger and that is validating or purchasing your ticket when entering the public transportation vehicle.

The device also can sell additional tickets to one ticket-carrier (up to three tickets per carrier); show information about the current ticket on the carrier; the device checks that the client’s daily limit (up to three tickets) would not be crossed; and the device “checks in” the user`s periodic card.

3.1.2 Interface build-up

Figure 8 Tallinn ticket validator interface

The validator uses sound and visual feedback for communication with the client.

On the visual side there is a four-light system, where blue light symbolizes the readiness of the system (when lit, the system is working and online); the green light shows an action successfully being completed (ticket sale or period ticket validation), the red light informs about an unsuccessful event (not enough value on the ticket etc.) and a yellow light informs about a continuous action (ticket being currently validated etc.).

The positive (green light) or negative (red light) actions are also assisted by sound notices.

A LCD screen is also used to further describe the information offered via the light sign system and to also give out specific information when “checking in” for the second time on the same vehicle:

- The number of tickets on the carrier
- The status of credit on the carrier
- The end date of the periodic ticket validity

3.1.3 Online supporting system

The following online supporting systems were browsed out for Tallinn's on-board ticketing system:

Online channel	**Content description**
City`s website[30]	Gives an overview of the ticket carrier (instructions how to use it).
System`s online management[31]	Gives an overview of a person's ticket carriers (if personalized); also account transactions information of the last three months.
Online ticket sales[32]	Possibility to buy periodic tickets; check to current validity of already purchased periodic tickets; load finances to one's ticket carrier and to set up monthly direct debiting.
SMS & Call ticket purchases[33]	Possibility to buy periodic tickets and to load finances to one's ticket carrier, using SMS or regular call functions.
Apps for smartphone (Android, iPhone)[34]	Possibility to check timetables; purchasing of periodic tickets.

Table 4 Overview of Tallinn`s online supporting channels

3.1.4 User feedback

Merlin Miido has used Tallinn's smartcard based ticketing system since its launch. She travels via the public transport on a daily basis, using a monthly ticket, which has been purchased from a retail shop (R-Kiosk). (Appendix 2.2)

Upon entering the vehicle she then simply validates the trip as required by the city. From the elements that communicate with the user she only uses the lightning (green light as a sign of successful validation).

[30] Tallinn City Web, How to buy ticket, Retreaved March 2013, http://www.tallinn.ee/eng/pilet/Transport-Ticket-Information
[31] Tallinn's public transportation's ticketing system's operator United Tickets Ltd, https://www.pilet.ee/viipe/uhiskaart/cardstatement?lang=ee
[32] Tallinn's public transportation's ticketing system's operator United Tickets Ltd, https://www.pilet.ee/cgi-bin/splususer/splususer.cgi?op=list_trans&piirkond_id=1&type=E
[33] Tallinn's public transportation's ticketing system's operator United Tickets Ltd, https://www.pilet.ee/cgi-bin/splususer/splususer.cgi?op=view_trans&product_id=3102
[34] United Tickets Ltd app for Apple, Retreaved March 2013, https://itunes.apple.com/ee/app/bussipiletid.ee/id552331439?mt=8;
United Tickets Ltd app for Android, Retreaved March 2013, https://play.google.com/store/apps/details?id=com.timetables

According to Merlin, there is one mayor problem with the user interface of the validator (aside from the overall problems, raised from background systems work faults): the area where the ticket carrier should be placed is unclear to some of the travellers. She proposes that the area should be better marked for the benefit of the users.

Merlin currently does not use the system's online supporting system, but sees her using it in the future:

> *"If I would buy a monthly ticket in the middle of the month, then I would maybe use the Internet to see when my ticket ends."* Translated by the author, (Appendix 2.2)

3.2 Ticket validator solution used in Helsinki City

The city of Helsinki uses a validator solution that not only is an inner-city sales-solution, but it extends to neighbouring municipalities and sub-cities. Altogether 5 districts are joined under the sales system, therefore extending the sale processes one can take via the validator.

Also it is important to mention that the validator solution is used regardless of the type of the public transportation vehicle. This means that validators are installed in trains, trams, buses etc.

3.2.1 The logic of sale

The city's validator is used in the larger region of Helsinki city (consisting of its neighbouring municipalities also), therefore the validator does not only sell fixed price tickets (as was the case in Tallinn), but also zone-based tickets.

Zone-based ticket sales are more difficult to offer via on-board self-service systems as the zones ergo the final price of the ticket depends on the correct actions that the user must carry through.

The core function of the Helsinki validator is "checking in" – whether this is done with a valid periodic ticket (no further communication is needed with the validator) or with simply the carrier, with its on-board credit. If the latter one is the action carried through, the user needs to define his or her nature of passage:

- Button "1" > traveling within the limits of the current zone
- Button "2" > traveling in the Helsinki zone + and its neighbouring zones
- Button "3" > traveling within the whole region of zones
- Button "L" > traveling outside the Helsinki zone

- Button “0” > when traveling only by tram in Helsinki
    - NB! To purchase a discount ticket (for students and seniors), number 1 need to be pressed

Once the desired button has been pressed, no further action is required by the passenger. If the passage consists of trips made by different vehicles, the passenger needs simply to “check in” each time he or she changes the vehicle.

It is also possible to buy additional tickets via the validator to one’s ticket carrier. Up to 31 tickets are possible to purchase, with the requirement that the type of the ticket (same customer group, etc. student) needs to be the same at all time.

3.2.2 Interface build-up

Figure 9 Helsinki ticket validator interface

The validator has a 3-light signal interface (red, yellow, green). Green light is assisted by a sound signal (beeping).

The green light lights up when the check in has been successful (periodic ticket is valid; journey has been paid for; checking in with a journey ticket is still possible, considering the time limits). A red light lights up when the ticket carrier is not valid. The reason for error is described via the LCD screen (periodic ticket validity has ended etc.). A yellow light is also used. A combined use with a green light gives a notice to the ticket carrier owner when his or her periodic ticket is nearing its end of validity (three or less days). A sole yellow light is used, when the purchase needs to carried through via the conductor or bus driver.

The validator has a 5-button interface for sales processes. The functions of the buttons are needed for fulfilling sale tasks and their functionality was described in the previous chapter.

A LCD screen is also used to further describe the information offered via the light sign system and to also give out specific information when requested (a 5 second "holding period"[35] is necessary):

- season ticket and its expiry date
- the sum of value on the card
- valid value ticket(s), and
- expiry time of the ticket(s)

3.2.3 Online supporting system

The following online supporting systems were browsed out for Helsinki's on-board ticketing system:

Online channel	**Content description**
City's website[36]	Gives an overview of the ticket carrier (where to use it and where to gain additional information about how to use it).
System's website[37]	Gives an overview of how to use the ticket carrier (also how to use the validators); where to gain additional information and how to buy tickets
SMS ticket purchase[38]	System has an availability for purchasing one-time tickets via SMS
Apps for smartphones[39]	Although the system does not seem to have any official apps, the system's website addresses many possibilities for such apps. The core function of the apps listed is overview of timetables (on one occasion the possibility of ticket purchase was available).

Table 5 Overview of Helsinki`s online supporting channels

[35] to hold the ticket carrier still next to the reading area of the ticket validator
[36] City of Helsinki, Trams, buses, metro rail and commuter trains, Retreaved March 2013, http://www.hel.fi/hki/Helsinki/en/Services/Transport+and+maps/Trams%2C+buses%2C+metro+rail+and+commuter+trains
[37] Helsinki Region Transport, Using the Travel Card, Retreaved March 2013, http://www.hsl.fi/EN/passengersguide/travelcard/Pages/usingthetravelcard.aspx
[38] Helsinki Region Transport, Single ticket by mobile phone, Retreaved March 2013, http://www.hsl.fi/EN/ticketsandfares/singleticketsanddaytickets/Pages/ticketbymobilephone.aspx
[39] Helsinki Region Transport, Mobile Apps, Retreaved March 2013, http://www.hsl.fi/EN/timetablesandroutes/Pages/Mobileapps.aspx

3.2.4 User feedback

Valeria Gasik has used the city's smartcard based ticketing system since its introduction in public transportation vehicles. She travels on a daily basis, using a monthly ticket, which has been purchased from a retail shop (R-Kiosk). (Appendix 2.5)

As the owners of monthly tickets are not required to use the validators (except in buses), the author asked Valeria to describe the period, when she travelled using one-time tickets (purchasable via the validators, using credit that has been loaded to the user's ticket carrier).

When she used one-time tickets, then upon entering the vehicle she then simply validated the trip as required by the city. From the elements that communicate with the user she only uses the lightning (green light as a sign of successful validation).

Valeria sees that the biggest problems with the validator are related to its user interface:

> *The biggest problem is that it's really ambiguous and it seems illogical… The colours and the numbers seem to be from left to right. … It's hard for you to focus on what you press. …* (Appendix 2.5)

Also the system's online supporting system is lacking in the sense, that there is no possibility to check the ticket carrier's account history.

3.3 Ticket validator solution used in Riga City

The city of Riga introduced an e-ticketing system in its public transportation on the 1st of March 2009.

The ticketing system consists of an electronic ticket carrier, ticket validators (used in trams, trolleys and buses) and the supporting services (both online and traditional[40]).

3.3.1 The logic of sale

As was the case with Tallinn, Riga also has a one-zone basis in its ticketing logic, meaning that the ticket price is fixed, regardless the distance a customer decides to travel.

The passenger is required to validate his or her trip via the validator when entering a public transportation vehicle.

Then a ticket is sold to the passenger, from the means available by previous credit loaded on the ticket.

[40] information outlets, spread out the city limits

When the user has an already valid periodic ticket, a simple validation is carried through via the validator.

3.3.2 Interface build-up

Figure 10 Riga's ticket validator's service design

Figure 11 Photo of Riga's ticketing validator interface.

The validator has a 3-light signal interface (green, yellow, red). Each of the light is assisted by a sound signal.

Upon successful action, the validator lights a green light with a tone. When a red light lights up, this means that the ticket cannot be purchased and the customer needs to head to the driver to buy a ticket.

The validator has an additional interface element LCD screen.

3.3.3 Online supporting system

The following online supporting systems were browsed out for Riga's on-board ticketing system:

Online channel	**Content description**
System's website[41]	Gives an overview of the usage (how to use; types of tickets and prices)
System's online management[42]	As the system was built up in a way, where a login was required (via the ticket carrier number and the account had to be created via the system's customer service e-mail), no author-side review could not be given. Based on the information received from the user feedback, the login was difficult for the regular users as well, as preregistration was necessary. (Appendix 2.4)

Table 6 Overview of Riga`s online supporting channels

[41] Rigas Satiksme Ltd, What is e/ticket?, Retreaved March 2013, https://www.rigassatiksme.lv/en/tickets-and-e-ticket/what-is-e-ticket/

[42] Rigas Satiksme Ltd, Online management, Retreaved March 2013, https://www.rigassatiksme.lv/lv/mans-e-talons/autorizacija/?do=login

Compared to the online supporting systems offered in the case of Tallinn's and Helsinki's ticketing systems, Riga's ticketing system relied more on the customer service points (located around the city) and the online systems were used less.

43

Customer: „I need an e-Ticket! "

Cashier: „Driving one time or multiple? "
Customer: „One time. "

Cashier: „Sitting or standing? "
Customer: „Sitting. "

Cashier: „Sitting near the window or near the gangway? "
Customer: „Enough! Give me a normal one for 60 cents! "

Figure 12 Caricature of Riga's supporting system

3.3.4 User feedback

Dace Lasmane has used Riga's smartcard based ticketing system since the beginning of its introduction. She travels on a daily basis, using a monthly ticket purchased from a retail shop (local kiosk). (Appendix 2.4)

Upon entering the vehicle she validates the trip. Out of the elements that are present on the validator, she uses sound (specific beep as a sign of successful validations) and the LCD screen (to gain information about the end date of the current ticket).

According to Dace, the main problems with the validator are the use of LCD screens in the validator and the logic of ticket sales:

> *It would be also nice, that the validator shows all of the tickets on the ticket carrier when I want to see them.*
>
> …

If I'm going somewhere, when the kiosks are closed, I should buy the ticket from the driver. It would be great if I can buy the ticket from the validator on the bus. (Appendix 2.4)

3.4 Ticket validator solution used in Amsterdam City

The city of Amsterdam uses a kilometre-based ticketing, which means that the cost of the trip depends of the whole distance that the passenger travels.

This sales logic can be seen as most objective in terms of interest of the transportation companies (a traveller pays by the kilometres); on the other hand it is quite difficult to know your total costs of travel when you travel by new ways or new routes.

3.4.1 The logic of sale

As the system's ticket price setting logic depends on the total length of the trip made by the passenger, a check-in / check/out system is introduced. According to the use logic, a traveller is required:

- When boarding a vehicle, one needs to check in (a successful check-in is accompanied by green light and a tone. After the check in, the system reserves a specific amount of credit in one's ticket carrier (depending on the type of vehicle entered).
- A check-out is required, when leaving the vehicle. There are special check-out validators (as check-in validators are meant only for checking in). If a person forgets to check-out, then the credit reserved previously will be automatically deducted (otherwise there would have been a deduction, as the total cost of the trip would have been smaller than the credit reserved after checking in).
- When using metros, a simpler check-out regulation is used by the system.

Periodic tickets are also used in the system. In cases of traveling using periodic ticket, no monetary transactions are carried through on the ticket carrier (if the travel is made only on the routes applicable under the specific periodic ticket).

[43] Mosties.org Blog, Retreaved March 2013, http://mosties.org/projekti/atteli/e-talons.jpg

3.4.2 Interface build-up

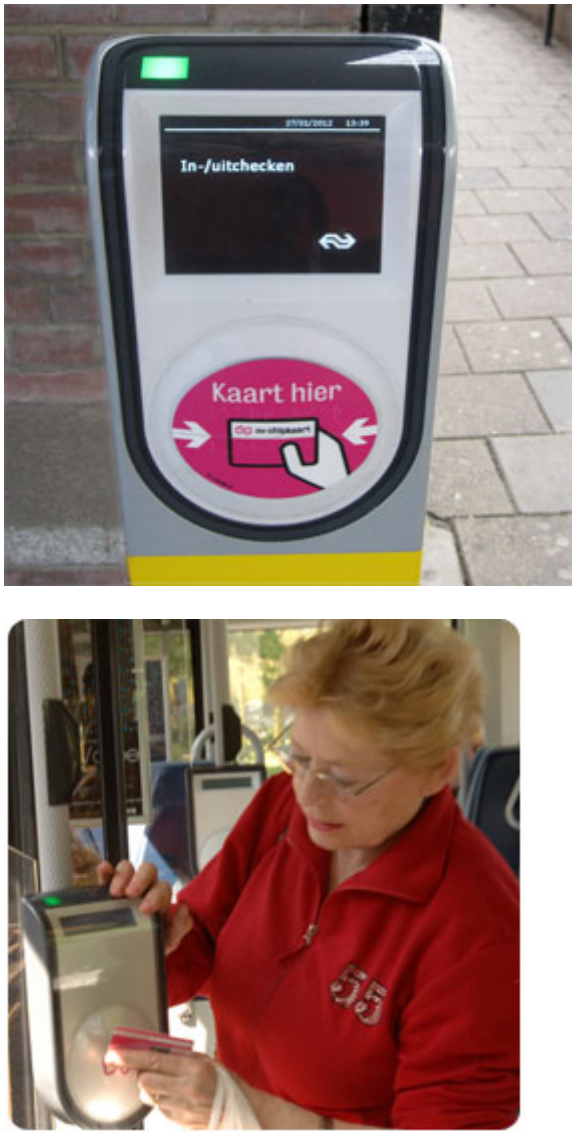

Figure 13 Illustrations of Amsterdam`s public transportation validator solutions

The validator has a 2-light signal interface (green, red). Both lights are assisted by a sound signal.

The validator also has a LCD screen, which gives more detailed information about the outcomes of user activities taken via the validator.

The LCD screen gives the following information to the passenger upon successful “check-in”:

- Checked in successfully

The LCD screen gives the following information to the passenger upon successful “check-out”:

- Checked out successfully

- The amount of money deducted
- The amount of credit left on the ticket carrier
- If the user has a valid periodic ticket, only official farewell wishes are given by the system.

3.4.3 Online supporting system

The following online supporting systems were browsed out for Amsterdam's on-board ticketing system:

Online channel	**Content description**
City's website[44]	Gives an overview of the public transportation and its ticketing system.
System's website[45]	The system's website gives detailed overview of the ticketing system and how to use it in different vehicles. Also a significant effort has been put into the customer service (information about customer service phone line, frequent problems and its ways of solving etc.)
System's online management[46]	There is a separate website for only managing one's ticket carrier. The website gives thorough information about transactions history and gives also the passenger the ability to reload its ticket carrier with credit and also to purchase different periodic tickets.
Apps for smartphones[47]	Ticketing system has an official app that gives information regarding the timetables. No possibilities exist for ticket purchases.

Table 7 Overview of Amsterdam`s online supporting channels

3.4.4 User feedback

Kaarel Koosapoeg used Amsterdam's (also Hague and Leiden) public transportation while studying in a university as an exchange student in the autumn semester of 2012. He travelled

[44] Amsterdam City Web, Public Transportation, Retreaved March 2013, http://www.iamsterdam.com/en-GB/experience/plan-your-trip/getting-around/public-transport
[45] GVB Ltd, OV-chipkaart overview, Retreaved March 2013, http://en.gvb.nl/service_en_verkoop/ov-chipkaartoverzicht/Pages/ov-chipkaart-overzicht.aspx
[46] OV-chipkaart Website, http://www.ov-chipkaart.nl/

mostly via train on a daily basis, using smartcard based ticket carrier and the credit that was loaded on it. He also travelled by bus (couple of times per month). (Appendix 2.3)

Upon entering the train (waiting platform in the station), he passed through check-in gates (where he checked in with the ticket carrier using the validator). When he reached the desired destination, he departed the railway station via the check-out gates (where he checked out with the ticket carrier using the validator).

From the elements mounted on the validator, he used the lighting (green as a sign of successful validation) and the LCD screen:

> *"You could see the credit status of the ticket carrier automatically when checking out of the vehicle."* (Appendix 2.3)

Out of the online supporting systems he did not use any. Although he was vaguely familiar with the solutions, he did not use them, as he used the station-based self-service kiosks.

Couple of times there were of problems with the check-out function of the ticketing system:

> *"When checking out, the validator did not check me out, and therefore my total costs were bigger than expected."* (Appendix 2.3)

3.5 Ticket validator solution used in Goteborg City

The city of Goteborg uses a validator solution covering an area with a larger than 200 km diameter. The ticketing logic in such a big area is based on the zones and therefore the validator solution is dependent on the possibility of zone-defining.

3.5.1 The logic of sale

The validator has a variety of buttons, regarding where the validator has been installed (what type of vehicle).

The first type of validators (blue) has three buttons:

- Button "?" > for information requests
- Button "+" > for a trip being made in a multiple ticketing-zones. NB! A check-out procedure is required so that the system knows the total number of zones travelled in with the ticket.

[47] GVB Ltd, Android App, Retreaved March 2013, https://play.google.com/store/apps/details?id=nl.moopmobility.gvb

- Button “T” > for purchasing an additional ticket, when already having a periodic ticket. For use in situations where the passenger has already a periodic ticket, but wants to travel in lines not covered by the periodic ticket.

The second type of validators (yellow) the before-mentioned buttons and the following:

- Button “V” > for purchasing an additional ticket for an adult co-traveller
- Button “S” > for purchasing an additional ticket for a student co-traveller
- Button “K” > to confirm the total amount of additional tickets wished to purchase for co-travellers
- Button “a” > no information was given regarding the functionality of the button on the company’s website[48]

[48] Vasttrafik Ltd, Using the card reader, Retreaved march 2013, http://www.vasttrafik.se/#!/en/travel-information/7/4/

3.5.2 Interface build-up

Figure 14 Photo of Goteborg-s ticket validator

The validator has a 2-light signal interface (green, red). Both of the lights are assisted by a sound signal.

Validator also has a button interface. The work/logic and selection of buttons was described in the previous section.

It is important to note that the creators of Tallinn/s ticketing system were introduced with the Goteborg's ticketing system and the system creators said themselves, that the button-based interface is quite incomprehensible for use by tourists and other than everyday commuters. (Konks, 2013)

3.5.3 Online supporting system

The following online supporting systems were browsed out for Goteborg's on-board ticketing system:

Online channel	**Content description**
System's website[49]	A thorough overview is given regarding the ticketing system use and regulations.
System's online management[50]	Upon registration it is then possible to review the card's transactions history; add extra credit to the card (up to 1500 SEK). Also it is possible to close the ticket carrier after theft or loss of it.
SMS ticket purchasing[51]	It is possible to purchase a one-time ticket via SMS. NB! The customer is required to register his or her mobile phone number only after which the purchasing of tickets is available.
Apps for smartphones	Ticketing system has an official app for purchasing a SMS ticket and timetable information. Also user-created apps exist (mostly regarding the timetable information).

4 Closing Remarks

To sum it up, the on-board ticketing systems under case study divided into two sub-groups: zone-based ticketing and one-type based ticketing sales logic. Depending on the latter, the service design varied, being more elaborate with the zone-based ticketing systems (Amsterdam's system with its check-in & check-out and Göteborg's multi-button interface.

Despite the differences in service design, the user interface elements in the on-board ticketing system were of the same categories, mostly based on visual interface (LED signals, LCD screens) and audio output (supporting sound signals).

4.1 Overview of the systems under case study

	Tallinn	Riga	Helsinki	Amsterdam	Göteborg
Periodic card validation	Yes	Yes	No	Yes	Yes
One time ticket	Yes	No	Yes	Yes	Yes

[49] Vasttrafik Ltd, Pay-as-you-go card, Retreaved March 2013, http://www.vasttrafik.se/#!/en/2/4/
[50] Vasttrafik Ltd, My pages, Retreaved March 2013, http://www.vasttrafik.se/#!/en/14/
[51] Vasttrafik Ltd, SMS tickets and codes, Retreaved March 2013, http://www.vasttrafik.se/#!/en/2/3/to-buy-sms-tickets-from-february-1/4/

purchase via card-based credit					
Use of LCD screen	Yes, two-row non-coloured	Yes, two-row non-coloured	Yes, two-row non-coloured	Yes, large coloured	Yes, large non-coloured
Use of coloured LED signals	Yes, 4 colours	Yes, 3 colours	Yes, 3 colours	No	Yes, 2 non-coloured
Use of supporting sound signalling	Yes	Yes	Yes	Yes	Yes
Option to review credit status on the ticket carrier	Yes	No	No	Yes	No

Table 8 Comparison table of different on-board ticketing solutions

Pros	**Ticketing system**	**Cons**
• Good network of supporting systems • Interface is ascetic enough to be easily maintained (low threat of vandalism e.g.)	Riga	• Unable to do transactions on-board via the validator • Low level of interactivity
• Suitable for use in any type of vehicle or route	Helsinki	• Somewhat bloated user interface
• Simplistic and easy to use user interface • Intelligent online supporting systems	Tallinn	• One zone based, therefore usable only in the city
• Possibility for different types of pricing schemes • Suitable for use in any type of vehicle or route	Amsterdam	• Lack of supporting systems • First time entry obstacles (bureaucratic forms to be fulfilled in an aim to gain a ticket carrier)
• A multitude of possibilities of on-board transactions	Göteborg	• Conservative user interface • Lack of online supporting systems

Table 9 Overview of the strengths and weak-points of ticketing systems under case study

Chapter 5. The Proposed Requirements for Elektriraudtee's On-Board Self-Service Ticketing System

1 Introduction

This chapter offers possible requirements for the creation of on-board self-service mass-transit ticketing system to be used in or around Estonia.

The requirements are based on the case studies' outcomes, while also taking account the knowledge gained from expert interviews (important requirements from the companies' point of view) and academic research (possible solutions currently available for use in Human-Computer interaction).

2 Proposed requirements for on-board ticketing solution

The proposed requirements for the on-board self-service mass-transit ticketing system are divided into sub-categories: first, the elements necessary for the physical user interface itself, secondary the built-up of the service design available on-board and thirdly the overview of the online supporting systems.

2.1 Interface elements

The main component of the interface elements used in the on-board ticketing system in Elektriraudtee is the lighting signals. Based on the case studies and related user interviews the majority of validators built have such signalling in them and the users mostly consume (interact) the feedback from the lighting. The solution proposed is based on the MasterCard

Corporation's approved solution (Worldwide, MasterCard, 2007), as the system will be built to be ready for NFC-based transactions.

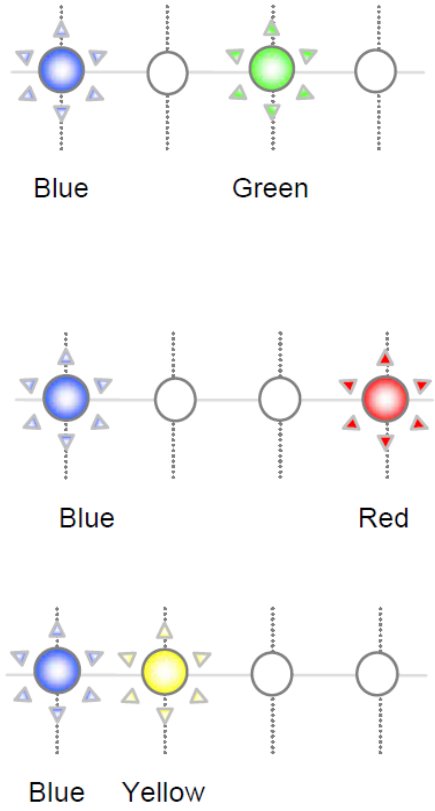

Figure 15 Proposed lighting information solution (Worldwide, MasterCard, 2007)

The lighting will be assisted by sound on the following cases:

- positive sound (mellow beep, with the green LED) – successful validation of a periodic ticket, successful purchase of a one-time ticket based on the credit on the user's ticket carrier
- negative sound (error continues sound, with the red LED) – unsuccessful purchase of a one-time ticket (there is no periodic ticket or enough of credit on the user's ticket carrier)
- attention sound (double beep, with the yellow LED) – signalling the upcoming ending of the periodic tickets (ending in 3 or less calendar days), signalling the depletion of credit on the user's ticket carrier (amount left on the ticket carrier is not applicable for further ticket purchases)

The interface also has up to three customizable buttons that are aligned in a one row, from right to left. The buttons are touch-based, with a coded covering to be used by travellers with visual disabilities. This means that the touch force needed to use the button needs to be stronger, so that the traveller with visual disability can at first get familiar with the button (using light touch) and the use the button (using stronger touch).

- "+" button – for purchasing additional tickets
- "i" button – for information requests
- reserve button – left at start as a blank one, to be used in later system developments if necessary

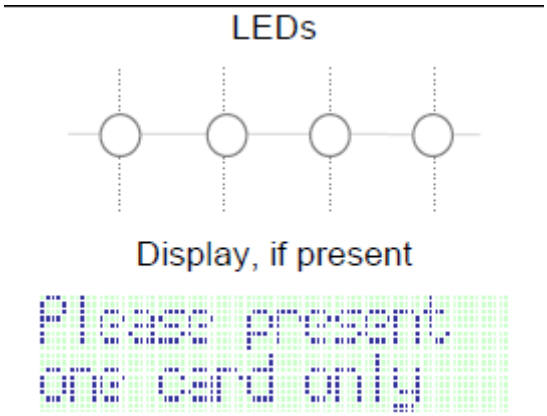

Figure 16 LCD screen position proposed by MasterCard Corporation. (Worldwide, MasterCard, 2007)

It is proposed, that the LCD screen would be used as an additional element to support the lighting information (as seen by the representative from Elektriraudtee as well. (Tiitsaar, 2013)), but based on the feedback from Helsinki's ticketing system user (Appendix 2.5), the screen should not be a two-row screen, but a bigger one. The solution used in Amsterdam's system can be taken as an example to follow.

The aim of this solutions would be to give clearer (more visible screen solution) and richer in information content to the possible user.

OV-chipkaart reader at Utrecht Centraal railway station.

Figure 17 LCD screen solutions used in Dutch public transportation network

Figure 18 Proposed smart card area signifier (Worldwide, MasterCard, 2007)

Based on the feedback from Tallinn's ticketing system user (Appendix 2.2), it is proposed also, that the smart card area signifier would have an outline of the smart card, so that the user has a visual aid of how to position his or her ticket carrier to the validator when using it.

2.2 Service design solutions

When focusing on the service design what can be done with the ticketing system by the user in Elektriraudtee trains, one has to look at the current situation. Currently the following monetary actions with the smartcard based ticket carrier are possible in Elektriraudtee trains (via ticket sales personnel)[52]:

- Sales of one-time and 24 hour tickets
    - 30-day ticket is also offered (with a considerably higher price)
- Credit upload to one's ticket carrier
- Sales of additional tickets to one's ticket carrier
    - Tickets for co-travellers

- "Ticket upgrade" product in express trains for regular train 30-day ticket owner

If an unmanned service is intended to be offered onwards in Elektriraudtee trains, using ticket validators, the following monetary transactions with the smartcard based ticket carrier should be possible in Elektriraudtee trains (based on the Amsterdam's validator's usage logic solutions and user feedbacks):

- Sales of one-ticket
  - The logic of sale starts with the person checking in via the validator upon entering the vehicle. This sets the starting zone or stop for the ticket.

    By default the end stop is already set by the system, with the end stop being the same as the current line's end stop.

    This means, that when the user checks in, the system already sells the user a ticket (based on the stop when checked in and the end stop of the current line).
  - When the user reaches his or her desired destination then upon leaving the vehicle the user checks out of the vehicle.

    This action gives the system the ability to correct the initial ticket in a way, where the end stop is now defined by the user. If the total price of the ticket is now smaller than previously calculated, the user receives that amount back to his or her ticket carrier.

    NB! It is important to state that the majority of travels made in Elektriraudtee trains are between start- and end zones (Tiitsaar, 2013), therefore the check-out procedures is not necessary for many of the travellers.
  - The sold ticket has a time-durance as well, depending on the start and end stop of the ticket.

    This means that when the user changes vehicles, in the longevity of the previous ticket no new ticket is sold to the user (when again checking in).
  - By default the type of ticket sold to the carrier is a regular ticket. If the user wishes to purchase discount tickets (for students and senior citizens), he or she

[52] Elektriraudtee Ltd, Piletid, Retreaved March 2013, http://www.elektriraudtee.ee/reisijale/piletid/hinnad

needs a special type of ticket carrier (sold only to people with the right for discount travelling).

When checking in with the "special type of ticket carrier", the system automatically sells a discount ticket to the carrier.

- If more than for example three tickets are purchased within 24 hours, the following tickets are sold with a zero price. The total cost of daily travel cannot therefore exceed the price of a 24-hour ticket.
  - This function can be extended to a solution, where monthly tickets are also sold based on the same logic: If more than for example 24 tickets are purchased within 30 days, the following tickets are sold with a zero price. The total cost of monthly travel cannot therefore exceed the price of a 30-day ticket.

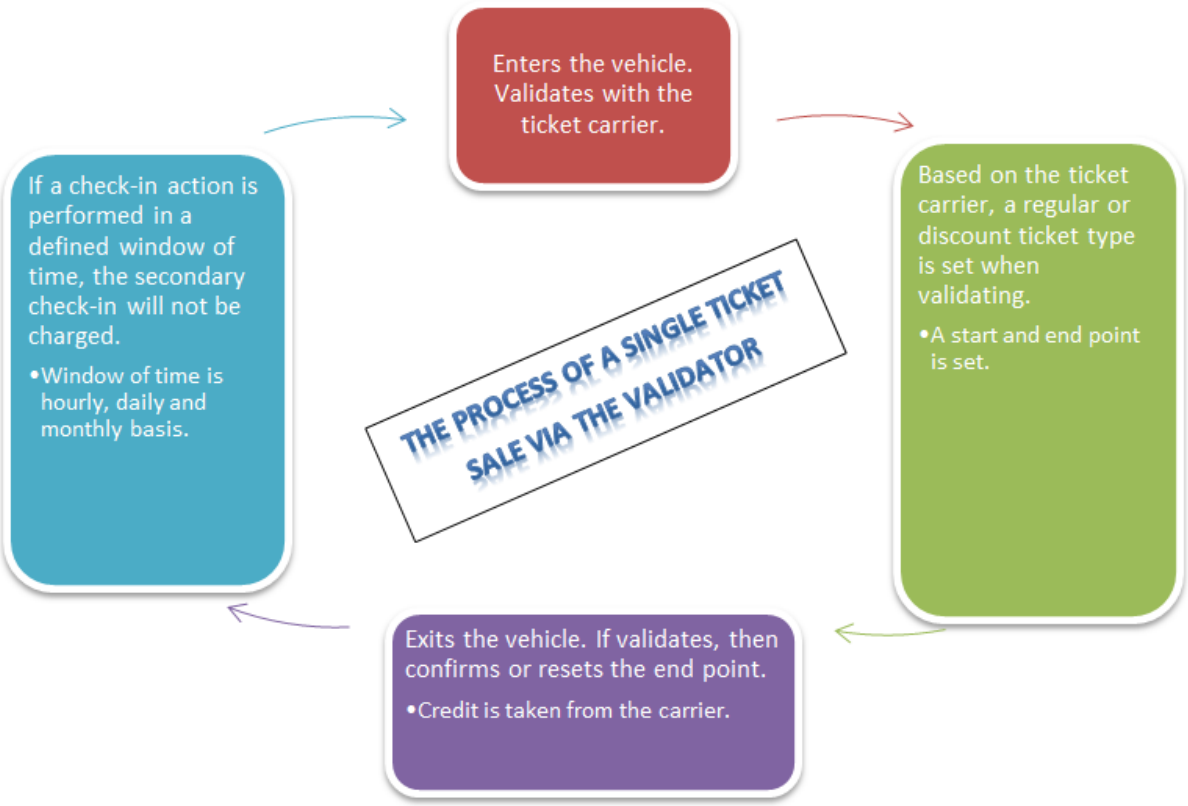

Figure 19 Process of a single ticket sale

- Sales of additional tickets to one's ticket carrier

- The user can by additional tickets to his or her ticket carrier, using the validator's user interface button ("+" button).

  The user has to check in via the validator at first and then define via the button, how many **additional** tickets (up to ten tickets) the system should sell to his or her ticket carrier. After the clarification of the number, the user should check in again.

  Checkout can only be done to whole of the active tickets on the carrier.

- If the user has an active regular train periodic ticket, then when checking in to an express train, only a fixed-price "ticket upgrade" is sold to the user.

- Checking in with the periodic ticket
  - As one of the aims of the ticketing system is to gain overview of total number of passages made by the user (Tiitsaar, 2013), the users with periodic tickets should also check-in themselves upon entering the train.

    No check-out is necessary, as the ticket already shows the end station of the user.

- Overview of the current status of ticket carrier
  - The user can look at the current status of the tickets in his or her carrier via the validator, when pressing the "i" button.

    At first the "i" button should be pressed (stays active after that until a ticket carrier is presented against the validator) and then the ticket carrier should be put next to the carrier. The following information will be then presented:

    If the user travels by active periodic ticket

    - Type of the monthly ticket (for example "I-III zone 30 day ticket"
    - End date of the monthly ticket
    - Current credit stance on the ticket carrier
    - Number of active additional tickets on the ticket carrier

    If the user travels by active one-time ticket

- Type of the current one-time ticket (for example "I-IV zone express train ticket")
- Time left for the one-time time (countdown-like)
- Current credit stance on the ticket carrier
- Number of active additional tickets on the ticket carrier

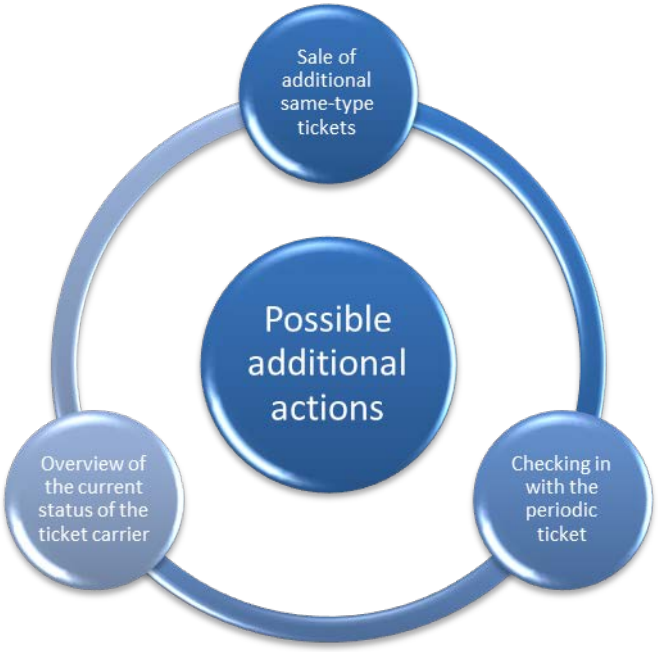

Figure 20 Overview of possible additional actions (performed by the user via the validator)

2.3 Online supporting systems

Based on the fact that the majority of Estonians purchases smartphones (rather that common cell phones)[53] and tablets & laptops (rather than common PC-s)[54], a significant amount of investments should be made to online supporting systems that the users can access where they want and when they want.

As the Elektriraudtee trains are with free Wi-Fi areas[55], it is very easy for a user to access Elektriraudtee online supporting systems "right on the spot".

[53] EMT Ltd, Telefonimüügi edetabelit juhib nutikas Samsung Galaxy Y, Retreaved March 2013, https://www.emt.ee/et/uudised/-/uudisvoog/uudis/20698646
[54] Arvutimaailm Journal (January 26, 2013) Tahvelarvutite müük ületas esimest korda Eestis sülearvutite müügi http://www.am.ee/tahvelarvuti-muuk
[55] Elektriraudtee Ltd, Online management, Retreaved March 2013, http://uus.elektriraudtee.ee/data/

Online channel	**Content description**
Elektriraudtee website	The website is promoted in the train via address & QR code. The website gives basic information (cartoon-like built up of information) on how to use the on-board ticketing system. Extensive information is available for those interested. All of the information is presented in Estonian, Russian and English (secondary support for Finnish if possible).
Ticket carrier online management	Elektriraudtee website will have a sub-website where the user can manage his or her ticket carrier information. The information extends to three categories: • **Overview of transactions** – The user can see the history of all of the transactions made with the ticket carrier (tickets bought, on/board validations, credit uploads). All of the transactions can be downloaded (.PDF-cheques) and disputed seamlessly. This means that when a transactions seams faulty or false, the user can dispute it right there, in the carrier's management website. • **Ticket sales & credit upload** – The user can purchase online additional tickets to his or her ticket carrier (periodic and one-time tickets) and upload credit to the user's ticket carrier (for later use in the trains). • **User information management** – The user can manage the information related to his or her ticket carrier. For example if the user is a student, he or she can validate the right to use discount tickets (both online and on-board) via the online management

	environment. Also there is a possibility to close my ticket carrier on the case of theft or loss of the carrier.
SMS & call-based ticket sales	Using tertiary partners, Elektriraudtee offers the possibility of ticket purchases to one's ticket carrier via SMS or call-based service.
Apps for smartphones (Android, secondary support (if possible) for iPhone & Windows Phone)	Elektriraudtee offers all of the information available on its ticket carrier online management website also as an installable Android application.

Table 10 Overview of Elektriraudtee online supporting system solutions

3 Closing Remarks

To sum it up, the requirements listed in this chapter aim to be sufficient enough to be used by Elektriraudtee Ltd in its on-board self-service mass-transit ticketing system procurement.

It is important to stress out that the collected ensemble of requirements lies in the standards' scope of MasterCard (Worldwide, MasterCard, 2007). In return this offers readiness for the step of ticket carriers, which will be bank-cards or mobile phones (Konks, 2013).

The requirements offered for user interface elements divide into three: LED lighting, LCD screens, assistive sticker for the smart-card placement. The interactive visual signals are supported by audio signals.

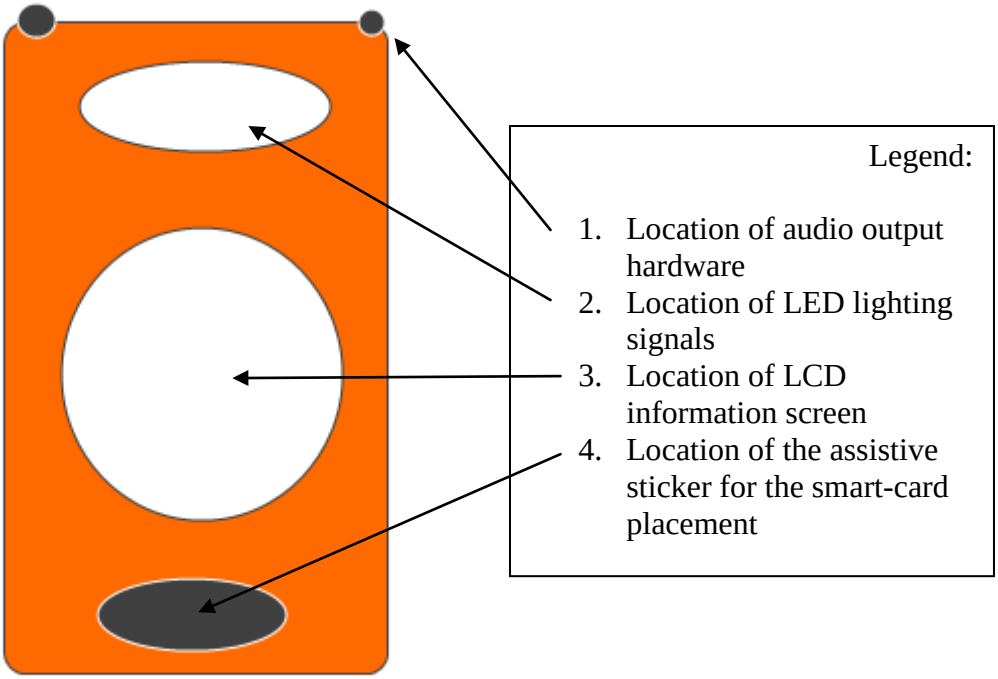

Figure 21 Outline of the possible ticket validator

The service design solutions were based on Elektriraudtee current ticketing system, preserving the selection of tickets offered (one-time, 1-day and 30-day tickets) and sales design currently (based on departure and arrival stations) used.

The online supporting system was constructed in a way, which fully utilizes the trains' on-board Wi-Fi functionality – a selection of smartphone apps, online ticket carrier management and call/SMS-based ticket sales solutions were described.

Chapter 6. Conclusion

The purpose of this master thesis was to give analytically constructed criteria for a public transportation company (in this case Elektriraudtee Ltd.) for the user interface and service design (usage logic) for one's on-board ticketing system.

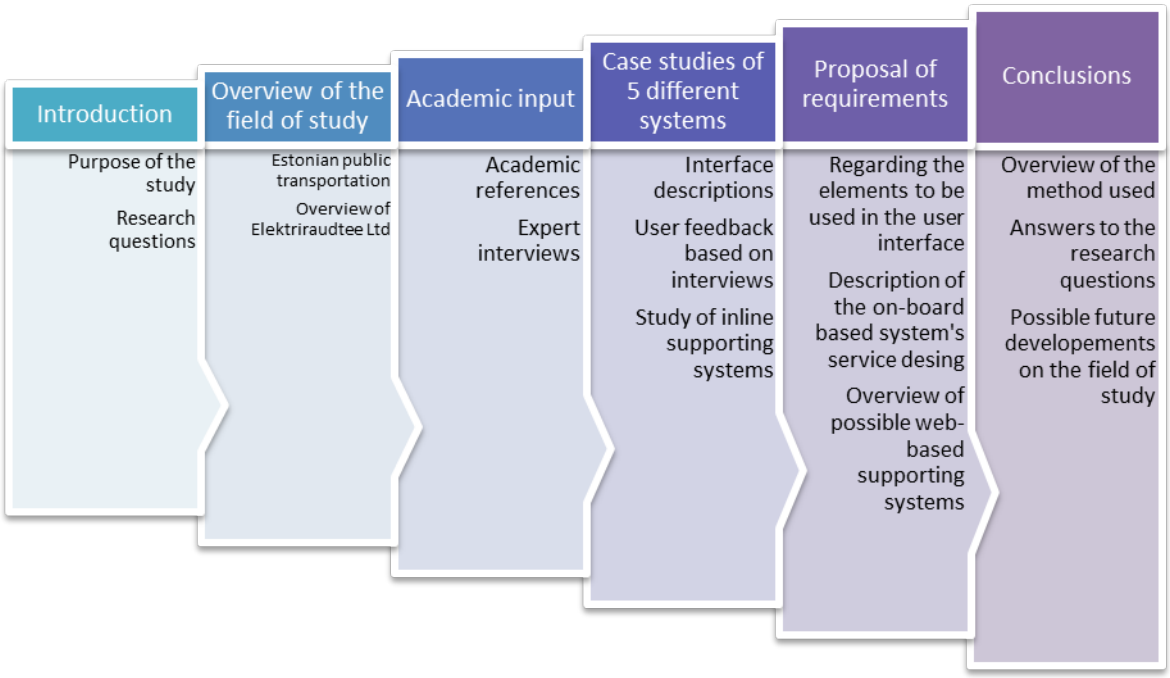

Figure 22 Overview of the work process

This paper results in offering such criteria for the UI of the on-board ticketing system; the built-up of online supporting systems and the overview of service design adapted via the on-board ticketing system.

Final recommendations presented in the thesis can be sufficiently used by any company who desires to implement self-service on-board mass-use cashier systems to its vehicles etc. It is important to state that as the requirements were based on Elektriraudtee Ltd., the proposed requirements suit mostly companies active in the same market or having similar customer basis.

At the beginning, an overview of the Estonian Public Transportation sector was given, as one of the results of this study is to generate a list of requirements for an Estonian mass-transit ticketing system.

For next, the overview of client expectations (demands for self-service systems) was outlined, via the academic review (Reasons behind self-service usage, (Curran, Meuter, & Surprenant, 2003). From the other hand, the system owners requirements for such systems were outlined,

based on the expert interviews carried through with specialists from Estonian public transportation sector's ticketing system developers (Konks, 2013) (Tiitsaar, 2013).

The next step was to carry through case studies of five different on-board self-service ticketing systems located around the Baltic Sea area. Case studies were conducted in a way where the ticketing system's on-board user interface was examined (via usage practice or photo analysis (Riga's case)) in terms of user interface elements used and service design built-up. In an addition, user interviews were carried through with selected everyday users of each public transportation system under study (Appendix 2.1), in an aim to collect user feedback regarding the system's ease of use and overall opinion about the service design of the system. Finally the author browsed through each system's online supporting systems in an aim to gain knowledge of the solutions and service logic regarding the system's online support.

To conclude, the author outlined propositions for Elektriraudtee on-board self-service ticketing system. The requirements offered for user interface elements divided into three: LED lighting, LCD screens, assistive sticker for the smart-card placement. The interactive visual signals are supported by audio signals.

The propositions outlined for Elektriraudtee give explicit input to answer one of the research questions "What would be an effective solution to be used in an Estonian mass-transit on-board ticket-sales interface solution in terms of the speed of usage processes and the ease of use?". This was possible due to the case studies and input gained from expert interviews. As for the second research question "What are the demands for the interface based on the theories of user accessibility and usability principles?", it is objective to bring out the repeated statements by the Estonian experts (Konks, 2013) (Tiitsaar, 2013), who stated, that "*every output from the UI should be dubbed, in an aim to ease the use of the system.*"

A future work direction could go further to the second research question, focusing on expert interviews with minority user groups in the public transportation sector (persons with mother tongue different than used in the UI; persons with visual or hearing impairment etc.) in an aim to create more accessible UI for a wider audience.

Also as there is a constant desire for more seamless and faster transactions in the self-service cashier systems, an interesting are for research would be a realistic overview of the possible experimental input and output elements to be used in such systems. When thinking about the current solution offered in the thesis for Elektriraudtee Ltd, it could have been further developed in the sense, that experimental UI elements would have been offered (face

recognition as a substitute for ticket carrier; vibration as a system feedback for visually impaired customers etc.). As this area requires more extensive research and experiments (testing of offered solutions in real time environments), it gives matter for further research.

Another important tendency to take under further academic review is the privacy-related issues regarding validator usage by customers. Latest developments in Estonia regarding the launch of Tallinn's self-service ticketing system brought a negative reaction from the Estonian Information System's Authority as well as Estonian Data Protection Inspectorate. Both have expressed concerns regarding the system owner's possible capability of unauthorized surveillance[56] or the defence of personal data of personalized ticket carriers[57]. Latest developments in this matter are now involving the Estonian justice system, as the Harju County Court[58] has stated, that the service design logic, where the user has to validate his or her trip, is against the law, as the validation as a process holds the threat of information leaks[59].

[56] Postimees News (December 19, 2012) Ühiskaardi piletisüsteemi turvalisus kahtluse all http://www.tallinnapostimees.ee/1079108/uhiskaardi-piletisusteemi-turvalisus-kahtluse-all/
[57] Postimees News (December 19, 2012) Andmekaitse võib Tallinnal isikustatud ühiskaartide kasutamise keelata http://www.tallinnapostimees.ee/1079666/andmekaitse-voib-tallinnal-isikustatud-uhiskaartide-kasutamise-keelata/
[58] Estonia's first instance court
[59] Estonian Daily Newspaper (April 26, 2013) Kohtuotsus: ühiskaardiga pole vaja piiksutada http://www.epl.ee/news/eesti/kohtuotsus-uhiskaardiga-pole-vaja-piiksutada.d?id=66033990

Chapter 7. Summary in Estonian

Käesoleva magistritöö eesmärgiks oli anda analüütilistel alustel koostatud kriteeriumid ühistranspordi ettevõttele (antud juhul Elektriraudtee AS), juhtimaks kasutajaliidese ja teenuse disaini (kasutamisloogika) ühissõidukis asuva iseteenindusel põhineva piletimüügisüsteemi loomisel.

Antud magistriöö esitab ettepanekuna rea kriteeriume - esmalt ühissõidukis asuva kasutajaliidese disaini puudutav; lisaks veebipõhised tugisüsteemid ning kolmandana kogu teenuse disaini ülesehitus ühissõidukis (kasutamisloogika).

Töös välja toodud soovitusi on võimalik rakendada iga ettevõtte poolt, kes soovib luua iseteenindusel põhineva müügisüsteemis, mis asub mobiilses keskkonnas (sõidukis). Oluline on märkida, et kuigi välja toodud soovitused põhinevad Elektriraudtee AS kirjeldatud tingimustel, sobivad autori arvates loetletud soovitused kõigile antud turul tegutsevatele või sarnase klientuuriga ettevõtetele.

Magistritöö on üles ehitatud viisil, kus töö alguses antakse ülevaade Eesti ühistranspordisektorist, kuna töö üks eesmärke on välja pakkuda soovitused, mis on kohaldatavad laiale ringile ühistranspordiettevõtetele, kes sarnaseid süsteeme soovivad Eestis arendada.

Järgmises etapis keskenduti kliendi ootuste (nõudmised iseteenindussüsteemidele) ülevaatele, mis põhines akadeemilistel allikatel (Reasons behind self-service usage, (Curran, Meuter, ja Surprenant, 2003). Lisaks kasutati ekspertintervjuudes saadud teadmisi, et selgitada võimalike

piletimüügisüsteemide omanike huvid mainitud lahenduste loomisel. Ekspertidena olid kaasatud spetsialistid Eesti ühistranspordisektoris tegutsevatest, piletimüügisüsteeme haldavatest ettevõtetest (Konks, 2013) (Tiitsaar, 2013).

Järgmise sammuna viidi läbi juhtumiuuringud viie erineva, ühissõidukis asuva iseteeninduse põhineva Läänemere piirkonnas asuva piletimüügisüsteemide põhjal. Juhtumiuuringud viidi läbi viisil, kus vaatluse all oli konkreetse piletimüügisüsteemi ühissõidukis asuv kasutajaliides (põhinedes kasutuskogemusel või pildimaterjali analüüsil (Riia puhul)). Antud etapis vaadeldi kasutajaliideses kasutatud elemente ning teenuse disaini (kasutamisloogika). Lisaks viidi läbi kasutajaintervjuu iga juhtumi puhul (Lisa 2.1), mille raames uuriti kasutaja rahulolu süsteemi kasutuskorra asjus ning üleüldist arvamust piletimüügisüsteemi teenuse disainist. Viimasena lehitses autor läbi iga süsteemi veebis asuva tugisüsteemi võrgustiku, eesmärgiga koguda infot funktsionaalsusest, mida konkreetne piletimüügisüsteem pakub kasutajale läbi veebis asuvate iseteeninduskeskkondade.

Viimases osas koostas autor ettepanekud, mida Elektriraudtee AS saab kasutada oma ühissõidukis asuva iseteeninduse põhineva piletimüügisüsteemi kasutusliidese disainimisel. Kasutusliidese elemente puudutavad soovitused jagunesid kolmeks: LED valgustid, LCD ekraanid ning abistavad kleebised kiipkaardi õige asetuskoha asjus. Lisaks toetavad helisignaalid interaktiivseid valgussignaale.

Töös välja toodud ettepanekud Elektriraudtee AS-ile annavad selge sisendi, et vastata magistritöö esimesele uurimisküsimusele "Milline oleks efektiivne lahendus, mida kasutada Eesti mass-ühistranspordi sõidukis asuva piletimüügisüsteemi kasutusliideses, pidades silmas tehingukiirust ning kasutuslihtsust? ". Uurimisküsimusele vastuse leidmine oli võimalik tänu juhtumiuuringutele ning ekspertintervjuudest saadud sisendile. Teise uurimisküsimuse "Millised on nõudmised kasutusliidesele, võttes aluseks kasutushõlbustust ning kasutatavuse põhimõtteid?" vastuseks saab pidada korduvalt ekspertintervjuudes välja toodud seisukohta, milles märgiti, et *“kõik kasutajale süsteemi poolt antavad väljundid tuleks dubleerida, eesmärgiga suurendada kasutuslihtsust,*. (Konks, 2013) (Tiitsaar, 2013).

Käesoleva magistritöö edasine uurimissuund võiks sügavalt käsitleda töö teist uurimisküsimust, keskendudes ekspertintervjuudele, mis on läbi viidud ühistranspordisektori klientuuri vähemusrühmades (isikud teise emakeele; nägemis- või kuulmisvaegusega isikud jne.). Antud uurimissuuna eesmärk oleks anda laiem ülevaade võimalustest muuta senised kasutusliidesed veel laiemale osale ühiskonnast soovitud tasemel kättesaadavaks.

Samuti on iseteenindusel põhinevate süsteemide puhul olemas pidev tarbijasoov aina enam märkamatuma (vähem-häirivama) ja kiirema kasutuskorra järele, kuhu suunas aitaks kirjeldatud piletimüügisüsteemidel areneda akadeemiline teemakäsitlus, kus oleks kajastatud ka eksperimentaalsed sisend- ja väljundlahendused, mida rakendada iseteenindusel põhinevates müügisüsteemides. Kui vaadelda kasutajaliidese lahendust, mille autor pakkus kasutamiseks Elektriraudtee AS-ile, siis see võiks antud juhul kujuneda hoopis selliselt, kus eksperimentaalsed, seni vähese levikuga kasutusliidese elemendid oleks pakutud ühe osana kasutusliidesest (näotuvastus kui piletikandja asemik; vibratsioonid kui tagasiside kasutamisel jne.). Kuna selles valdkonnas on vaja kindlasti laialdasemaid kasutaja-uuringuid ja ka katseid (pakutud lahenduste reaalajas testimine suletud keskkonnas), siis see annab ainest edasiseks uurimustööks.

Kolmas oluline tendents, mida tuleks võtta edasise akadeemilise käsitluse alla, on eraelu puutumatusega seotud küsimused kirjeldatud iseteenindusel põhinevate müügisüsteemide puhul. Viimased arengud Eestis on seoses Tallinna iseteenindusel põhineva piletimüügisüsteemi käivitamisega toonud negatiivset tagasisidet Riigi Infosüsteemide Ametilt ja ka Andmekaitse Inspektsioonilt. Mõlemad on väljendanud muret seoses süsteemi omaniku võimaliku võimega teostada ebaseaduslikku järelevalvet isiku üle või talletada isikustatud andmeid personaliseeritud piletikandjate baasilt. Viimased arengud antud valdkonnas on haaranud endaga ka Eesti kohtusüsteemi – nimelt on Harju Maakohus märkinud, et selline teenuse disaini loogika, kus kasutaja peab kinnitama oma reisi, on seadusega vastuolus, kuna antud protsessis eksisteerib info lekke oht.

Appendices[60]

1 Expert Interviews

1.1 Expert Interview questionnaire

1.2 Interview with Tallinn's ticketing system development project leader Kristjan Konks *(transcription)*

1.3 Interview with Elektriraudtee ticketing system development project leader Tõnis Tiitsaar *(transcription)*

2 User Interviews

2.1 User Interview questionnaire

2.2 Interview with Tallinn's public transportation user Merlin Miido *(transcription)*

2.3 Interview with Amsterdam's public transportation user Kaarel Koosapoeg *(transcription)*

2.4 Interview with Riga's public transportation user Dace Lasmane *(transcription)*

2.5 Interview with Helsinki's public transportation user Valeria Gasik *(transcription)*

3 Tallinn's ticketing system development materials

3.1 Scenario for LCD-based messages

3.2 Overview of possible validator user interface designs

[60] All appendices are located on the DVD added to the thesis or an online location (https://drive.google.com/folderview?id=0B_ELqLw8-twtWGFCVzZsN2FVbW8&usp=sharing)

4 Elektriraudtee ticketing system procurement document

4.1 List of company-set demands for the validator user interface

5 Data tables

5.1 Statistics of customer complaints, Elektriraudtee Ltd.

	I half of 2010	I half of 2012
Complaints regarding sales by customer service personnel	19	100
Overall number of complaints	134	345

5.2 Statistics of Elektriraudtee ticketing channel percentages

Ticket sales kiosks	13%
Via phones	51%
Via internet web page	36%

Table 11 The distribution of the sales of daily and monthly tickets via United Tickets Ltd sales channels

5.3 Statistics of Elektriraudtee online credit upload changes

Credit upload	Online	In train
IV quarter of 2010	334 420 eek (21 373 eur)	2 579 726 eek (164 874 eur)
IV quarter of 2011	31 100 eur	165 134 eur
IV quarter of 2012	35 745 eur	173 353 eur

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