Enabling Future Waterborne Public Transportation With Automated Service Piers.

Human-Centred Service Design for Automated Maritime Travel within the Urban Archipelago.

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This research investigates the future possibilities for recreational waterborne passenger transportation systems within the Helsinki archipelago. Automated service piers (ASP) are examined as a solution within a future autonomous ferry system, to provide and enhance human-centred services for recreational island visitors. The conceptualization of ASP has been completed for the ÄlyVESI Smart Cities Ferries Research Project (ASCFRP) which is developing solutions to promote a future autonomous ferry system within Finnish archipelagos. The ASCFRP is a collaboration between cities (Helsinki, Turku), various technology companies and universities (Aalto University, Turku AMK, NOVIA) and is an EU funded project. The other stakeholders within the ASCFRP are investigating safety engineering, power engineering and ferry design concepts, however, this thesis examines the role of ASP within a future autonomous ferry system.

To develop ASP, an investigation into the progress of autonomous ferry development is conducted within the literature review. As little has been published about autonomous ferries, their progress is situated with some of the developments of autonomous transportation. Human-centred design (HCD) and service design methodologies are examined to inform the development of autonomous smart piers.

The first phase of the design process discovers the needs, wants and desires for the users of the existing ferry system by conducting primary and secondary research. The broad scope of information discovered is then defined. The methods utilized by the designer to define insights include affinity diagramming, personas and customer journey mapping. This investigation reveals that the current skippers not only drive the ferry but are a key enabler of existing service touchpoints. By analyzing both the services that the skippers currently provide and the services that users desire, three guiding design drivers - safety, logistics and exploration - became critical goals for the development of ASP.

After understanding the HCD goals, it became clear that service design methods are required to develop ASP concepts. The author develops future service concepts and touchpoints for users that are either currently enabled by the skipper or desirable for the future system. As these ASP concepts are developed, they are validated with users and iterated prior to delivery.

The four final outcomes of the project include Automated Service Pier Storyboard, Service Blueprint for Automated Service Pier, Possibilities for Future Intelligent Service Piers and Site Specific and Modular Structures and Attachments. This thesis’ ASP proposals provide a road-map for future development and prove that the development of smart urban waterborne transportation, specifically ASPs, require holistic HCD services to flourish.

Keywords: Automation, Urban Waterborne Transportation, Human-centred Design, Service Design
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1. Introduction
1.1 Background

In recent years, the significant developments in the deployment of autonomous technologies throughout various modes of public transportation, have been radically transforming public transit systems in many places around the world. These autonomous developments are beginning to transform public urban transportation by creating traffic efficiencies, reducing human errors and freeing commuting time, however, this is only the beginning of the transformation (Litman, 2017).

The emerging implementation of automation are affecting public transportation vehicles and networks. Some of the automated vehicles and networks that have been implemented include automated metro systems, which have been widely adopted within city transit systems worldwide, and driver-less buses, which are currently undergoing piloting in various urban centres such as Helsinki and Las Vegas (Scott, 2017). Although these vehicles are proving the technology, there are many more autonomous applications that could be realized.

In the seaside capital city of Helsinki, the next frontier in which these efficiencies could be realized is through automating the waterborne passenger ferry system that provides the public with access to recreational islands. Currently, traditional passenger ferries provide people in the seaside city of Helsinki the ability to visit the recreational islands within the urban archipelago during the summertime. These ferries provide a high quality public service which enhance the public’s enjoyment of the city, however, the service could be further enhanced by exploiting autonomous technologies. High quality public transportation is important for critical local public service stakeholders such as the City of Helsinki and the Helsinki Region Transport Authority (HSL) which have both highlighted the importance of developing intelligent technologies to enhance their service offering, create logistical efficiencies and reduce environmental impacts in order to provide a high quality of life for the citizens (City of Helsinki, 2017; City Planning Department of Helsinki, 2013; Helsinki Regional Transport, n.d.). The development of autonomous public passenger ferry system supports these goals.

Currently there are many types of autonomous vehicles that have been in use in many different sectors. Autonomous personal cars are a prominent example, as they have been developed by key technology companies, such as Google which has driven over 5
millions of miles autonomously with their Waymo company (Waymo, 2018). Unmanned and autonomous industrial equipment has been in use in various sectors including agricultural harvesting and mining development which has created increased harvesting efficiencies and miners safety (Eaton, Katupitiya, Siew and Dang 2008; Brown 2012). Furthermore, autonomous technologies have been implemented in public transportation systems including the operation of autonomous public metro systems and the piloting of autonomous public buses. Norwegian organizations including Kongsberg Seatex, Kongsberg Maritime, Maritime Robotics, NTNU and Sintef have created the first autonomous vessel testing area which is located in Trondheim where they have been testing unmanned vessels (Norwegian Maritime Authority 2016). All of these technologies are radically changing their respective sectors, however, there is still further room for further development and implementation.

Autonomous ferries combined with the services offered through the smart pier’s platform, will improve services for users in logistics, navigation and safety. Such a platform not only provide the same services that a driver and the traditional ferry service touchpoints provides, but these services will optimize and enhance features throughout the service. Logistical services will provide all of the services such as ticketing, payments and reservations. Navigational services will allow passengers to understand and book their routes, review the amenities of the nearby islands and understand the location of different historical landmarks on the islands. Safety services will provide all the security that a driver would have traditionally provided users such as allowing the passengers to enter and exit the ferry at a safe time.

Furthermore, automated service piers on either end of the users’ journeys would provide a new easily accessible public service platform for passengers to engage with. These piers could have modular core structures and site specific spatial elements. ASP would be adopted at either end of service the service journey and be implemented at the same time or earlier as the autonomous ferries within the system. The implementation of automation for public waterborne vessels, including the adoption of automated service piers, could improve the public transportation network and travel experiences for people in other various maritime cities in the Nordics such as Stockholm and Trondheim, in the rest of Europe in places such as in Athens and Amsterdam, and international cities such as Vancouver and Brisbane.
1.2 Motivation

Although there are many benefits to be gained from the automation of public ferries, many of the existing services require optimization and adaptation and future services must be developed for the users needs when developing new autonomous solutions. Currently, passenger vessels do not require on pier services as skippers provide a majority of the services to the passengers. Some of these services include providing information about the islands, guiding passengers to safely enter the vessels, accepting fare payments and navigating the vessels. Within an automated ferry system, all of these services must be provided to passengers. Not only maintaining but exceeding the service features that a skipper would traditionally provide is necessary for the success of a future automated public ferry system. Developing a future system does not need just the automation of existing services but the development of services that address the future needs of users. The human-centred services would be enhanced through the development of the future automated ferry system. Because existing ferries utilize an outdated service model and autonomous ferries are at the early stage of research and development, there are significant opportunities to shape the future services of the island archipelago. ASP can provide a platform to shape these services.

1.3 Contribution

The aim of this research is to conceptualize the automated service pier in order to apply the benefits of autonomous technology to the public urban waterway transportation that services the islands of the Helsinki archipelago. Therefore, this thesis proposes service design concepts to support the deployment of autonomous vehicles in the Helsinki archipelago and evaluates their potential impacts and implications on the future users of these services. In order to accomplish the research aims, this thesis utilizes a human-centred design methodological approach to engage with a representative sample of potential users. This qualitative research engages with users through the use of observations, interviews and informal discussions. The data gathered directly informs insights.
about the needs, wants, desires, and concerns of the users. This study has be executed in the three overall phases of the customer journey - before, during, and after service. This process allows the users to inform and iterate the service design concepts as they develop. This research will leverage human-centred design and service design to understand how the possibilities of autonomous waterborne transit innovations might better serve citizens as they explore the Helsinki Archipelago.

This thesis forms part of the ÄlyVESI Smart City Ferries Research Project (ASCFRP), which aims to contribute “new solutions and services for the intelligent transport of mass traffic in urban waterways” (Salokorpi, Kannos, 2016). This EU supported research project is a collaborative initiative between cities, technologies and universities to create new knowledge, models of collaboration, automation technology solutions and service concepts (Salokorpi, Kannos, 2016). The research within the ASCFRP is conducted across various disciplines with many stakeholders investigating such things as safety and business development, however, this thesis investigates and conceptualizes ASP and the services that it would provide users. This thesis will investigate user services but it will not investigate the technological requirements for the autonomous vessels operation.

The smart piers provide a unique opportunity for the development of a temporary docking point for vessels at either end of a route that autonomous urban waterborne vessels may travel. These piers will fulfill required technological necessities and provide a platform of service touchpoints that can create better services that provide value to visitors. The smart pier has the opportunity to provide a platform that fulfills technical features required by the vessels with human-centred services for visitors.

To address the topic this thesis poses the following question:

What role might automated service piers play in the development of human-centred services for passengers while accommodating the development of smart urban waterborne transportation? (Research Question)
1.4 Overview

The remainder of this work is organized as follows:

Chapter 2. Literature Review starting on page 16 explains the relevant literature around the topic. In order to develop an autonomous concept this thesis will explore earlier autonomous concepts in order to find the main features that should be included in this theme.

Chapter 3. Methodologies starting on page 26 presents the methodological approaches that were utilized within the design process. Human-centred design and service design are examined to understand how they can be implemented in the project.

Chapter 4. Process starting on page 39 describes the double diamond design process utilized within this project. Within the discovery, definition and development phases, the methods are defined and how they are used is described.

Chapter 5. Findings starting on page 78 presents the delivery phase of the double diamond design process and the final outcomes of the project.

Chapter 6. Conclusions starting on page 92 presents the authors thoughts and reflections about his progress made over the course of this project. This section also describes how the process answers the design question.
2. Literature Review

The literature review within this thesis will examine the progress and definitions of autonomous developments in vehicles. Currently autonomous technology has been applied to a variety of vehicles. This study contextualizes the development of autonomous ferries with the increasing adoption of autonomous vehicles transportation modes.
2.1 Introduction

Speculations about how automation will reshape urban transportation landscapes into highly choreographed scenes of self-driving vehicles, where human-driven cars are abnormal if not outlawed, have become commonplace visions depicted in major media publications such as the New York Times (Thomsan 2017). These speculative visions for the new transportation landscape are suspected to emerge as a reality as autonomous technologies continue to develop. Although in recent years, the public discourse of autonomous vehicles has revolved primarily around the progress of autonomous cars, there are many other types of autonomous vehicles that are rapidly developing.

The literature review examines the history and progress of autonomous vehicles by reviewing early driverless vehicles, the evolving definitions of automation, and the applications of automation to public transportation, motor vehicles and maritime vessels. Although autonomous ferry developments are only beginning to emerge the final section of the literature review analyzes these developments. To first understand the development of autonomous vehicles, this next section will explain some of the earliest examples of autonomous vehicles and describe how these vehicles are considered autonomous vehicles.

2.2 Early Driverless Vehicles

Nicolas Tesla created a vehicle controlled by encoded radio frequencies transmitted through a remote control. At Madison Square Garden in New York City in 1898 Nicolas Tesla demonstrated a 4’ long unmanned surface vehicles (USV), a type of unmanned vehicle that operates on the surface of water with some degree of automation, which was controlled by a remote control; this device controlled speed, direction and lighting (Cheney, 2011, p.105-118). This demonstration of this USV presented a predecessor to the modern radio, future robotry, automated industry, and guided weapons & vehicles (Cheney 2011).

Although Tesla demonstrated many revolutionary technologies that would not be adopted for many years, his speculation about the future of automated vehicles is profound. In 1889, 30 years prior to the release of the Ford Model T, Tesla proposed car manufacturers to create an automated car which, “left to itself, would perform a great deal of
operations involving something akin to judgment” (Cheney 2011, p. 167). This vision of Nicolas Tesla outlined current autonomous vehicles that are Google Waymo and others are currently developing, more than a century later - fully autonomous vehicles that are able to control and make decisions for themselves.

Although Tesla’s project was revolutionary, it was much too shocking to be understood or acknowledged in its time. The audience and their perception must be considered in implementing new technologies. This is relevant now as new autonomous technologies are poised to radically reshape urban movement in the future. Tesla’s vision also applies to the technology that will be involved in an autonomous recreational ferry system, as the autonomous technology will allow automated ferries to navigate within the archipelago.

2.3 Defining Automation

Tesla gave insight into the visionary about the future of automation which is now proliferating. As automation proliferates, the technology is being defined and developed. The developments of autonomous technology is beginning to reshape the physical and digital world through the creation of new economies and new industries. This restructuring is happening by reassigning tasks which “humans do not wish to perform, or cannot perform as accurately or reliably as machines” (Parasuraman 2000, p.286). These developments are being accomplished by leveraging technology to replace laborious human tasks with more efficient machine automations (Parasuraman 2000). With global traffic accidents estimated to exceed more than 1.25 million deaths every year and maritime accidents caused by human error are estimate to account for between 70% and 95% of errors, one of the tasks that could be performed more safely, reliably and efficiently by machines is driving (Porathe 2014, p. 461).

As autonomous vehicles have progressed in their development, the definitions of the technology have also evolved. To understand the differences in vehicles reliance on, or ability to function without, a human operator, we must first look at the ways in which automation is defined. The Meridian-Webster dictionary defines automation in the following ways:
"1: the technique of making an apparatus, a process, or a system operate automatically
2: the state of being operated automatically
3: automatically controlled operation of an apparatus, process, or system by mechanical or electronic devices that take the place of human labor" (Merriam-Webster n.d.).

These definitions show that automation can refer to completely automatic operation or the replacement of some aspect of human labour with automatic operation. Another definition proposes that automation is "the full or partial replacement of a function previously carried out by a human operator" (Parasuraman 2000, p. 287).

As these definitions suggest that automation can be implemented in both full or partial control, different scales of automation for specific sectors and applications of autonomous technologies have been developed. For some specific cases individualized scales of autonomy are necessary, however, a general scale of autonomy is applied to other autonomous applications. To account for the differences of replacement of human operators with automated processes when applied the different systems, various researchers of automation have created different scales of autonomy which can be used to classify the differences in automated vehicles. Parasuraman’s creation of a scale of levels of automation depicts automation not as a binary of all or none but a continuum with varying shades of self-control (Parasuraman 2000, p. 287). Expert researchers within the Bundesanstalt für Straßenwesen (BASt) the German working group on automated vehicles identified six levels of automation based on the degree of automation (Gasser and Westhoff 2012). For automation in the maritime sector, the most relevant scale of automation is created by Lloyd’s Register, “a leading international provider of classification, compliance and consultancy services to the marine industry” (Lloyd’s Register, 2018). The Lloyd’s register also defines six levels of automation. The six levels of automation according to Lloyd’s register can be seen in Fig. 1.1 - Levels of Autonomous Ships on page 20.

Giving classifications of vehicles based on the level of human involvement clarifies who is responsible for the vehicle during specific levels of automation. The critical transition from human controller to autonomous control is between AL 4 and AL 5 on the Lloyd’s register scale (or level 8-9 in Parasuram’s). The AL 4 level ensures that humans are supervisors and constantly in the loop. They must actively supervise the computers decisions. The responsibility of the errors that the system may make is still within those of the human operator,
AL 0. Manual – no autonomous function.
All action and decision making is performed manually – i.e. a human controls all actions at the ship level. Note: systems on board may have a level of autonomy, with ‘human in/on the loop’; for example, pms and engine control. Straight readouts, for example, gauge readings, wind direction and sea current, are not considered to be decision support.

AL 1. On-ship decision support
All actions at the ship level are taken by a human operator, but a decision support tool can present options or otherwise influence the actions chosen, for example DP Capability plots and route planning.

AL 2. On and off-ship decision support
All actions at the ship level taken by human operator on board the vessel, but decision support tool can present options or otherwise influence the actions chosen. Data may be provided by systems on or off the ship, for example DP capability plots, OEM configuration recommendations, weather routing.

AL 3. ‘Active’ human in the loop
Decisions and actions at the ship level are performed autonomously with human supervision. High-impact decisions are implemented in a way to give human operators the opportunity to intercede and over-ride them. Data may be provided by systems on or off the ship.

AL 4. Human on the loop – operator/supervisory
Decisions and actions are performed autonomously with human supervision. High impact decisions are implemented in a way to give human operators the opportunity to intercede and over-ride them.

AL 5. Fully autonomous
Unsupervised or rarely supervised operation where decisions are made and actioned by the system, i.e. impact is at the total ship level.

AL 6) Fully autonomous
Unsupervised operation where decisions are made and actioned by the system, i.e. impact is at the total ship level.”

Fig. 1.1 - Levels of Autonomous Ships
(Lloyd’s Register 2017, p.1-2)
however, when full automation in AL 5 is enabled, the ship is responsible for its own decisions. Defining automation levels does allow for vehicles to be classified, however, the classifications do create some ethical concerns such as the priority of actions in cases of eminent collisions (Gerdes and Thorton 2016). With the vast variances in waterborne vehicles, collision avoidance scenarios when coordinating with human boat operators requires in-depth analysis regarding the ethics of collisions when applied to the maritime industry.

The scope of automation can vary for a variety of reasons. The implementation of automation varies from removing much of the mental workload of operators to removing the human operator completely thus eliminating errors caused by them, however, new types of errors may emerge. Automation technology must be designed carefully to ensure that new types of errors are limited. The benefits of automation are poised to create many efficiencies and reduce accidents.

Autonomous technology has been innovating quickly within on-road vehicles. Some of the benefits that autonomous vehicles in urban environments are expected to achieve are increased safety, reduced space requirement, create traffic efficiencies and lower congestion (Smith and Svensson 2015). Although safety is considered to be a benefit, piloting of autonomous buses in Helsinki, shows that user perception of driverless buses are either equally safe or safer without a human operator, however, emergency management and security are perceived as worse without a driver (Salonen 2018, p.108).

It is clear that there are many possible benefits for autonomous vehicular technology that could be applied to an automated ferry system. The application of autonomous technology to the recreational ferry system in Helsinki must consider the level of autonomy for the system. This will define how many operators will be within a control centre and what kind of services these operators can provide in different situations.

2.4 The First Automated Public Transit System

Currently, autonomous public transportation can be seen in selected cities across the world in fully automated metro systems. The reported benefits of automated metro systems include lower operating costs, reduced wait times, increased frequency, higher capacity and lighter trains (Cohen, Barron, Anderson and Graham 2014).

The Vancouver public transportation network - Translink - implemented advanced
Automated Service Piers

Automation technology within its local metro network in the late 1980’s. In 1986 the first unattended train operation (UTO) was completed in Vancouver, Canada (Castels 2011). As the host of the World Expo in 1986 Vancouver was in a complicated political climate. As the city required either a mass metro system or a central freeway system for Expo86. As the theme for Expo86 had a focus on transportation and communication one key reasons for Vancouver adopting a driverless metro system in 1986 was a desire to pioneer innovative transportation technologies on the world’s stage of Expo86 (Castels 2011). Furthermore, the technology for the metro system was developed in Canada and was highly successful when it was released.

Although many UTO metro systems was implemented in Vancouver more than 30 years ago, there are often barriers to implementing. In Helsinki, the metro system was set to be automated in 2014, however, there have been various barriers to implementation. When completing metro driver and traffic controller interviews in Helsinki, one researcher identified that there are many hidden roles such that “the drivers anticipate, observe, interpret, and react to events in the surrounding environment” (Karvonen et al. 2011 p.1-2).

The pioneering of this technology was an example of how adopting of new public technologies can bolster a cities reputation. As Finnish organizations are leading pioneers of autonomous waterborne technology, creating the first autonomous ferry system could bolster their reputation and that of Finnish cities as well however it is necessary to examine the role of the drivers and ensure that there are no impacts to the level of service for passengers.

2.5 Autonomous Progress in Maritime Industry

Automated metro systems, autonomous personal vehicles and autonomous public buses have shown some of the benefits that can also be realized in the maritime industry. The evolution of automation within the maritime industry begins with the proliferation of unmanned surface vehicles (USV). The development of USVs began with Nikola Tesla’s performance at Madison Square Garden, however, it was not until the 1990’s that a proliferation of USV’s began (Bertram, 2008). The majority of USV’s have been created after 1990 for navy purposes such as reconnaissance and surveillance as these vehicles are operated remotely and can be either manned or unmanned. These vessels are small or medium in
size from 2-15 metres in length operating at up to 35 knots in calm water (Bertram 2008). All of these vessels have the ability to be remote controlled however some are able to operate in autonomous autopilot modes.

The maritime industry continues to see radical changes as the development of USV’s has evolved into autonomous maritime vehicles through ongoing developments by many public and private stakeholders. Currently the industry is undergoing rapid development and implementation new autonomous technologies including autonomous navigation (Cross and Meadow 2017).

Autonomous maritime technologies when attributed to shipping have the potential to profoundly impact the field. There are several organizations within the maritime industry that are working towards fully unmanned autonomous shipping technology such as Rolls-Royce Marine and Kongsberg Maritime which are looking to be the first to develop autonomous ships for commercial use (Kongsberg 2016; Levander 2017). Public research initiatives such as MUNIN investigated the feasibility of unmanned shipping and the implications of autonomy on human error (Porathe 2014). Furthermore public-private partnerships have been established to coordinate industry and research such as the Advanced Autonomous Waterborne Applications (AAWA) partnership (Rolls-Royce 2018). The AAWA is a joint partnership between Rolls-Royce Marine, ship designer Deltamarin, satcom technology company Inmarsat, class society DNV GL and ship design and ship operation software developer NAPA in addition to Finnish academic institutions VTT Technical Research Centre of Finland, Tampere University of Technology, the University of Turku and Abo Akademi (Rolls-Royce 2018). Other stakeholders are researching the implications of information and communications technology (ICT) on shipping by examining the risk implications to understand their compliance with existing maritime rules, regulations and classification of ships (Lloyd’s Register 2017).

A few ways that the global shipping industry will be affected relate to the absence of a driver and crew. Without the time constraints caused by the economic feasibilities in place because of the driver and crew, who account for a major share of the operating expenses of a cargo ship, shipping speeds will be able to reduce to increase fuel efficiency (Levander 2017). This elimination of operators and crew is feasible because of the potential of autonomous technologies to reduce human errors, however, such technologies need to be calibrated, maintained and constantly monitored by humans so there are many new challenges to ensure safe operation of the vessel (Hogg and Ghosh 2016).

Currently many commercial ships are outfitted with low level automation technol-
ogy such as electronic navigation instruments that determine the ship’s position, distance to other ships, their course and speed as well as the predicted trajectory (Blanke, Henriques and Bang, 2018). Fully implemented autonomy will be explored to develop technologies that would allow the ship’s systems to understand and interpret their situation to make decisions to capably navigate through any situation that may happen in their surroundings (Jalonen, Tuominen and Wahlström 2017). Currently there is significant research being conducted on the safety and security of unmanned ship operations.

Currently the level of automation technology that has been developed and applied are AL 1, AL 2 and AL 3. The first ship to be receive Lloyd’s Register AL 3 level descriptive note is the MV COSCO Shipping Aries Vessel in January 2018 (Lloyd’s Register 2017). This ship provides a clear examples of how quickly the shipping industry is innovating autonomous shipping solutions. Many of the technologies utilized in maritime shipping can also be applied to autonomous ferries so an autonomous ferry system within the Helsinki archipelago could become a reality in the near future.

2.6 Autonomous Ferries

The developments in autonomous technologies within waterborne vessel are becoming a reality. Although no ferries have currently been developed, Rolls Royce’s VP of Innovation, Oskar Levander, estimates that autonomous ferries will become a reality in 2020-2022 (Levander 2017). There are many opportunities to implement autonomous ferries as a mode of transit into the urban fabric of cities around the world. This is because numerous cities, including Helsinki, are either adjacent or intersected by bodies of water. Many cities benefit from local ferry system as a part of the public transportation system, however, automation can provide additional benefits and feasibility.

Leading Finnish digital service agency Reaktor also recognizes that urban waterborne transit could be the next frontier of transportation that autonomous vehicles could transform. They suggest that in maritime cities, investing in urban waterways and public water transit could be a viable way to reduce the stresses and emissions when compared to conventional transportation infrastructure whereby the reduction in manual labour costs could create an appealing business model (Hagström n.d.). Further to the practical gains that would be realized, autonomous ferries would create unique experiential opportunities for mass transit users when adopted into their daily routines. Hagström suggests
that urban autonomous passenger vessels would produce four societal impacts: they would increase the level of mass transportation service, easily adapt to the usage of users, improve the quality of living and add opportunities for new service touchpoints (Hagström n.d.).

Currently researchers in Trondheim, Norway are examining the benefits of an autonomous ferry within their transit network. The project is funded by MAROFF programme of the Research Council of Norway and funds two PhD candidates, one post-doctoral fellow and several MsC candidates based at NTNU to develop the Revolt test ship then a fully certified passenger ferry (Brekke 2016). The researchers are attempting to prove the prospected economic advantages of autonomous ferries when compared to the infrastructure investments of building a bridge, by leveraging the municipalities historical attachment to maritime activities and by proving the concept through a test ferry and full scale ferry certified for passengers (Brekke 2016). The development of this autonomous ferry would be considered a success if they achieve several safety and reliability issues such as “monitoring and support from harbour authorities” and “ease of use” (Brekke, 2016).

Two MSc thesis’ have been completed within this project to this point. One masters thesis completed within this project examines technical requirements of the Revolt model scale ship including its application to docking where the model ferry successfully performed a docking test (Alfheim 2017). The second MSc thesis completed within this research project examines the technical requirements around docking. Although this thesis presents a scenario of docking events and examines the technical requirements, it additionally specifies some services such as automatic ticketing that are required to serve customers within the future automated system (Bitar 2017).

As there are clear benefits and businesses cases for autonomous ferries, companies such as ABB Marine, Kongsberg Maritime, Rolls-Royce Marine and Wärtsilä are developing autonomous ferries in private. This project in Trondheim, Norway is a primary source of public academic publications related to autonomous ferries, however, user-centred services have not yet been published. As the digital service consultancy Reaktor recognizes opportunities for innovative service touchpoints, this thesis attempts to identify ASP service touchpoints for users of a future autonomous ferry system in the Helsinki Archipelago. The race to develop the first operational autonomous ferry is underway.
3. Methodologies

To investigate the design methodologies which inform the development of autonomous smart piers, human-centred design and service design methodologies are examined. HCD is investigated based on contrasting definitions and stakeholder involvement. The increasing importance of services in contemporary society and the role of service design is investigated.
3.1 Introduction

When approaching a design brief, there are various ways in which designers can work towards developing a solution. The overall approach to a design brief can be considered a methodology and these can be adopted for various reasons. Some reasons why designers may adopt a certain methodology are based upon the desired amount of stakeholder involvement such as user as inspiration, human-centred design, collaborative design or the intended outcome such as service design, UX design or product design. Within the methodologies section of this thesis, the methodological approaches are examined to be appropriate for the project brief. Furthermore, the overall methodology throughout this work, human-centred design (HCD), is described and compared with alternative approaches of stakeholder involvement. As this project pivots towards developing service design specific outcomes, the later part of this section will describe the development of service design from HCD. The evolution of service design from HCD, is reviewed as well as some of the different applications service design. Furthermore, the contrasting applications of service design through varying amounts user involvement is reviewed.

3.2 Human-centred Design

Human-centred design is a methodological design approach that can be utilized by practitioners who are developing design solutions for various problems by understanding the perspectives of stakeholders. HCD is characterized by the relationship between the ‘designers’ developing solution and the relevant ‘stakeholders’ of the problem including the ‘humans’ whom the design is intended. HCD coordinates with various relevant groups of people, however, there are varying understandings among academics and practitioners about the extent and scale in which the different these relevant groups are involved within a HCD project. HCD is utilized in this project to understand the existing ferry system and develop ASP concepts.

To appropriately adopt the HCD approach within this project, a clear definition of human-centred design is necessary however, there exist varying discrepancies of definitions of HCD. To propose a definition of human-centred design that fits this project, we must first understand the variations among existing definitions. In addition to creating
a definition of human-centred design, this section of the thesis situate human-centred design among other methodological design approaches. This section will propose a definition of HCD as it is utilized within this thesis. Human-centred design and the creation of a framework of methodological design approaches categories will provide clarity about human-centred design and how it is interpreted within this thesis. In understanding the differing definitions of HCD and various methodological approaches to design this sections attempts to clarify what the author means by HCD to clarify its selection within this thesis.

Methodological design approaches often differ by the design methods adopted during the design process. For this thesis, the methods utilized are fundamentally those of HCD. The specific methods utilized in this project will be described in the following chapter about the process.

3.2.1 Contrasting Definitions

As human-centred design is a methodological approach which has been researched by many academics and utilized by many contemporary practitioners, variations among the boundaries of the definition occur. This section summarizes the origins of the approach and depicts the varying shades of differences that occur in research and practice.

The origins of the human-centred design methodological approach evolved from methods that were devised to develop appropriate solutions for the users of these new machines. In 1969 Nickerson (1969) acknowledged the need to understand human factors issues about the users of computers. In the 1980’s after user-centred design, a process which focused on the needs of only the end user, became widely adopted, a HCD approach diverged by expanding the UCD user focus to include a focus on human capabilities more broadly (Ritter, Baxter, and Churchill 2014).

The evolution of human-centred design from UCD was founded on a semantic choice to emphasize diverse human involvement to emphasize the impacts of all stakeholders not just the end user (DIS 2010; Steen, 2011). Although the origins of HCD differentiated the approach from UCD there are varying viewpoints about their contemporary relationship in research and in practice.
3.2.2 Stakeholder Involvement

Contemporary discursive variations about HCD reveal discrepancies about where its situated in relationship to the UCD approach and as such provokes questions about the diversity of those involved in the process. Although the HCD and UCD approaches are often considered to be distinct, for some these terms are regularly used interchangeably and frequently as synonyms (Lee, 2012). Some researchers and practitioners (INUSE, 2015) use the terms HCD and UCD interchangeably, while others (Lee, 2012) use HCD to encompass not only UCD but other human focused approaches as well. The varying extent to the exclusion of stakeholders within these definitions reveals that individuals involved in a project can range from only end-users to all stakeholders and still be considered HCD depending on the definition of HCD used.

Within projects that utilize a human-centred design approach there exists a consensus that developing an understanding of relevant some humans, from end-users to all relevant stakeholders, is necessary, however, there are deviating theories about how an understanding of these individuals is obtained. On one side experts argue that within HCD user understanding is gained from the designers engaging with users in an investigatory process to gain insights through dialogue. Alternatively other researchers believe that participatory involvement of users is vital within the HCD design approach. Additionally, some believe that user involvement from users engagement to user involvement can all included within HCD.

As INUSE (2015) defines the HCD approach as “giving the needs, wants, and limitations of end users of a product, service or process extensive attention at each stage of the design process” (INUSE 2015), they do not include user participation within the HCD approach and focuses fundamentally on the end user rather than all relevant humans. Giacomin suggests that “human centred design is based on the use of techniques which communicate, interact, empathize and stimulate the people involved, obtaining an understanding of their needs, desires and experiences” (Giacomin 2014, p. 610). Within his variation of the approach involvement includes not only users but all relevant actors but the extent of involvement does not include participatory action in the designing of solutions. Instead, this approach engages in developing an understanding about the stakeholders involved through various investigatory methods. The ISO standard on human-centred
design includes all types of stakeholder involvement from users as sources of data to participatory actors (DIS 2010). IDEO (2018), a leading human-centred design consultancy, only considers the HCD approach to involve “the people you’re designing for as you immerse yourself in their lives and come to deeply understand their needs” during the early inspiration phase of a project so in this sense they consider users and clients as sources of insight but not active participants in the process. Although some consider there to be differences among those involved and the extent of their involvement, others consider a vast array of possibilities of involvement and participation. Steen considers the HCD approach to include participation in facilitating “researchers and designers attempt to cooperate with and learn from potential users of the products or services which they are developing” (Steen 2011, p.45). JJ Lee’s inclusive understanding of HCD allows both users and stakeholders engagement and involvement as well as empathic design and collaborative design (Lee 2012). Although these definitions of the HCD approach includes varying degrees of individuals in the design process, the extent to which they include them also varies.

HCD refers to a design process which includes people but this can vary in diversity and extent. For some, human-centred design but for others it can include non-user stakeholders. HCD can also vary in the extent in which people are involved in the design process from sources of inspiration to active participants. Although for some the human-centred design approach can act as an overarching term, for others it can refer to a specific amount of stakeholder diversity and type of engagement.

3.2.3 Other Approaches to Stakeholder Involvement

As HCD varies in its inclusion and involvement of people, to better understand this approach it is necessary to examine other methodological design approaches as they vary in the aspects in which HCD is unclear. In this section different methodologies approaches are categorized by the relationship between designers and the involvement of stakeholders in approaching a problem. A categorization and comparison of methodological design approaches facilitates an understanding of what is uniquely HCD. The involvement of users within design methodological approaches can be categorized on a spectrum. On one side designers are primarily active wherein user engagement and involvement is absent,
whereas, on the other side stakeholders act as empowered collaborators where users are primarily active designers and designers can act as facilitators (see Fig. 3.1: Scale of Designer Involvement on page 33). The three methodological design approaches categorizations depicted include users as inspiration, stakeholder as collaborators and stakeholders as designers.

The first methodological approach categorization represents users as inspiration. In this approach, rather than understanding stakeholders through engaging with them designers passively understand users in such ways as intuition or secondary research. In this approach, expert designers create solutions for users without any direct guidance from them. Designers envision solutions that will appeal to users through their own insight and intuition as design professionals. In this approach ‘designers’ are the only users in the design process (Zhang and Dong 2009). In this approach, users are not involved in design development process in anyway, however, they may be involved in market research testing. Stakeholders are comprised exclusively as members of the product development team. Challenges of this approach often allow designs to be copied (Baldwin and Von Hippel, 2011). Although, this approach to problem solving has allowed designers to create products suitable and desirable for users without their input, the input of users can oftentimes allow for better products when compared to increasing competition. As the complexity of problems which design is attempting to address has grown, the insights and participation of users are a vital way in which these problems can be addressed.

The second methodological approach categorization represents stakeholders as collaborators. As HCD uses stakeholders as consultants, ‘stakeholder as collaboration’ approaches include them as participants within the design process. Within this approach users are viewed as collaborators through the “collective creativity as it is applied across the whole span of a design process” (Sanders and Stappers 2008, p.6).

The design process involves users as active members of the design team throughout the development life-cycle. Stakeholder diversity in each project can vary, however, more diverse groups are considered to be valuable. Although this approach can allow for more diverse results, some challenges include the difficulty coordinating and resources required to coordinate and include a diverse body of users.

The final methodological approach included in this comparison is stakeholders as designers. In methods where stakeholders act as designers, participants are actively creating for themselves. In these approaches, users form innovator communities primarily
independent from design experts. Within this approach, users are at the core of the design process. In this approach, stakeholders comprise of user communities often brought together by a common interest in the outcomes that they are developing, however, companies are increasingly approaching communities to design products and services for themselves. Some of the challenges with this approach include the difficulties in making products widely used because of the unknown techniques, skills and resources but could be a source of inspiration for traditional developers.

3.2.4 Approach

In this way, within this thesis I understand HCD to include varying stakeholders perspectives, but only through stakeholder engagement methods, not stakeholder participation. The title HCD does not need to be a catch all phrase, it can refer to a specific methodological approach which differs from user inspiration and collaborative design. For this thesis I attempt to delineate the design methodologies although I recognize that there are blurry boundaries between the methodologies. As human centred design is a methodological approach for examining various problems, one type of problem that human centred design can approach is that of services. The practice of service design is considered by many researchers and practitioners to be based around the human centred design approach. As the body of work in this thesis became service design oriented, understanding the service design approach is necessary. The next section will review service design as it relates to human-centred design in detail.

3.3 Service Design

In today’s society, services have become increasingly important offering in serving the demands of people; service design is a way to address these demands. The increasing importance of services can be seen in their representation of gross domestic product in developed nations representing between 60 and 70 percent of GDP (Erlhoff and Marshall 2008, p.354) to 80 percent (Katzan 2011, p.44) for most developed nations. Furthermore, most new jobs created and business founded fall within the services or tertiary sector
of the economy of developed nations (Mager 2009). In representing a vast majority of the GDP, new jobs and founded businesses, services are vastly diverse. Although services first became an important topic in marketing in the 1970’s (Kimbell, 2009), the concept of service design emerged in the early 1990’s (Erlohoff and Marshall 2008) and has developed in a variety of ways to address the varying complexity in the diverse demands of services.

Although services can vary greatly, there are four constructs unique to services, namely, intangibility, heterogeneity, inseparability and perishability (IHIP) (Zeithaml, Parasuraman and Berry 1985), which are often referred to by service design researchers and practitioners. Although recently the IHIP model has been criticized when applied to services as a single entity, the FTU framework of service provisions (facilities, transformation and usage) validates the four IHIP constructs when they are applied to a specific stage of a service (Moeller 2010). Furthermore, a service is “a socially constructed temporal event that possesses a lifecycle” (Katzan 2011, p.44) and are part of a larger system. Additionally, the value of services are realized through co-produced only when the value proposition is delivered by the service provider and consumed by the user (BlackMon 2011; Sangiorgi and Meroni 2016).

Service design emerged as an application of the human-centred design approach but specifically addressed the complex demands of services “to understand or influence the behaviour of people” (Mager 2009, p.38). The application of service design as a human-centred design approach is significant in the way that practitioners and researchers address the development of services for people. More specifically, the HCD based approach of service design understands, plans, develops and organizes the service offering of a firm, its users and its stakeholders. In the same way that HCD considers relevant stakeholders, the objectives of service design are to satisfy the service requirements services for both the
users and other stakeholders as well. Although service design utilizes a HCD approach to services, there are a variety of considerations specific to service design.

A service system is based around a network of coordinated service touchpoints, the physical or digital places that users engage with, which function through the supporting back-end processes. Service design enables a holistic alignment of front-end and back-end interactions with the service providers strategy. “Whilst working on the details of a touchpoint you need to keep in mind where that touchpoint sits within the whole customer journey” (Stickdorn 2011, p.118). Individual service touchpoints are arranged to create a system of planned interactions to deliver a unified message to achieve the strategic business goals of the service provider and creates value for the user.

Although there exists no single accepted definition for service design, the following description frames the practice in a broad and inclusive way.

“Service design addresses the functionality and form of services from the perspective of clients. It aims to ensure that service interfaces are useful, usable, and desirable from the client’s point of view and effective, efficient, and distinctive from the supplier’s point of view. Service designers visualize, formulate, and choreograph solutions to problems that do not necessarily exist today; they observe and interpret requirements and behavioral patterns and transform them into possible future services” (Erlhoff and Marshall 2008, p.355).

Varying definitions exist not in the ways which the service design attempts to address the development of services but in their relation to the complexity of service systems. As a service is made up of a network of touchpoints which includes signs and products, service design is inherently more complex than most information design and product design problems, however, the complexity of services can vary. Service design problems include the overall service system and the various touchpoints within them. Researchers and practitioners often do not acknowledge specifics that go into developing these individual information or product based touchpoints and instead define service design by the most complex problems that service design can address.

Wicked problems are complex societal problems such as those of public policy (Rittel and Webber 1973) which Buchanan suggests that designers can begin to address through “new integrations of signs, things, actions, and environments that address the concrete needs and values of human beings in diverse circumstances” (Buchanan 1992, p.21). The integrations of orders of design that Buchanan is referring to are present within
some complex service design problems, however, researchers such as Lugt define service
design in way that suggests that service a “service design problem is a ‘wicked’ problem”
(Lugt 2009, p.203). Not all of the issues that service design addresses however are wicked
problems. Certain multidisciplinary applications of service design have the ability to
address the wicked problems of complex service systems, however, different applications
of service design are necessary for those of different service systems.

Although the overall objectives of service design are clear, many researchers and
practitioners have conflicting definitions about the process related to the extent of the
application. Sangiorgi and Junginger (2015) have pointed out that the service design canon
requires further understanding about its impact throughout society. One way to under-
stand the impacts of service design in various applications throughout society is to under-
stand and differentiate the applications and impacts of service design and compare them
with different approaches. As service design proliferates the academic and professional
spheres in many forms, the Service design process must be reflected in academic litera-
ture in the different ways that it exists in practice. A key differentiation in the approach is
the extent and diversity of stakeholder involvement within the design process.

Considering this, service design should not be considered to be a fundamentally
human-centred design practice. Service design should be classified in a different way. One
way that service design could be classified is by clarifying the amount of user involvement
in the process. This could be completed by signifying the methodological approach of
user involvement when proposing service design. User inspired service design, user cen-
tred service design, Human centred service design and collaborative service design could
be some of the ways in which service design could be clarified to signify the user involve-
ment in the process. It is important to signify the user involvement in the service design
process to add transparency to the process. Different levels of user understandings and
thus design outcomes can be achieved through different levels of user involvement. Dif-
ferent levels of user understanding are important for different types of design outcomes.

In this way, the design output could be another way to clarify the service design
process, however, due to the vast possibilities of outcomes that can be achieved within
the service design process this type of signification is difficult. Although difficulties arise
in this alternative clarification of service design, less user involvement is related to less
holistic design approaches and more user involvement can facilitate comprehensive and
radical service design innovations. When aiming to complete comprehensive service
innovations, which requires comprehensive design work and will drastically shape the way stakeholders engage with a client, it can be considered important to not only engage, but collaborate with stakeholders. One reason the human-centred design and co-design were first considered and remain to be considered valuable for service providers is their ability to understand the requirements of these stakeholders. Service design in this project is utilized within a human-centred design methodological approach because that is the approach that is considered appropriate by the designer within the context of the project.
Fig 3.2 Author 2017. Image of Särkkä, Harakka Pier.
4. Process

This section describes the design process of the author while designing solutions for autonomous ferry piers. This section describes the first three phases of the authors design process of the project - Discovery, Definition and Development - and the methods he utilized.
4.1 Overview

This section describes the design process which utilizes a HCD methodology and my selection and application of suitable methods. Having established the overall methodological approach within Chapter 3: Methodologies, this section describes my design process to address the objectives posed in the brief from the ASCRP. Within my process, I utilize a selection of HCD methods and explain their implementation. These methods have been selected for strategic reasons; the overall method mix attempts to investigate the research landscape of this project and propose outcomes that satisfy the initial brief and research question.

This section describes my HCD process for understanding and developing automated service piers. The design process is not a linear toolkit. The process of designing is an approach to problem solving which requires an in depth understanding of the selection, application and iteration of different methods. Although the selection of methods for any design process can vary greatly, my design process uses several established design methods. This design processes uses a common approach to organizing the method mix over a design process through the use of a double diamond design process visualization (Design Council 2015).

The double diamond process was adopted for planning the methods utilized in developing concepts about automated service piers. This model depicts the four phases of a design process and the convergent and divergent modes of problem solving within
each phase. The process section describes the first three phases of the design process which include discovery, definition and development (Design Council. 2005) are described within this section. The final phase of the project, the delivery phase, is described in the findings section where the outcomes of the project are presented.

The first diamond within my process visualization depicts my use of HCD specific methods to investigate and make sense of the problem landscape. Although I began my process with HCD specific methods the second half of my process makes use of several service design specific processes as well. The transition to service design processes developed as the appropriate outcomes for the users became increasingly service focused. In this sense my double diamond illustration acts as a roadmap for the ‘process’ and findings sections.

As will be seen in my pivot from HCD to service design, my design process was iterative, whereby, different methods were applied, implemented and improved along the way. Although the double diamond illustration seen in Fig. 4.1 on page 39 depicts a linear and logical process that this section will follow, the reality is often less clear. The design process is often messy and non-linear. Fig. 4.2 (below) depicts the approximate timeline and schedule of the design process and the methods utilized during the design process as my chronological schedule. Although this figure is more chronologically accurate than the double diamond, the double diamond is useful in building a coherent narrative about a design process. The remainder of this chapter will be dedicated to explaining the design process within the double diamond structure.

![Fig. 4.2 Project Schedule](image-url)
4.2 Discovery

When initially approaching a problem with a design process, the discovery phase encourages the designer to investigate the problem area. The problem landscape often has many new areas and opportunities to investigate. The discovery phase of the double diamond process encourages divergent thinking and the selection of various methods of discovery. Within human-centred design, the context of discovery is centred around the people whom you are designing for.

“Designers try to look at the world in a fresh way, notice new things and gather insights”  (Design Council 2015)

To begin the discovery phase in this project, I interpreted the project brief from ÄlyVESI to form my own research question to guide my approach of the design problem. These objectives guide an investigation into many different sources of information. Prior to my initiation with this project, I was vaguely familiar with a few technological progressions of towards automation in commercial shipping vessels, however, I was not familiar with the automation of passenger vessels. Furthermore, I had only visited the main Helsinki archipelago island - Suomenlinna. Because of this, I selected HCD discovery methods to broadly understand the problem space before utilizing tools that allowed me to dig deep in the experiences of users. Although there are many tools available, I first utilized methods to gain a broad understanding of the problem space before selecting methods to dig deeper into the people.

This section depicts the method mix I chose to gain an understanding about the existing ferry system, its users, and their views about automation of passenger vessels. The background research method reviews secondary research to establish the local context. Beginning my investigating into the different available sources about the existing system.
After developing an appreciation and understanding of autonomous ferry progress and the local ferry context, I began to observe and immerse myself in people and their interactions with the local ferry system. Having immersed myself in the contextual environment and observing how people interacted with the system, I had various questions to ask the users. I developed a set of questions which I asked people in the field. The established methods that I utilized to approach developing an understanding of the problem landscape include:

4.2.1 - Initial Brief starting on page 43
4.2.2 - Background Research and Literature Review starting on page 44
4.2.3 - Ethnographic Observations and Immersion on page 46
4.2.4 - Field Interviews starting on page 50

To understand the existing system and proposals for the future two relevant resources aided my discovery of the problem landscape. Firstly, there were secondary sources in the previous thesis’ conducted within the ÄlyVESI project provided a relevant introduction to the design space. This work proposes developments that coordinated with the desired outcomes of this thesis. In this way this work acted as a starting point as well as proposals of adjacent services in the overall proposed autonomous ferry system. The literature review represents part of my discovery process in developing an understanding of autonomous waterborne transportation systems in general. The literature review analyzes developments within autonomous vehicles in various urban contexts, however, when approaching the design brief in a human-centred design way, I investigated the local context and developments.

The discovery phase of this project became specifically concerned about investigating the local context. Because the autonomous waterborne system is proposed to replace the existing system, the investigation began by looking at the existing ferry system. The existing ferry system including its informational resources and its users were available to investigate as the project began in September and many of the recreational ferries were running. To investigate the existing system, ethnographic investigation and immersion as well as user interviews were conducted to discover the existing ferry system. Additionally, I had many questions to ask the different users of the ferry system how they felt about the current system and the future system as well.
4.2.1 Initial Brief

The initial focus of addressing a design problem with the discovery process, especially when framing the process within a double diamond process map, is to understand and contextualize the initial brief. The beginning of most design processes begins with a brief or problem to investigate. Often times the initial design briefs are reinterpreted by the designer to frame the design investigation in a specific way. Reframing the brief can guide the design process and create more clear objectives.

“In this task the aim is to find out ideas and concepts of a smart quayside for the traffic of an autonomous ferry and more widely for additional services. Design engineering of the pier concentrates on e.g. ticket sales, access control, accessibility of disabled, safety aspects and also on transferability of the pier. Concept specification of smart pier will be a result of this task.”

(Salokorpi, Kannos 2016)
brief I determined that it is critical to view the design outcomes specified in the ÄlyVESI task as services for the people who may be using the ferry system. Because the services specified in the ASP initial task are intended to be used by end-users, understanding their perspectives are critical in addressing the problem. To specify the importance of the end user I specified human centred outcomes within the research question. The research question for this thesis I posed can be seen in the introduction on page 14.

The drafting of the research question was an iterative process which evolved as I understood more about the topic. The briefing then was refocused into proving part of smart urban waterborne transportation should be the ASP. This pier should be developed in a human-centred way. This briefing defines HCD should be part of an autonomous ferry system.

4.2.2 Background Research and Literature Review

This background research method is a relatively straightforward tool that refers to the investigation of secondary research to understand the context of the research question. Often times this investigation can look into various informal, official and academic documents.

The background research and literature review method within this project seeks to understand the existing ferry system and recently proposed autonomous developments through these types of documents. The background research investigation found information in three areas. Firstly, the literature review began a broad investigation reviewing different related academic writings. Secondly, I investigated official and informal information about islands. Finally, I reviewed the completed ÄlyVESI thesis’ to situate some of their conclusions as the starting point of this project.

The results of the literature review can be seen in section 2. Literature Review on page 16, however, the process and extent of literature that was actually reviewed in developing this thesis was important in the understanding of my topic. I reviewed many different topics related to autonomous evolution and public transportation experience.

To understand the existing services, I investigated various information published by official sources such as the City of Helsinki and Helsinki Regional Transit (HSL) as well as various informal online information about the islands and the ferries. In reviewing this
information I discovered some information about each of the 21 ferry routes and the various operators. Additionally the review of the previous thesis allowed me to understand the design space of my thesis. The information gathered from the informal documents allowed me to understand the area of investigation in conducting my own research. It helped me to choose locations to observe and immerse myself in. See Appendix B for all the documentation I viewed during the background research process. In many cases there are not links to relevant information available online. For non-Finnish speaking residents and tourists, there is a lack of guiding information in English and even if it is available online it is often difficult to access. The guidebook of islands “Tule Ja Tutustu Stadin Saarin - Helsingin vesiliikenteen aikataulut 2017” which has the most unified and comprehensive information about the different islands and their offerings is not available in Swedish or in English (Liikuntavirasto, H. 2017). This publications provided a comprehensive catalogue of all of the islands in a single PDF. It may be valuable for the city of Helsinki to have a Google searchable website based upon this PDF. Such a service could easily be made more widely available on a digital platform in several languages.

Fig 4.3. Helsinki ferry Map.
The existing ÄlyVESI thesis’ allowed me to review the other design work which has been completed as a part of the project. As Kruskopf investigated digital services for the ferry system as well as a vision of one short range autonomous ferry, this helped me to understand the design space of my own thesis (2017). At this point I generally understood the area between the existing pier and Kruskopf’s ferry concept where my ‘smart pier’ would generally fit. With the general understanding of the ferry system and existing design proposals, I went into the field to further understand the system and investigate the people who may use it.

The initial process of discovering basic information such as the ferries locations, departure points and destination island proved to be difficult because they were not available within my typical public transportation planning services. This is because official information from the City of Helsinki or HSL for many of these journeys are not coordinated or optimized to populate other services or to search online, however, within the city website, there are valuable documents for tourists and for myself in my research to understand the system as a whole.

These three types of sources provided me with information about the existing ferry system, islands and amenities and led me to find the places and people that I wanted to investigate further.

4.2.3 Ethnographic Observation and Immersion

Ethnographic observations and immersion are methods of discovery to investigate people in their natural environment. Within a design process, these methods allow designers to immerse themselves in a specific context to document and observe humans in an environment. In documenting and observing, the designer can discover the problem area and observe contextual human behaviours. This can allow the observer to gain insight into the experiences and behaviours of users within the systems they are investigating.

The design ethnography process began in this project as a way to understand the overall context of design through observations and immersion. With the background research into understanding of the ferry system, the author had developed some starting points for initiating ethnographic observations. Ethnographic research was utilized early in the project to understand the overall network of local of ferries to recreational islands.
within the Helsinki region. This design space was investigated both by experiencing the existing ferry system and by observing others engaged in the process. Placing the designer into the context of a ferry system users led to the designer attempting to discover the ferry system himself.

“go where the customer works, observe the customer as he or she works, and talk to the customer about the work.

(Beyer and Holtzblatt 1998, p. 41)

The designer immersed himself in the design context by visiting 9 piers in Helsinki and 5 islands to understand context of users in the contextual design environment. The process of documenting the space was through observing, photographing and jottings when immersed in the context. To better understand the context of my thesis work I viewed several ferry passenger loading zones, took five ferries and visited two islands. This exploratory research has helped me to understand the scale of the ferries and the services that they may offer. Each different ferries that I experienced were unique which was both interesting in terms of the different experiences that the boats offered but frustrating in comparing the service times with the other ferries as there was not a unified platform to do so. Visiting the different islands also provided me with a better understanding of the types of services and information that are available to visitors.

The process of conducting ethnographic observations and immersing myself in the recreational island ferry system provided me with several general themes of information

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<tr>
<th>Date</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 17, 2017</td>
<td>Uuisaari Visit</td>
</tr>
<tr>
<td>September 21, 2017</td>
<td>Vallisaari Visit</td>
</tr>
</tbody>
</table>

Fig 4.4 Schedule of Ethnographic Observations

Fig 4.5 Schedule of Ethnographic Immersions

(left)
to investigate further. Some of this information was useful in crafting specific questions for contextual user interviews but much of the information was left to be analyzed in the definition phase. The general themes about the existing system that I wanted to investigate further included availability of information, payment system preferences, how the driver affects experience and first-time ferry system experience.

The ethnographic and immersion method was my first method for conducting primary research about the existing recreational island ferry system. The photographs, jottings and sketches provided me material to analyze in the definition phase and provided a foundation for the to create a design program.

“Driver appears to provide many services for passengers

- Driver answered questions of a young couple with two kids
- Driver accepts payments - card and cashbox
- I use my card to pay
- Passengers sit around ferry
- Driver announces we are departing after untieing boat
- Land and Driver moores the boat
- Driver says that he will be in the cafe waiting for more passengers and how to reach him with the sign post
- driver says last ferry time”

Fig 4.6 Raw Ethnographic Jotting Mustasaaren Pier

Fig 4.7 Ethnographic Jotting Uunisaari (Transcribed)
Fig. 4.8 Mustasaaren Dock Sign. 07.09.2017.
Fig. 4.10 Vallisaari Dock. 21.09.2017.
Fig. 4.12 Kauppatori Docks. 13.09.2017.
Fig. 4.9 Harkka Särkkä Dock. 13.09.2017.
Fig. 4.11 Uunisaari Dock. 13.09.2017.
Fig. 4.13 Föri Ferry. 19.10.2017.
4.2.4 Field Interviews

Field interviews are “conducted in the environment, or context, in which the service process of interests occur” (Van Dijk, Raijmakers and Kelly 2011, p.155)

Interviews are a useful HCD method as they allow the designer to ask users about their viewpoints directly. The HCD interview method first engages with users generally with general questions to establish a connection and then attempts to get more specific information by digging deep into specific topics. Field interviews are “conducted in the environment, or context, in which the service process of interests occur” (Van Dijk, Raijmakers and Kelly, 2011). They allow designers to investigate information and opinions directly from users about a specific design space. Semi-structured interviews can investigate targeted areas but also open up the conversation to understand a wide range of the users’ desires.

The field interview was vital in investigating the design requirements of the users of the ferry system. By building upon my own observations, I engaged in semi-structured interviews with users to ensure that the users’ perspectives were clearly understood and represented in this project. With the information that I gathered from the background research and ethnographic research & immersion methods different areas of knowledge emerged where I wanted to dig deeper and ask users questions within contextual environments. I engaged directly with end users in a dialogue to understand their needs, wants and desires. A desirable place for conducting interviews appeared to be within their service journeys. These environments within the ferry system were desirable because they would allow users to reference their current experiences while answering my questions. The goal of this was to refine and verify the direction of the design program for the development of a service design plan. This allowed for user-centred perspectives and facilitated user involvement in the project.

A script of semi-structured questions for contextual interviews was created to explore new areas and build upon information that I had already discovered (See appen-
dix B). These interviews were created with open-ended questions to engage the users in explaining their experiences but not to guide them in any way. Crafting the interview questions in this way was intended to allow the most honest responses from the users. The data collected from these interviews was valuable to understand the end users further during the definition phase.

In addition to asking questions about the existing ferry system, the interviews also investigate the relationship between ferry system users and their opinions about autonomous technology. I crafted the interview questions to understand how users felt about the current ferry system, how it could be improved and their opinions about driverless vehicles - both in general and future driverless ferries. The process of conducting interviews allowed me to understand the needs, wants and desires of people in Helsinki who could use the ferry system and helped me to understand the unique requirements of autonomous for ferry system users.

Ten interviews were conducted with ferry system users in the ferry context to understand their viewpoints better. I attempted to include a representative sample of the different users of the system as a whole. I interviewed people in various stages of life of different genders. I attempted to gather interviewees from different demographic groups when I was selecting them in context. Furthermore, I engaged Finnish people living inside and outside of Helsinki, non-Finnish people living in Helsinki, and tourists. Additionally, some of the people inside Helsinki were living on Suomenlinna.

The themes of interview responses ranged widely from reasons for traveling to on island service desires. I discussed the perception of automation of ferries with users and to my surprise no major concerns emerged. One senior, Heikki, proposed that maps were required to understand your position while on the ferry (see fig. 4.14). Some user generated concepts were created as a result of interviews such as a digital island passport to encourage discovery, AR binoculars and on ferry live location.

“I have to see where we are coming or going - a point on a map - you would have to see where you are coming and going and where the other boats are going - in traffic - not in some dark room on the deck. See where they are going. You have to make a switch apparent for disembarking or boarding so you can see when you can board and unboard.”

Fig 4.14 Quote from interview with Heikki - Suomenlinna Ferry, November 23, 2017
4.3 Definition

The first diamond within the design process represents the discovery of a broad understanding of the design space. The definition phase seeks to reframing the different information gathered during the discovery process about specific insights. The definition phase falls within the later half of the first diamond which represents the converging of the discovery phases into research insights.

“The second quarter represents the definition stage, in which designers try to make sense of all the possibilities identified in the Discover phase. Which matters most? Which should we act on first? What is feasible? The goal here is to develop a clear creative brief that frames the fundamental design challenge” (Design Council 2015).

Within this project, the goal of the definition phase is to make sense of the primary and secondary research data that was collected during the discovery phase investigation including the users and their experience with the existing ferry system of the design problem. I used established definition phase methods to make sense of the research data. To do this I grouped different ideas into thematic categories (affinity diagramming), visualized the data categories as human stakeholders (personas) and understood the journeys of prototypical customers through the existing system (customer journeys). The goal of this phase was to synthesize insights from the various data I uncovered during the discovery phase to better understand the areas that specifically need to be addressed for the stake-
holders if and when the ferry system becomes autonomous. The methods that I used to make sense of the information that I collected through the discovery phase include:

4.3.1 Affinity Diagramming starting on page 53
4.3.2 Personas starting on page 56
4.3.3 Customer Journey starting on page 57

By reviewing the results of all the definition phase methods, different themes emerged which needed to be addressed. In this way, these methods aided the definition of three guiding HCD goals for the outcomes of this project

4.3.1 Affinity Diagramming

“The affinity shows the scope of the customer problem: it reveals in one place all the issues, worries, and key elements of work practice relevant to the team’s focus.”  

(Beyer and Holtzblatt 1998, p. 154)

Affinity diagramming is a technique utilized to make sense of complex information through categorizing individual pieces of data into clusters. This process enables ... insights. The specific process of affinity diagramming is used after conducting discovery phase research. The process involves clustering different pieces of data collected into thematic groups which become an affinity diagram (Beyer and Holtzblatt 1998, p. 154). The groupings develop into thematic clusters or patterns which represent a pattern of the users or system. Eventually a model or framework that reflects and documents the categories or themes, as well as the relationships between and among themes, is created.
This framework can represent the knowledge of what people commonly experience in the problem area. After establishing a framework, the themes and the model drive the designers choices about what to do and what to make.

I approached affinity diagramming with the data I gathered through the discovery phase methods that I chose. I employed affinity diagramming with the data set I gathered and mapped this information into clusters of thematic groupings and patterns. Some of the clusters and patterns that emerged were based on the users, their experience with the ferry system and future autonomous service requirements.

These thematic clusters allowed me to refocus my definition of the design problem. Reframing all of the data clusterings and rearranging them allowed me to focus my definition of the design problem. This gave me the opportunity to review and reflect on the problem space and direct the focus of my research according to the emergent problems. To further develop and humanize these themes this data gave me the foundations into developing personas.

Within this process, the affinity diagramming process produced valuable insights about the users challenges, motivations and goals within the ferry service system. The affinity diagramming process allowed me to begin developing insights that populated four personas and a customer journey map of the existing service.

This was useful in developing an understanding about the different motivations of users. Furthermore, these customers populated the customer journey and showed me more precisely where problems exist and where to focus design outcomes. Some of the insights that were developed during affinity diagramming include:

**Unified Information System and Signage**

Within the existing system there is a lack of unified information available about the logistics of visiting the islands and the island’s amenities. When visiting departure piers, it was unclear in some cases whether the ferry was still operating in early September, specifically for visiting Mustasaaren from Töölö departure. Additionally, much of the signage is inadequate for those passer-byers who may be unfamiliar with the ferry service system.

**Fare Payment**

The payment and fare system, in most cases, relies on the driver. Most times the driver accepts cash or credit payments directly and Helsinki City Transit cards are not
accepted except on the Suomenlinna ferry. The Suomenlinna ferry is an oddity among the recreational ferry fleet as it operates through the winter to serve the residents of the islands. This ferry accepts HSL fares and transports vehicles as well. This is by far the most utilized ferry with the most accessed landmarks.

**Captain or Driver as Skipper**

As I became more familiar with the roles of the ‘ferry drivers’ as I initially referred to them, I realized that this terminology was not adequate for their duties and responsibilities. As they are the main service provider on and around the boat I realized that they should be referred to as skippers to embody this.

**Skipper Responsibilities**

For the non-Suomenlinna ferries, the ferry operations are primarily skipper guided. Not only the payment systems but the driver acted as a tour guide, providing information for island goers and ensured the safety and wellbeing of the travelers.

**Requests Available**

The skipper provides critical role in traveler experience. In many cases the ferry operations were completed on a relatively accurate schedule, however, a ferry request system exists when lines of sight are available for the driver from one pier to another. There is a signpost that users can flip to signal to the driver that there is a user looking to travel. Although this system is valuable to save some operating costs, the use of this posting system can be unclear to first time visitors.

**Unified Information Online**

There is a lack of information for novice users to request a ferry. There is limited tourist information available. Island visitors may discover various unique landmarks only from exploring themselves. Some of these landmarks exist on the island of Vallisaari where there is a small lake which signage advertises swimming. Additionally there was an open-air photographic exhibition on the island.
4.3.2 Personas

Personas are utilized to make sense of the diverse requirements of varying users. Persona’s distill the information from research and can create realistic representations of different user typologies.

“Personas are fictional profiles, often developed as a way of representing a particular group based on their shared interests.” (Van Dijk, Raijmakers and Kelly 2011, p. 172).

Personas are fictional profiles that are developed as a way to represent a particular group based on their shared interests. Their representations can facilitate dialogue and present data in an engaging way. A common way to create personas is to collect research and insights into groupings of common traits or representative characters. One key reason to use personas in HCD is that it provides various perspective into the users. Personas can depict the needs, wants and desires of various user groups and represent realistic motivations.

Within this project personas were utilized to take the insights developed with affinity diagramming from the primary and secondary researched gathered during the discovery phase to visualize these insights in a way that reveals humanistic archetypes. This transformation was realized through four user personas. Four user representations were realized by creating four personas with realistic user embodied characteristics directly informed by research. (see Fig. 4.16 Persona - Hitoshi, Fig. 4.17 Persona - Aleksanteri, Fig. 4.18 Persona - Liina and Fig. 4.19 Persona - Helen).

The discovery phases uncovered several types of users with varying demographic information such as age, gender, nationality and residence. Additionally, these people had various experience levels with the ferry system and reasons for their current trips. I mapped characteristics and motivations of the users to create representative personas. With these fictitious personas, I aimed to create vastly different representations of the
types of individuals that use the existing recreational island ferry system. In this way, I combined traits of people into four categories that create the widest representation of all users in the system.

Residential location: This category is meant to categorize the desires that the type of people may want when visiting Helsinki. Although this category does not necessarily mean that someone because Suomenlinna is by far the most visited island it is hard to ignore the fact that this destination is more tourist oriented than others. This is reflected in my categorization and additionally there are people who live on Suomenlinna who have unique motivations for using the system.

Experience with the Helsinki ferries: This axis is useful to understand how differently users understand the system based on their experience with the ferries.

![Figure 4.15 Persona Differentiation](image)

Fig. 4.15 Persona Differentiation
**Motivations for Visit**
To experience Finnish cultural, historic and scenic landmarks. Suomenlinna allowed a diverse experience and has great restaurants.

**I took the ferry because somebody who was going to Suomenlinna told me that I can use my transit ticket.**

**Biography**
Hitoshi is traveling to Helsinki from Japan is staying for 3 days to explore. He wants to visit the places in Helsinki that are especially unique from Japan. Being from the dense city of Tokyo he is looking forward to exploring Finnish landmarks through some unique site-seeing and cultural experiences. Reading in his guidebook he understands that tranquility in nature as a part of Finnish culture as well. He plans one day for the archipelago to visit Suomenlinna historic landmarks and will consider heading to Vallisaari if time allows.

**Personality**
- Introvert
- Thinking
- Sensing
- Judging

**Interests in Island Service**
- Restaurants
- Nature
- Cultural
- Beaches
- Historical
- Sauna

**Likes**
- Travel card accessible
- Ease of accessibility for Suomenlinna
- Information about history and scenery
- Historic ships

**Dislikes**
- Difficulty finding information.
- Precise time planning requirements

**I took the ferry because somebody who was going to Suomenlinna told me that I can use my transit ticket.**

(Autonomous ferries) would be cool but I think that a lot of foreign travelers would want to see the old ferries.

**Fig. 4.16 Persona - Hitoshi**

Sea enables unique tourist experience
Aleksanteri Nybacka

Age: 33  
Profession: Developer  
Family: Single  
Bio: 10 years in Helsinki after university in Tampere

Motivations for Visit
To get away from the busy city and recharge in nature but without the hassle of traveling to a national park. I might spend the night camping with a fire.

Biography
When Aleksanteri plans a trip to a recreational island in Helsinki he wants to escape the city and get away from services. He notices many islands when he explores his surroundings on Google maps but then finds that the ferry schedule might not accommodate him. The only service that he desires is the ferry to get him to a remote island and the ferry to get him home. On the island he would like to spend a night camping and relax with a fire.

"The sea is an important element whether it is summer winter, fall or spring. I like to walk beside the sea." 

"Last summer planning an overnight trip ... checked the ferry schedule then it turned out to be difficult because the ferries were a couple of times per day."

Sea promotes wellbeing & recreation

Fig. 4.17 Persona - Aleksanteri
Liina Akkola
Age: 55
Profession: Engineer
Family: Husband and adult kids
Bio: Suomenlinna Resident

Motivations for Visit
Taking our sailboat to a nearby island. Going to a less crowded island to enjoy the beaches and relax.

"Just walk around and maybe sunbathing or go to swim ... it is free time so i don't need any extra activities there."

Biography
Liina grew up in Helsinki and spent her summers on an island in the Archipelago. It was her dream to raise her kids on an island. She moved to Suomenlinna with her husband and children.

Although most of the time she enjoys Suomenlinna, there are many times when she would like to escape to an island less crowded with tourists with more untouched nature. Sometimes she would sail to one of these islands but other times she might take a ferry.

Sea services enable Island Living.

"I might go to the websites and check for services available such as cafe's or restaurants."

Fig. 4.18 Persona - Liina
Biography
Helen came to Helsinki as an exchange student during her master’s studies two years ago. She met her boyfriend Juuso during this time and decided to stay in Helsinki.

She really likes the atmosphere of the small capital city of Helsinki where there are many happenings in the local art community. She found a job at an artist run gallery through the art scene.

When she goes to an island she wants to see unique cultural activities. Suomenlinna has galleries and theatre.

Fig. 4.19 Persona - Helen
4.3.3 Customer Journey Mapping

The customer journey tool was created to depict the customer’s point of view within a customer’s existing service journey. The tool not only enables a depiction of the service period itself but also depicts the before and after service experiences as well. The customer journey canvas can be utilized documenting existing services and in conceptualizing new service journeys.

“A customer journey map provides a vivid but structured visualization of a service user’s experience. ... This story details their service interactions and accompanying emotions in a highly accessible manner”

(Van Dijk, Raijmakers and Kelly 2011, p. 151).

The findings of the discovery phase allowed for the creation of detailed insights with affinity diagramming. Some of these insights have been contextualized in the chronological service touchpoints they represent within the customer journey. The customer journey canvas tool developed by Canvizer provided me with a platform to first express my understanding of the customer journey before further contextualizing the journey with my own iteration of the method. The customer journey canvas organized my understanding of the design space for the current ferry system and the future autonomous ferry system. This understanding was seminal in gaining a holistic understanding of the existing system. Customer journey visualizations have been utilized to document the existing service (see Fig. 4.20 Existing Customer Service Journey) but later as well to document the driver enabled services within the customer journey (Fig. 4.21 Key Skipper Enabled Services within the Current Customer Journey) and to iterate on the proposed customer journey (Fig. 4.24...
Comparison between Existing and Proposed Customer Experience for Pier & Pre-Departure Services).

After creating these systematic insights about the system through affinity diagramming and vivid pictures of various users through personas, I opted to use the customer journey tool to visualize the customers progression through the existing service system. This tool allowed me to map many of the things that I learned and better understand the users through their journey. I mapped both inexperienced and experienced users to view the journeys through different lenses within the same system.

Within the existing overall customer journey map I visualized the experiential highs and lows through data I gathered about the system. By visualizing these highs and lows throughout the experience I could understand how the existing system was working. With this I was able to see that the services which the skipper enabled were experiential high points for both representational groups of users. The skipper on the small ferries provides many of the services. This visualization helped me to understand that there is an opportunity to spread the services enabled by the driver earlier in the customer journey to allow a more consistent service offering. Many of the experiential lows within the early journey are a product of a lack of information which the driver later fulfills. Bringing these driver services earlier can be enabled through automation and better early stage services. The customer journey facilitated insights into the three major stages of the journey which include:

**Pre-service:**

When analyzed in the customer journey canvas it becomes apparent that pre-service activities are limited or disorganized. Information regarding logistics about the travel experience are dispersed throughout individual ferry operator websites. Social media accounts are not created specifically for the ferry enabled customer experiences. Furthermore it is unclear how previous users engaged with the service directly through service touchpoints.

**Service:**

With limited information points, it is clear that the ferry driver enables service experiences more than any other actor. The ferry operator is one of the key touchpoints of the service. The ferry operator can guide users in their service experience. Much of
### CURRENT CUSTOMER JOURNEY MAP FOR RECREATIONAL ISLAND VISIT

#### PRE-SERVICE

<table>
<thead>
<tr>
<th>USER ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learn of islands, research trips and gain awareness of potential experiences</td>
</tr>
<tr>
<td>Plan trip, Coordinate plans, review ferry timetable.</td>
</tr>
<tr>
<td>Navigate to pier area with desired transportation method</td>
</tr>
</tbody>
</table>

#### PHYSICAL EVIDENCE

| |
| City websites, brochures, ferry operator info |
| ferry operator websites |
| Ferry operator websites, brochures, maps |

*See I for system information*

#### PHYSICAL EVIDENCE (Cont.)

| |
| Signage, sometimes flags |
| Pier and sometimes benches |

#### EXPERIENCE

| |
| Experienced user |
| First-time user |

#### QUOTE

*Last summer I was planning to go to them but it seemed kind of tricky and expensive.*

*Last summer planning a trip ... it would be hard to go there. We were planning to go there overnight and it turned out to be too difficult.*

#### QUOTE (Cont.)

*Yes I know from bits and pieces scattered around different medias. I don’t know if I know all of them or how to reach them.*

*Yes I know of them.*

*Difficult to find information about the pier.*

---

Kruskof proposes digital information and navigation services and pier signaget (Kruskof 2017)

*Investigation area of this thesis*
<table>
<thead>
<tr>
<th>PIER &amp; PRE-DEPARTURE</th>
<th>*Project brief</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferry arrives, captain Moore, boat, passengers onboard.</td>
<td>Ferry skipper welcomes passengers and provides information</td>
</tr>
<tr>
<td>Ferry skipper, boat, payment machine</td>
<td>Captain, payment machine</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FERRY</th>
<th>ISLAND</th>
<th>RETURN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferry Journey to island then unboarding at island pier.</td>
<td>Depart, find signage and navigating to destination of interest</td>
<td>On island experience</td>
</tr>
<tr>
<td>Signage, skipper</td>
<td></td>
<td>Same as outgoing journey</td>
</tr>
</tbody>
</table>

*See 2 for skipper enabled services

“the captains you buy tickets from ... I wouldn’t feel very safe with a grumpy one ...[ask] what time the last boat comes back.”

“I would like to trust them and that they know the boat - that is their main job.”

*Wayfinding varies by island. Valliseami pictured has good signage.

Kruskof proposes ferry design concepts (Kruskof 2017)

Fig. 4.20 Existing Customer Service Journey
the experience of the recreational island experience is up to the individual ferry operator, however, these services are not unified. Ferry operators do not have a standard of service and are not required to guide users experiences. There is a tourist information centre on the Suomenlinna island, which provides good information when planning a visit the this specific island, however, other islands are not served by this information.

**Post service:**
Further to the confusion in the pre-service activities and the lack of consistent information during the recreational island experience, the post experience touchpoints are not specifically established for the ferry network. The points of contact are scattered through different organizations. There is no clear point of contact or social media account to follow up with.

### 4.3.4 Design Goals

Through the methods and tools that I selected and complete in the development stage, I was able to identity three main design goals as being the most essential for the future autonomous ferry system’s automated service pier touchpoints’ development within this project. As a result of the insights made during the definition phase, three main drivers appeared to guide the process which include safety, logistics and exploration.

**Safety**
This design goal refers to the safety and security of the passengers while they are between their arrival on the pier until they leave from the destination dock. While they are engaging with the physical and spatial elements of the automated service pier, the users safety should be prioritized. Currently the skipper provides safety and security of passengers, however, automation with no human supervisor creates a critical need for safe outcomes.

**Logistics**
The logistics design goal refers to the fundamental processes in facilitating users to purchase a fare and understand the schedule for the ferries. Currently physical and digital schedules are problematic with both being unreliable and difficult to access. The
most reliable way to understand the schedule is by speaking to a skipper when they are on the pier. Without the driver, it is vital to provide reliable on-pier ticket purchasing services and scheduling information. Additionally these services should be provided in various places along the service journey with digital service touchpoints.

**Exploration**

When customers desire information about the current amenities or services on an island the skipper often can provide the most current information. Although there is some information online about the various islands’ current information, these are unreliable, difficult to access and many times are only available in Finnish. On the pier, customers need to be advised about vital amenities such as washrooms and availability of food, however, even more exploration material can be provided as well. This information should also populate digital service touchpoints.

In Fig. 4.21 Key Skipper Enabled Services within the Current Customer Journey - I was able to map the skipper enabled services onto the customer journey map and categorize the services based upon the three design goals. The skipper must be concerned with establishing safety, logistics and exploration within the customer journey of users. The skippers currently provide various services for users. The specific services along with the design goals they fulfill situates and provides a picture of the necessary future requirements in the existing customer journey.
1. Key Skipper Areas of Responsibility

When examining the existing customer service journey, there are three service areas that must be maintained or enhanced for the customers when the skipper is removed as a result of automation.

**SAFETY**
- The captain facilitates safety for ferry system users.
- The ferry driver gives users the feeling of safety.
- Safety is a priority for most passengers travelling by ferry on the sea.

**LOGISTICS**
- The captain enables passengers to travel by selling them tickets.
- The captain maintains schedule and ensures that passengers know the schedule of the remaining departing ferries so that they do not miss the ferry.

**EXPLORATION**
- The captain can provide users information about different concerns users may have about the journey to and facilities of the island.
2. Skipper Enabled Services

- Answers questions
- Accepts payment
- Captain maintains schedule
- Ensures comfort and safety
- Skipper responsible for safety of passengers
- Captain supervises passengers' actions
- Captain docks at destination pier
- Ferry navigates to destination
- Passengers unload
- Captain provides information about departure times

*project brief*

Ferry captain welcomes passengers and accepts payment for journey
Skipper readsies passengers for travel journey and departs
Ferry captain, boat, payment machine
Captain, payment machine

Ferry Journey to island then unboarding at island pier.
4.4 Development

The development stage marks a transition from attempting to understand and make sense of the problem space to developing and testing solutions. With the knowledge gained from utilizing a selection of methods to discover a problem landscape and define the critical areas of development, the designers can work to develop concepts. The development of problems is thus situated within the users needs. This is because the different sense making methods provide the context for the development methods.

“The third quarter marks a period of development where solutions or concepts are created, prototyped, tested and iterated. This process of trial and error helps designers to improve and refine their ideas”

(Design Council 2014)

Within this project the development stage began when framing had been carried out. As the discovery phase and definition phases providing a foundation of understanding, service design emerged as an appropriate methodological framework to utilize in the development stage of this project. Through the definition phase of the project direction, concepts to resolve the design challenge were sketched, visualized and iterated. Within this phase, concepts were continually iterated and evaluated with users service design tools became appropriate based on the projects developments. The types of tools were initially conceptualized within this phase of the project. The results from the service design process form the outcomes of this project.

The first resulting tool from ideation was the conceptualization of the automated service pier with ideas about how the service touchpoints resulting from the redundancy of the skipper could be spread across the service journey. Some concept were discussed
with users and their insights make up the suggestions for moving forward.

4.4.1 Sketching and Modeling starting on page 72
4.4.2 Proposed Customer Journey Map starting on page 74
4.4.3 Validation, Field Testing and Iteration starting on page 75

The service design process was based upon earlier investigations into users to create design suggestions to guide the Helsinki ferry system towards an autonomous future. The outcomes created include service maps and visualizations of the pier service systems. Service design was utilized to suggest unified user experiences through various touchpoints. As the scope of this project was the smart-pier the touchpoints are based around these piers. As service design is a holistic process, it is necessary that a unified system is developed throughout the service system so the project also provides suggestions for some elements outside of specific design area.

The process of this development and ideation focused on all three modes simultaneously understanding one component as a part of the system and visualizing them. I developed an understanding the current system and users visions of the new system with several critical components. I ideated and visualized the necessities of the new system. I tested and evaluated with users. Additionally, I ideated future services in the service blueprint. This process was done iteratively with visualizing through sketching and modeling to visualize how the process might look while attempting to logically reorganize the services.
4.4.1 Sketching and Modeling

By understanding the existing customer journey and iterating various customer touchpoints that would need to be spread across the customer journey, including the automated service pier platform, within the future customer journey provided a starting point for ideation I developed sketches and concepts for services and structures. These artifacts I began conceptualizing were always based upon the research completed into the reality of the users. I would sketch different service touchpoints and try to understand how they would be perceived by the previously created personas within the customer journey. This was a messy development process that went through iterative cycles. As I began to establish a desirable customer journey through sketches of touchpoints and services, I began to create a storyboard about a generic customer journey.

The existing customer journey was not plagued by a driver providing inadequate services. In most cases the driver was considered to be a key enabler and provider of services. In this way the ideation need to consider how to enhance service quality by spreading the service touchpoints and interactions across the pre-ferry departure (on-pier). As safety, logistics and explorations are the three key drivers of the project for replacing the ferry caption, touchpoints which considered these drivers were developed. Additionally this method allowed me to develop the concept for attaching the ASP to existing piers.

Fig. 4.25 Sketches of Pier Layout and flow
Fig. 4.22 Sketches of fare validation and security gate

Fig. 4.23 Early Proposed Customer Journey Sketches
4.4.2 Proposed Customer Journey Map

Within this project, customer journey mapping (see 4.3.3 Customer Journey Mapping on page 57) began to be adapted from a definition method to a method for conceptualization and development. The current and proposed customer journey map (see Fig. 4.24 Comparison between Existing and Proposed Customer Experience for Pier & Pre-Departure Services on page 77) began as a reinterpretation of the initial customer journey map (see Fig. 4.21 Key Skipper Enabled Services within the Current Customer Journey on page 69) to express a possible future outcome. I iteratively created this map as a way to organize my findings about the users desires for future services within the customer journey. This visualization provided a simple platform to experiment with different service touchpoints and their location within the service journey.

Furthermore, I was able to interpret my understanding about how these proposed service touchpoints would affect the highs and lows of the user experience. As I iterated different possibilities, I found that spreading the previously skipper enabled service touchpoints throughout the service journey would likely create a more balanced user experience.
4.4.3 Validation, Field Testing and Iteration

Within my design process, prior to finalizing the storyboard that I was developing about the different on pier touchpoints, I was able to test, validate and then iterate the storyboard through interacting with users. To validate and test the storyboard concept, I created validation storyboards with strategic selections of information and context. I first would ask the users various questions to test if I included all of the touchpoints they desired. The next storyboard would test if I included all of the touchpoints that they desired. The final test would review their perceptions of the system as a whole.

The information that I gathered from this storyboard allowed me to iterate on the storyboard before finalizing this outcome. I developed many of the components of the storyboard sketching and three dimensional modeling. The storyboard provided a foundation for the service blueprint, possible visualizations and modular & site-specific representations to develop from.
### CURRENT CUSTOMER JOURNEY MAP PIER & PRE DEPARTURE

**USER ACTION**
- Identify pier through signage and review related information (schedule)
- Wait for ferry to arrive. If possible, request ferry with pole

**PHYSICAL EVIDENCE**
- Signage, sometimes flags
- Pier and sometimes benches

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### PROPOSED CUSTOMER JOURNEY MAP PIER & PRE DEPARTURE

**USER ACTION**
1. Identify pier through signage
2. Review off pier digital schedule
3. Enter desired pier.
4. Identify ticket machine and possibility to download app.
5. Connect with desired platform
6. See next journey and current ferry location
7. Review Logistics and Exploration Services (Seasonal info, schedule)
8. See amount of people on island and places available on ferry
9. Request ferry (if available)
10. Purchase tickets
11. Confirm safety rules
12. Receive digital or physical ticket

**PHYSICAL EVIDENCE**
- Visible signage which identifies the location being travelled to
- Physical travel machine and digital application
- Digital or physical tickets
**Fig. 4.24 Comparison between Existing and Proposed Customer Experience for Pier & Pre-Departure Services**

<table>
<thead>
<tr>
<th><strong>Existing Process</strong></th>
<th><strong>Proposed Process</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferry arrives, captain moors boat, passengers onboard.</td>
<td>Ferry captain welcomes passengers and provides information.</td>
</tr>
<tr>
<td>Passengers pay captain for travel journey.</td>
<td>Captain, payment machine.</td>
</tr>
<tr>
<td>Ferry captain, boat, payment machine</td>
<td>Ferry Journey to island then unboarding at island pier.</td>
</tr>
</tbody>
</table>

**Existing Process Steps:**
1. Wait in adjacent area.
2. Observe live location of ferry and next departure time.
3. Listen to ferry journey 5 minute and pre-arrival information.
4. Stand clear of arriving ferry.
5. Wait for passengers to unboard ferry.

**Proposed Process Steps:**
1. Leave waiting area.
2. Proceed through safety gates with safety.
3. Enter ferry.
4. Dolly fare paid at ticket validator.
5. Find seat.

**Existing Process Locations:**
- Waiting area, Bench, Screens, Speaker.
- Safety gate, Information announcement.
- Payment gate, safety announcement.

**Proposed Process Locations:**
- Ferry Journey to island then unboarding at island pier.
5. Findings

The author describes the final stage of his design process and the outcomes that are realized as a result of this project. The final visualizations of the design proposals are presented within this section.
5.1 Delivery

The delivery phase is about utilizing all of the findings that have been developed throughout the process to realize solutions to address the initial problem.

“The final quarter of the double diamond model is the delivery stage, where the resulting project ... is finalized, produced and launched.”

(Design Council 2015)

The design process had an intended end goal which was to establish a conceptualization of the automated service pier. Within this section, I propose four automated service pier outcomes. These proposals were developed to guide further development of the automated service pier and show that human-centred services are necessary within the autonomous ferry system. In creating a storyboard, service blueprint and possible visualizations, I have established proposals for what automated service piers might be when they are released in Helsinki. The modular diagram shows the ASP structures that could be replicated and where individualization could occur.

First using the storyboard that I validated and tested with users, I iterated upon the storyboard to further represent the users views the development of various touchpoints for the automated service pier. I expanded upon the storyboard by creating a detailed service blueprint which depicts different levels of interactions within the service journey. I developed an illustration about the possibilities for future intelligent service piers to show some of the different experiential necessities to make the autonomous ferry system a desirable experience for people in Helsinki. The possibilities for future intelligent service piers visualization also provides a vision about what the ferry pier system might be. The modular requirements shows the necessary pieces that could be part of the foundations of the automated service pier and the different components which can be individually designed for the context.
The delivery includes the following documents:

5.2.1 Storyboard on page 80
5.2.2 Service Blueprint on page 84
5.2.3 Possibilities for Automated Service Pier on page 88
5.2.4 Modular and Site Specific Structures on page 90

Using proposed storyboard concept prompts I conducted evaluations of the concept with users then I iterated several outcomes that can act as a roadmap to move forward with the development of various touchpoints of the service pier for further researchers in the project. In creating storyboard, service blueprint, possible future visualizations and modular and site specific requirements, I have established a benchmark for what smart piers might be when they are released in Helsinki

5.2.1 Storyboard

Design scenarios can be used in almost any stage of a service design project. Problematic areas of a current service offering might be developed into scenarios in order to from brainstorm solutions to provoking discussions on what’s actually working well. Different scenarios are able to help review, analyze, and understand the factors that will define a service experience.

After the customer journey was created and sketches and models were developed to depict some of the service touchpoints that would be required, the designer attempted to contextualize these service touchpoints in a storyboard. These storyboards included the different touchpoints a users may engage with before boarding the ferry based on the three key drivers. This storyboard included the minimum necessary touchpoints for the service to function to replace the driver.
“By putting a service situation in its proper context ... storyboards can be used to provoke meaningful analysis, sparking discussions about potential problems and areas of opportunity.”

(Van Dijk, Raijmakers and Kelly 2011, p. )

This storyboard was visualized from the point in the service journey where the user would first see the pier’s signage in the distance and recognize that they are about to take the ferry. The storyboard depicts the journey of the user who would first engage with a travel machine to get a valid fare, explore the service offerings and receive safety information about the journey. Through user testing and my research it is clear that the safety waiver must be engaging but the information must also be presented to the users with another touchpoint. During the waiting period for the ferry, users would engage with audio and visual information about the arriving ferry and how they should interact with it. Additionally the user would receive information regarding logistics, such as the ferry schedule and exploration such as the weather.

This storyboard illustration depicts minimum viable service experiences to make an autonomous ferry system work and does not include representations of the architectural experience of the pier. The architectural experience should be considered when designing the piers for different contexts (see. 5.2.3 Possibilities for Automated Service Pier on page 88). Within the pier construction there can be modular, replicable elements as well as unique spatial elements (see. 5.2.4 Modular and Site Specific Structures on page 90.
Signage to guide passengers to the pier

LOGISTICS

EXPLORATION

Travel machine to assist visitors to purchase ticket, confirm safety & plan trip.

LOGISTICS

SAFETY

EXPLORATION

Seating for passengers to wait on

LOGISTICS

SAFETY

EXPLORATION
Fig. 5.1 Automated Service Pier Storyboard

- Automated security gates which open when ferry is secured to pier.
- Tap in-tap out fare scanner (on ferry)
- Coordinated videos with audio to further explain next steps in boarding live view of current location of ferry
- Audio queues to notify passengers of departure times and safety precautions
5.2.2 Service Blueprint

Service blueprints are an established service design method for depicting the overall service offerings of a service providing firm. Service blueprints examine the customers journey within a service as well as the onstage contacts, backstage processes and required support processes. The creation of service blueprints encourages a holistic look at the service system.

Service blueprints provide an “unrelenting focus on the customer as the center and foundation for innovation, service improvement, and experience design” (Bitner, Ostrom and Morgan 2008 p. 93)

As fig. 5.1. Automated Service Pier Storyboard depicts the various touchpoints that a user may engage with on a future automated service pier, the service blueprint was utilized to organize these service touchpoints in a different way. This service blueprint proposes the on pier service touchpoints necessary to accommodate the existing service demands that have historically (and currently) been provided by the ferry skipper, however, they additionally represent the desired demands which were discovered through the human centred design investigation process. The direct consultation with a representative sample of users of the ferry system assessed the needs, wants and desires of ferry using island goers. The organization and development of the service touchpoints have prioritized and developed touchpoints to address the three design goals - safety, logistics and exploration - as requirements that have been considered throughout the service blueprint.

As the skipper has been the main point of contact and enabler of many of the safety, logistics and exploration services that customers currently engage with, the service blueprint depicts how these services have been spread throughout the user journey and how
they will be provided. Within Fig. 5.2 Service Blueprint for Automated Service Pier on page 87 the touchpoints have been mapped with the actions of the users. To allow for the users to interact with the system various levels of service provider enablement has been are mapped such as the onstage contact - the person who the user would directly engage with - the backstage or system contact and the support process for implementation and maintenance.

The services shown in the service blueprint represent many of the required touchpoints whereas Fig. 5.3 Possibilities for Future Intelligent Service Piers on page 89 displays how they might be spatially. The third artifact is a depiction of what sort of modularity could be built into the pier to encourage a possibility to develop different appropriate piers for different communities.
PROPOSED SERVICE BLUEPRINT FOR PIER & PRE DEPARTURE SERVICES

**Physical Evidence**

- Visible signage which identifies the location being travelled to
- Physical travel machine and digital application. Digital or Physical Tickets

**User Action**

- Identify Pier
- Review off Pier Signage
- Enter Pier
- Identify Ticket Machine and Mobile Application

**Onstage Contact**

- Engage with desired platform
  - Application and Travel Machine Interface
  - Departure time and live ferry location
  - Exploration
    - Seasonal Info
    - People on Island
  - Logistics
    - Schedule
    - Request ferry (if available)
    - Ticket Purchase
  - Safety Confirm
    - Receive digital ticket
    - Receive Print Ticket
    - Using an HSL card with sufficient credit

**Backstage Contact or System**

- Optional: System attendant to aid in ferry pier and boarding process

**Support Process**

- Design and development of physical pier and autonomos pier branding.
- Pier signage live screen to be integrated with ferry information system and database
- Development and design of digital services on app and travel machine (coordinated with website and mobile website)
- Optional: Ferry control emergency system aids with help requests
- Audio/Visual Safety Info
  - Safety gate opening wait for passengers to unboard.
  - Audio/Visual Queues
  - Safety gate opening sequence
  - Enter fare paid area
  - Gate Opening
  - Observe Audio/Visual information
  - 5 minute general Pre-arrival

**Support Process**

- Optional: System attendant to aid in ferry pier and boarding process
Waiting area, Bench, Screens, Speaker.

Audio and Visual Queues, Safety Gate

Enter Ferry

Wait standing or seated nearby.

Observe Audio and Visual information

Live location and departure time of ferry on standby

5 minute general

Pre-arrival

Audio/Visual Safety Info

Safety gate opening sequence

Observe Audio/visual Queues

Safety gate opening for passengers to unboard.

Gate opening

Proceed through gate

Gate opens

Enter Ferry and Find a Seat

Show ticket at proof of fare gate

Enter fare paid area

Enter Ferry and Find a Seat

Optional: System attendant to aid in ferry pier and boarding process

Optional: System attendant to aid in ferry pier and boarding process

Audio/Visual Safety Info

Safety gate opening sequence

Safety gate coordinated with ferry arrival

Ticket coordinated with fare control system

AV Notifications linked to ferry live location

Develop and design waiting area

Develop and design AV Notification system

Fig. 5.2 Service Blueprint for Automated Service Pier
5.2.3 Possibilities for Automated Service Pier

This imagery does not depict one way that the autonomous ferry systems automated service pier should exist as, but different possibilities. The core set of service benchmarks are depicted as well as the spatial experiential aspects. These possibilities depicts different ideas about the appropriate contextual style requirements based on the planning and architectural vision of a community or area.

The imagery within Fig. 5.3 Possibilities for Future Intelligent Service Piers on page 89 offers a representation of the various ways the modular service pier could exist. I created a collage of possibilities rather than a single vision. As the automation of the recreational ferry system within Helsinki is a vision, I attempted to represent different interpretations of what the experience could be, rather than my vision of a single automated service pier. Additionally, I found that there is value in unique spatial elements among the different piers. These images show concepts with different considerations for project realization. The bottom images visualize a minimum viable product for establishing safety, logistics and exploration. Furthermore the top image depicts a future possibility for a site specific structure.

The next section explains how the ASP can be created with a modular and replicable structure combined with a site specific designed structure. When considering all the different contexts of ferry piers around Helsinki and on all of the different islands within the Helsinki archipelago, there are various site specific specifications that must be defined and designed for. Within the city ASP the spatial and architectural experience development should consider such factors as prevailing wind direction, architectural history of the area and unique signage systems. On the islands, the ASP’s should be created to integrate with historical or natural elements. Within fig. 5.3 the image on the bottom right depicts a way in which two modular piers could be attached together to create a higher capacity pier.
Fig. 5.3 Possibilities for Future Intelligent Service Piers
5.2.4 Modular and Site Specific Structures

The necessity for developing and depicting modular requirements became an apparent outcome of this project for various reasons. One reason is to highlight the possibility of creating a replicable structure through consistent core components. Another reason to depict the modular core imagery is to provide spaces where non-modular services can be developed.

A replicable structure provides various perceived benefits for the development of an autonomous ferry system. The modular structures depicted within Fig. 5.4 Site Specific and Modular Structures and Attachments on page 91 would allow for larger scale production of the core components of the system. Larger scale productions often correspond with decreased prices based on volume. Furthermore, modular structures often involve less labour in assembly and maintenance because they have fewer unique components. The modularity additionally adds flexibility to the application of the automated service pier. Two or more piers can be arranged next to each other to create a larger capacity.

In addition to creating various efficiencies through modularity, a modular automated service pier structure can provide a platform for pre-determined spatial elements. Specific locations on the automated service pier can allow for unique spatial elements and service touchpoints. Unique site specific structures can be developed to provide experiential value for the users of the service touchpoints within the different contexts that the automated service pier can be deployed. Examples of unique spatial and service elements include the signage such as flagpoles, furniture such as the bench and structure such as the canopy or windscreen. Allowing for uniquely designed structures can enhance the passenger experience, increase logistical wayfinding and reflect the community identity.

The development of the unique elements could be completed in various ways. Some ways that this could be completed is through a design competition which outlines specific criteria or themes. Alternatively, the designs could be completed by significant figures within the community or in conjunction with a relevant community group. There may be various reasons to adapt the design of the unique elements on the island side of the journey such as local fauna or limited services available.
Fig. 5.4 Site Specific and Modular Structures and Attachments
6. Conclusions

The conclusion section presents a summary of the authors thoughts and critical reflections about the his progress throughout the design process over the course of this project. This section describes how the design process and final deliverables answer the re- search question.
6.1 About the Findings

This section frames my process and results in how the answer the research question. The aim of this thesis was established as the means to realize task 2.5 “Smart Pier” for the ÄlyVESI Smart City Ferry Project. The desired outcomes of this task was to create concepts of the automated service pier. In approaching the ASP development, I proposed a research question that encouraged a human-centred design process. I chose a human-centred design approach to gain an understanding of the different user perspectives of the system existing systems and to understand different people’s perspectives about automation.

To understand the problem, a literature review was conducted so that I could understand the progression of autonomous technology and how it may apply to the development of an autonomous recreational ferry system in Helsinki. To understand the users, existing ferry system and requirements for an autonomous system in Helsinki, background research, ethnographic observations and user interviews methods were utilized. This research was important in understand how the exiting ferry system ecosystem is functioning.

Investigating the problem in this way allowed me to first understand current and potential users relationships with the existing system and their perception of autonomous technologies replacing the ferry skipper. The skipper is a key enabler of services within the current system so important to ensure that all of the that they provide tasks are enabled and enhanced during the development of ASP. In this sense the skipper is also the bottle neck in the current service flow. Spreading the services out from the skippers responsibility to the customers enables the system to function without the driver. Considering how to replace and enhance the services that the existing skipper provides is critical for the realization of automated service piers.

In addition to enabling and enhancing the skipper enabled touchpoints through automation of the existing ferry system, understanding the existing ferry system and how users experience it reveals the current experiential high and low points. The experiential highs and lows were discovered through the definition phase of analyzing the primary and secondary research findings. The experiential highs appeared after the skipper became present in the customer journey. In this sense, the development of future touchpoints aimed to place the services that the skipper previously enabled throughout the service
journey to enable a more consistent service experience. Furthermore, the understanding the customer journey and defining the research informed three design goals. These goals include enabling features which provide safety, logistics and exploration throughout the service journey. These drivers were fundamental design goals which came from HCD research.

When first developing concepts with the design goals in mind, the process was iterative. Many different possible solutions were developed. Some of these solutions have been tested with users to evaluate the validity of my designs. Users responded positively to my assumptions, however, I also iterated the developments to include the feedback that I received.

I developed four final outcomes for this project. The final outcomes include:
- Fig. 5.1 Automated Service Pier Storyboard on page 83,
- Fig. 5.2 Service Blueprint for Automated Service Pier on page 87,
- Fig. 5.3 Possibilities for Future Intelligent Service Piers on page 89 and
- Fig. 5.4 Site Specific and Modular Structures and Attachments on page 91

These outcomes have all been informed by the human-centred design goals. These outcomes are developed to improve the human-centred services for users of the ferry system. These services come out of research with the users of the ferry services. This research shows that automated service piers can be designed with a selection of human-centred service touchpoints that encourage a human-centred development of smart urban waterborne transportation.

### 6.2 Further Development and Reflections

In addressing the brief from ÄlyVESI and the research question, this thesis proposes visions about how the smart pier could bring together a physical location for some of the services that the skipper previously enabled within the ferry system. This thesis offers a vision and a roadmap about how to proceed in the future.

There are many future considerations to address when developing the autonomous ferry system and the piers together in the future. In the future the development process may benefit from co-design workshops where many different stakeholders come together to discuss the vastly different aspects of the project. For the purposes of this research
question, it was not necessary to understand the technical requirements of the ferries or the piers on the island, however, as the development of an autonomous ferry system proceeds, it is critical to develop a shared understanding. Without an understanding of the development of the autonomous ferries for which the pier is being developed there may be disconnect in the touchpoints. As the former responsibilities of the driver are being spread throughout the ferry service journey, it will be important to maintain consistencies across the entire system. In this way it will be valuable to have designers interact with the technical team.

The smart pier has been designed as though it would dock to existing piers, however, there may be locations with docks that are unsuitable for this type of attachment. In this sense, the design of the smart pier requires further site specific development.

As I was developing the minimum viable product for the automated service pier some of the illustrations may seem crude. Throughout the process I attempted to provide and enhance all of the services of the existing skipper enabled system. The visualizations of the automated service piers are ways that they could look in the future. Further spatial considerations are necessary in the future as it is important to consider the site specific context of each pier when developing the design of the piers. There are diverse areas in which the ferry piers will be located from the city centre to cultural islands to natural islands to restaurant islands. Experientially it is important to focus on this, however, my thesis was primarily about the service touchpoints required on the pier in order to replace the driver. In this way it would be important to consult with local stakeholders. I did not include additional potential stakeholders such as private boat owners, however, in the future it would be valuable to understand some of their opinions.

Although I carried out a human centred design process, the diversity of stakeholders was limited. I was primarily interested in the experiences of users, their desires for the future, and their perceptions of autonomous ferries. I believe that there would have been some benefit to including the existing drivers more in my research. I spoke informally with three skippers about their responsibilities, however, it may have been valuable to have included them more in the design process.

One of the goals of this process was to depict the value of the human-centred design process for the clients of this project who may not often work this way. This approach was helpful in reflecting upon my process and the human-centred design process throughout the project.


Fig. 4.2 Author. 2018. Project Schedule


Fig. 4.2 Author. 2018. Project Schedule

Fig 4.3 Author. 2018 Helsinki ferry Map.

Fig 4.5 Schedule of Ethnographic Immersions

Fig 4.4 Author. 2018. Schedule of Ethnographic Observations

Fig 4.6 Author. 2018. Raw Ethnographic Jotting Mustasaaren Pier

Fig 4.7 Author. 2018. Ethnographic Jotting Uunisaari (Transcribed)
Fig. 4.8 Author. 2018. Mustasaaren Dock Sign. 07.09.2017.

Fig. 4.9 Author. 2018. Harkka Särkkä Dock. 13.09.2017.

Fig. 4.10 Author. 2018. Vallisaari Dock. 21.09.2017.

Fig. 4.11 Author. 2018. Uunisaari Dock. 13.09.2017.

Fig. 4.12 Author. 2018. Kauppatori Docks. 13.09.2017.

Fig. 4.13 Author. 2018. Föri Ferry. 19.10.2017.

Fig. 4.15 Author. 2018. Persona Differentiation

Fig. 4.16 Author. 2018. Persona - Hitoshi

Fig. 4.17 Author. 2018. Persona - Aleksanteri

Fig. 4.18 Author. 2018. Persona - Liina

Fig. 4.19 Author. 2018. Persona - Helen

Fig. 4.20 Author. 2018. Existing Customer Service Journey

Fig. 4.21 Author. 2018. Key Skipper Enabled Services within the Current Customer Journey

Fig. 4.22 Author. 2018. Sketches of fare validation and security gate

Fig. 4.23 Author. 2018. Early Proposed Customer Journey Sketches
Fig. 4.24 Author. 2018. Comparison between Existing and Proposed Customer Experience for Pier & Pre-Departure Services

Fig. 4.25 Author. 2018. Sketches of Pier Layout and flow

Fig. 4.26 Author. 2018. Validation Results

Fig. 4.27 Author. 2018. Image from Validation

Fig. 4.28 Author. 2018. Validation Results

Fig. 5.1 Author. 2018. Automated Service Pier Storyboard

Fig. 5.2 Author. 2018. Service Blueprint for Automated Service Pier

Fig. 5.3 Author. 2018. Possibilities for Future Intelligent Service Piers

Fig. 5.4 Author. 2018. Site Specific and Modular Structures and Attachments
Appendix
Appendix A: Interview Questions

**Helsinki City Ferry System - User Interview Questions**

Lives in:   Profession:
Age:   Gender:

**General Opening Questions**
1. What are some of your favourite recreational activities to do in Helsinki?
2. How do you make use of the sea in Helsinki?

**Ferry System Specific Questions**

Pre-service
3. Are you familiar with the recreational islands in the Helsinki area? (How did you learn about them?)
4. How would you plan a trip to an island in the Helsinki area? (which island would you choose?)

During service
5. When you are visiting an island, what types of information do you engage with?
6. What services do you value?
7. How does the ferry captain or driver affect your overall island trip?

Post-Service
8. What type of experiences have you had when visiting recreational islands? (What types of things have you done? how did you feel about the experience?)
8. After visiting an island what ways would you engage with the service provider? (social media, phone, website, etc.)

**Driver enabled Services**
9. How familiar are you with the automation of vehicles?
10. How would you feel about autonomous recreational ferries?
11. What services would you need to feel comfortable if there was no driver?
12. What additional services would you like to see if there is no driver?