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MASTER'S THESIS

Using digital technology to help users of public transportation to cope when experiencing lack of control

A user-centered Design Research

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Abstract

Public transportation networks are widely recognized as a critical infrastructure for cities. They are deeply integrated into a city's culture and a traveller's every day. This form of transportation is crucial for a well-functioning city, as it provides an efficient way of mass transportation compared to private transport, such as the car. However, providing a coordinated service in a somewhat chaotic network is not possible without compromises which affect the individual traveller. As this design research presents, users often experience a lack of control when relying on public transportation resources. Accordingly, this thesis aims to help users to cope with this lack of control.

The research is a qualitative study, which follows an iterative design thinking process to explore the problem, ideate, prototype possible solutions, test and analyse the outcome. A total of 45 user interviews were conducted as well as a user workshop to ensure a user- and problem-focused process. Various service design practices were applied during the different design phases. The final iteration resulted in the design and prototyping of a digital application that provides user-generated content on a platform, based on the principal '*users helping users*'.

The final testing of the prototype demonstrates how and why various features and functionalities help the users to cope with the lack of control when relying on public transportation resources. The evaluation of the findings indicates that only some of the application's features supported the coping process and led to additional conclusions regarding information load, customization and reliability of user-generated content.

Keywords:

Public Transport, Coping, User-Centered Design, Design Science, Service Design, Features, Design Thinking

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1. INTRODUCTION

Public transportation (PT) systems have operated in the cities since the emergence of the horse-drawn omnibus in Paris in the 1820s. Now, these services have evolved to incorporate a range of operating vehicles across different surfaces, elevated and underground routes. What has been achieved so far in the engineering of public transportation networks are extensive and significant. Many large cities are defined by their public transportation systems as the New York Subway, Paris Metro or London Underground attest (Dodson, Mees, Stone and Burke, 2011). Although public transportation is a consistent *system*, it often operates in an inconsistent and chaotic *network*.

A Public transportation *system* can be described as overall physical infrastructure, where information technology provides the opportunity for individuals or groups to move within cities and urban areas (Dodson et al, 2011). However, a public transportation *network* can be described as a spatial and temporal relationship between lines of connection given by the system (Dodson et al, 2011). Being acquainted with this connectivity is what travellers need. Thus, the factors facilitating this are the adequacy and legibility of structures along with their connectivity, and how it is communicated to the users (Dodson et al, 2011).

Each country or cities possess different means of transportation and each traveling passenger has his or her own preferences for a good user journey with minimal stress and frustration. Many factors play a role in creating a good travel experience for passengers. To create the best user experience, communication is required with travel related information interconnected. Information which simplifies travel, creates reliability and increases the number of options during the journey. Users who are well-informed are content passengers, as effective and efficient communication makes public transportation more attractive and reliable (MultiQ, 2017).
In the chaotic network, users are depended on reliable communication and when that communication diverges from real time events it creates friction between the user and public transportation resources. When this friction occurs, it can cause a feeling of lack of control which

leaves users either frustrated, stressed or helpless. As a consequence, this affects the user experience in a negative way.

Thus, even when it becomes impossible to prevent changes and irregularities in the network of public transport, we can try to impact the user experience by providing tools that will help the users to cope when they feel helpless and encounter lack of control.

"Noticing an inconsistency is a wake-up call to resolve conflicts" (Dowden, 2019), we therefore make it our research to explore ways of improving the user experience and thereby give users a sense of control before, during or after their use of PT resources.

1.1 Motivation

We have chosen the context of public transportation, as it covers a range of possible problem spaces and perspectives. Public transportation plays a big role in a city's infrastructure and a domain that has a large user base. Public transportation has become a large and crucial part of people's everyday lives, especially in big cities, where the population, spanning from young to old, is depended on PT resources.

Further we see the growing awareness for sustainability and in correlation to that the increasing demand for the amplification of public transportation resources. We are unfortunately facing one of the greatest environmental challenges that lies in mobility, as transportation vehicles accounts for approximately 23 percent of world energy consumption and carbon dioxide emissions (WHO, 2020). Therefore, sustainable urban mobility requires a shift where we move away from cars towards optimal use of PT. We also see how people aim for a more sustainable lifestyle which means that we have an increased demand for PT. We believe or hope that constant improvements in public transportation will contribute to a more sustainable lifestyle in cities.

Another motivation is our own previous experience with public transportation resources as well as all the literature and articles that generously elaborate of the issues and inconveniences around PT resources. Thus, this is giving us a problem area to explore further and work within. Furthermore, as the network of PT is used by a large and diverse group of users, we see a

potential in applying a user-centered design approach. This large user base is both conducive and to our advantage.

1.2 Defining the scope

After introducing the topic and stating our motivation for this thesis, the following subchapter addresses the scope of this project. It presents the framework, topic delimitations, the objective of this thesis as well as the research question. This will help us to set a clear project line, exclude irrelevant content and consequently achieve the objects.

1.2.1 Objective of thesis & research question

Public transportation networks are widely recognized as a critical infrastructure for cities, mostly if the network is well planned, coordinated, convenient, multi-directional to a diverse range of passengers (Dodson et al, 2011). As these systems are of a consistent and static form, unexpected occurrences and irregularities in this system can disturb the user experience and lead to a feeling of lack of control. It is interesting to explore how users can be supported to cope better with this lack of control and how the user experience can be improved by designing features for a digital product.

Further this thesis will follow a product-oriented approach. We will apply known frameworks and methods from the domains of *Service Design* and *user-centered Design* to the problem space of PT. As a result of this utilization, we will develop a digital product. Gregor and Hevner (2014) propose with their *Knowledge Innovation Matrix* (see Figure 29) a formal typology for categorizing new products or services in relation to their new knowledge contribution. As we are going to develop a new solution for a known problem - the poor perception of the user experience of PT - the knowledge contribution of this thesis can be categorized as an improvement in context of a known problem.

To come up with a possible solution, we will follow a user-centered design approach, by focusing on users of PT. We will apply various service design methods and practices to create a possible solution and consequently improve the users' experience.

As the experience of PT covers large aspects of the entire interaction between user and service provider, such as ticket systems, travel planning or pricing, we have chosen to narrow the scope down to the area of communication.

By choosing a topic such as PT, we are limited in what we can accomplish because of its wide context. In order for the thesis to also exist in the realm of E-Business, communication is an interesting aspect to investigate.

Communication in PT can manifest in different formats such as; displayed information on screens, information on digital applications such as *Google Maps* or *Rejseplanen*, information displayed through a timetable printed on paper, announcements through speakers, and as simple as the information coming from a service employee (Figure 1).

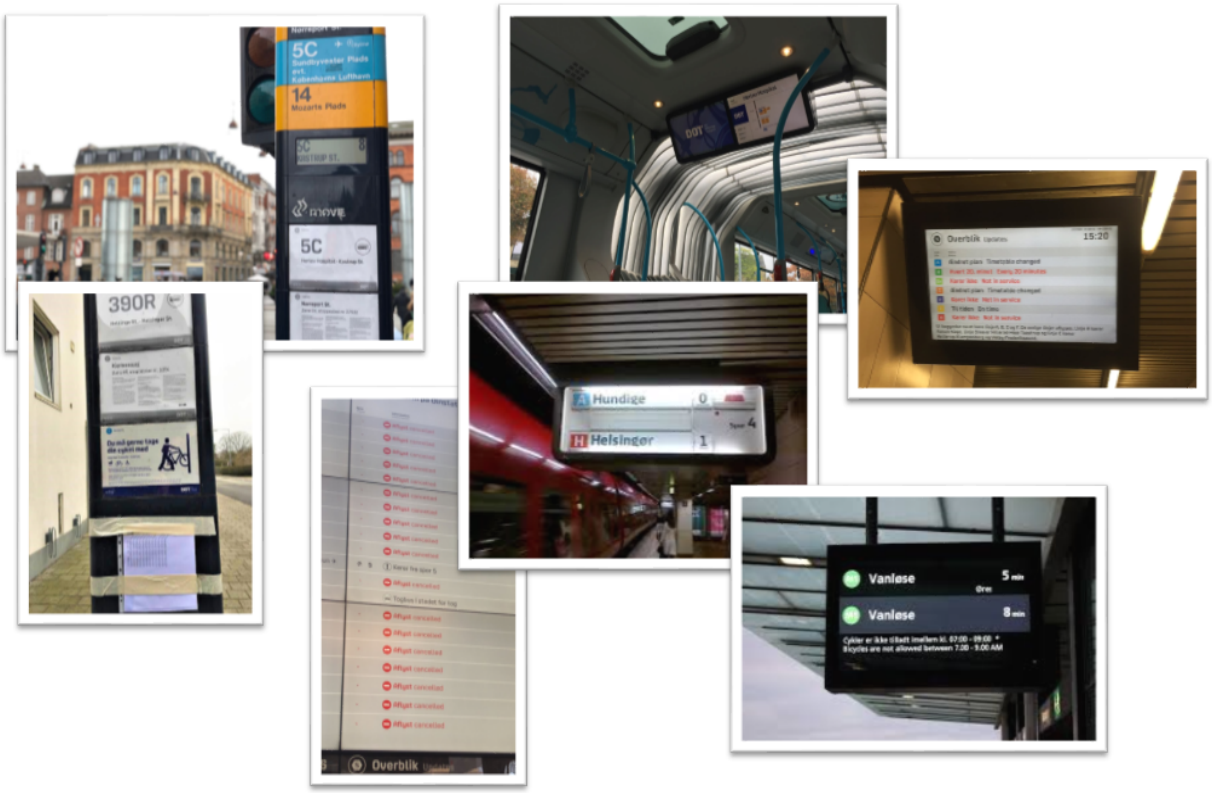

Figure 1. Images of communication channels.

When it comes to perceptions and norms, it is the time and delays that are in focus. Users want to rely on information that is communicated to them. So even when PT services are delayed,

users can trust the information available and thereby have the possibility to regulate and give them a chance to find an alternative route to their destination, or simply give them the ease and comfort of knowing.
Further, the communication in the context of PT is nowadays mainly mediated by using digital technology. The popularity of applications and web services that provide information to PT users, indicates, that most of this communication takes place in a digital environment (Rejseplanen, 2019). In addition to that, the general wide distribution of mobile devices, can derive the conclusion that almost every user of PT carries a mobile device with her or him (Gu, 2019).
That is why this research will focus on developing a digital solution, to provide help to cope better with the lack of control when relying on PT resources.

In this project we actively explore the research context of public transportation and wish to help users to cope with a lack of control when relying on PT resources. To achieve this objective, we apply practices and methods from the domain of service design as well as user-centered design and the concept of *coping* from research literature. In this way, this
thesis both, add theoretical and practical value to the context. To support the coping of the user, we will explore and apply features, that aim to leverage coping. These features will be applied in a digital context. By implementing these features into a digital product and then testing them with users, we hope to make generalisable conclusions.
Consequently, we going to answer the following research question within this project:

How can features of a digital system help users to cope with a lack of control when relying on public transportation resources?

1.2.2 Delimitation

To answer the research question to the best of our abilities, it is crucial to present the thesis' delimitation. Public Transportation is a comprehensive domain and can be understood and approached in various ways. As our objective of this thesis is to improve the user experience, it seems reasonable to include or collaborate with a service provider of PT. However, this thesis will be delimited in the way, that the research will be conducted independently from existing services,

which are already available for users. Developing a solution, that is based on or is related to existing services or applications would require information, that is not accessible and would force us to make assumptions or guessings. Hence, we will develop a new solution based on literature and user inputs independent from any existing service providers.

1.3 Thesis structure

This subchapter will give a short outlook on the structure of this thesis with the objective to convey our general approach to the reader and to assure the understanding of our way of working within this project.

Chapter one included the introduction of the topic, our motivation, the objectives and our research specification as well as our research question.

Chapter two will address our literature review. Starting by determine our problem space with literature about problems in the context of PT, this section will present the contextual concepts and place them in relation to each other. As a second part of the literature review our theoretical framework will be presented. This includes theory about coping, a problem-solving strategy, as well as design theories, that will guide our strategies and practices of this project.

Chapter three will touch upon the philosophy and methodology around the thesis. As this research includes several iterations with user interaction as well as qualitative data gathering, it is important that the reader understands our research philosophy and research approach, setting and strategy.

Chapter four includes the entire design process of our research. It will take the reader through each phase of the design thinking framework and elaborate on each design methods and practice. Every insight gathered through different design practices will contribute to the next phase and continue this way until we reach the final phase of the framework.

Chapter five will take its departure of summarising the findings, analyse them and conclude with contributions.

Chapter six will cover the discussion of the main contribution and uncovered areas found through the design process from *Chapter five*. The research structure will finally be completed with *Chapter 7*, will firstly present our research limitation and future outlook, and finally be completed with our final conclusion. Figure 2 illustrates the overall structure.

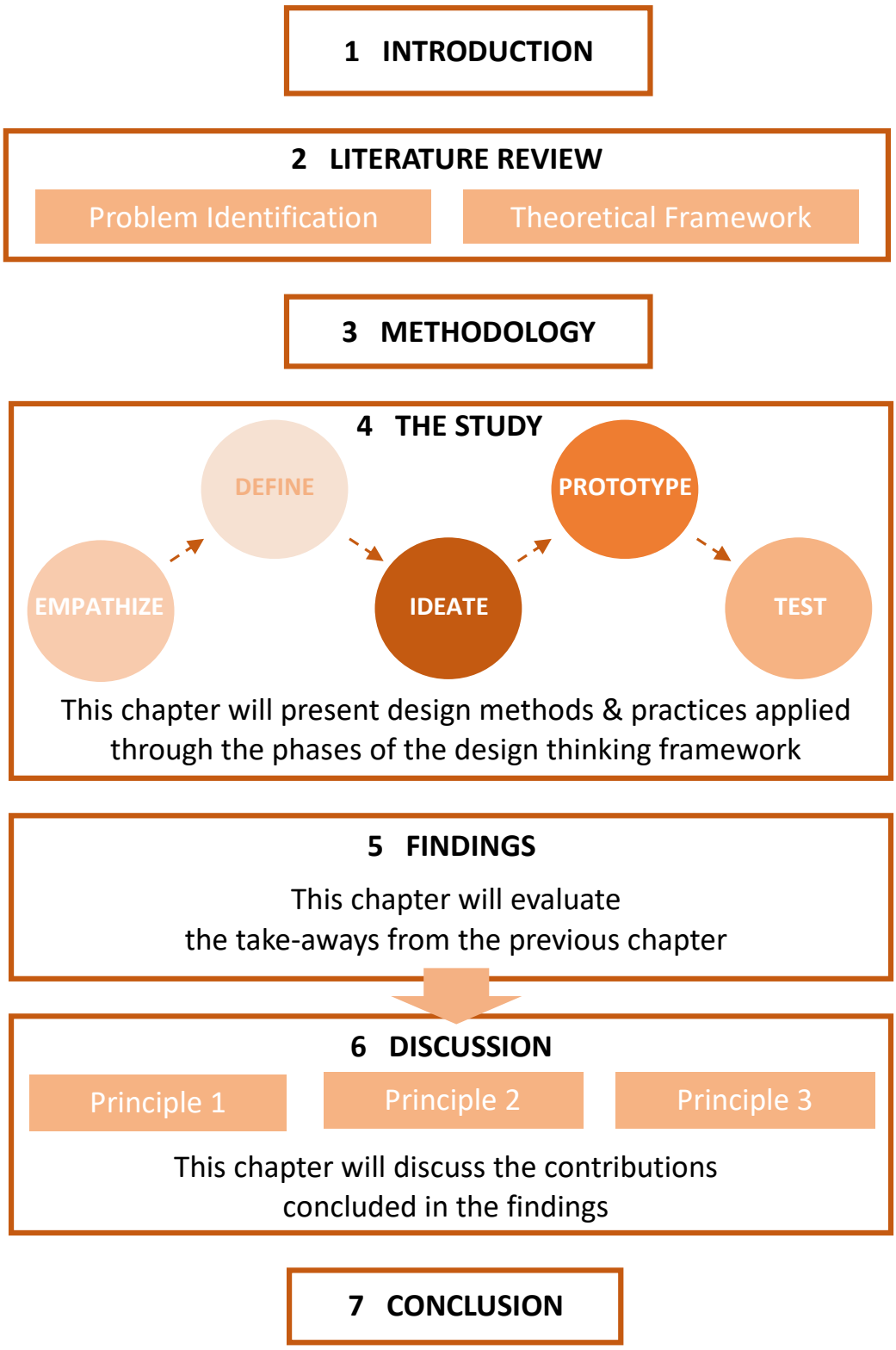

Figure 2. Overview of research structure

1.4 Clarification of terms

Before *Chapter two* will present the literature review, this introduction will be finalized by clarifying some of the key terms, that will be mentioned frequently throughout this thesis.

Public Transportation (PT), also often referred to as mass transit, mass transportation, or public transit, can be described as the "*movement of people within urban areas using group travel technologies such as buses and trains*" (Mass transit, 2020). Its main feature compared to other forms of transportation such as by car or bicycle is, the bigger number of people carried on the same vehicle. This higher density of people being transported, creates a greater efficiency, followed by lower transportation costs. (Mass transit, 2020).

In the context of this thesis, we will primarily focus on PT within urban areas, but also consider PT with national-wide and long-distance connections during the design process.

The term **Service Design** describes "*a process in which the designer focuses on creating optimal service experiences*" according to the Interaction Design Foundation (2020). This process requires a holistic view of the whole service, including its involved actors, their interactions and their environment with the objective to create and or improve a service, that meets the user's needs. (Design Foundation, 2020).

Chapter 3 will present a more comprehensive definition of service design, classify it in relation to other design domains and elaborate on its practices and methods.

However, it is necessary to define this term to ensure a general understanding of the followed approach and object of this design project.

Furthermore, we want to distinguish between the two terms ***Design Method*** and ***Design Practices*** - two terms, which were chosen and defined by ourselves, to ensure the reader's correct understanding of applied design practices as part of this thesis.

With the term *Design Method*, we describe the setting, environment and the design approach, that we will follow during the design process. This includes different forms of interviews, but also workshops or ways of testing.

By contrast, we define *Design Practice* as a specific tool or aid, that supports the design process and leads to a concrete outcome. Design Practices can, but not necessarily must be applied as part of a design method. Examples for design practices are tools like *Personas, How Might We, User Stories, Brainstorming, Dot-Voting, Sketching*.

Finally, the term **feature** needs clarification, as this phrase is frequently used to describe the findings in *Chapter 5*. Because of the diverse application of this term, the definition will be limited to a technical context. It can be defined as "*a product characteristic from user or customer views, which essentially consists of a cohesive set of individual requirements*" (Chen, Zhang, Zhao and Mei, 2005). We chose this definition, since it incorporates the user-focused approach of this thesis. An example could be a *notification* feature of a digital product: The characteristic could then be, that the feature informs the user with a pop-up notification. The set of individual requirements could include a text message and a notification sound.

2. LITERATURE REVIEW

"A review of prior, relevant literature is an essential feature of any academic project" (Webster and Watson, 2002, page XIII). The following chapter will elaborate on the literature identified and synthesized in order to develop a preliminary review to establish the research. Furthermore, it will describe and evaluate the framework and practices identified for this research.

2.1 Problem identification

By analysing, correlating, and synthesizing isolated cases through the literature, this research aims to generate a better user experience for users of public transportation. A literature review offers an opportunity of identifying and synthetizing factors that support the topic of this thesis. A literature review is also an effective review that *"creates a firm foundation for advancing knowledge. It facilitates theory development, closes areas where a plethora of research exists, and uncovers areas where research is needed"* (Webster and Watson, 2002, page XIII). This research will do so by exploring and initiating a literature review by identifying the relevant literature, structuring the review, and finally to evaluate it. The following paragraphs will elaborate on each step by using elements of Webster and Watson's proposal in conducting an efficient literature review.

2.1.1 Strategy review

The initial literature review took place with the objective to identify literature in the context of public transportation as well as insights into user's pain points during travelling with PT. Since we went through several iterations during the whole design process, this literature review got changed and extended multiple times. The search was conducted by using combinations of key words such as *issue, problem, complains, public transportation, train, bus, metro, stress, frustration, user journey, user thoughts, user feedback, user experience* etc. For the search of relevant literature, we primarily used online resources. Next to common academic search engines

such as *Google Scholar*[1] and *ACM Digital Library*[2], we used other databases such as Statista[3] or the resources provided by Copenhagen Business School - the library and the internal databases. Although we primarily conduct this study in the environment of Denmark and involving mainly users located in Denmark into the development process, this literature review will present the problem area in general, without a specific geographical limitation. That is why this literature review includes both English and Danish literature. Nevertheless, it is important to consider that different countries experience different problem areas with PT, depending on; how developed a country is, technological matureness, cultural barriers, system and network dependencies.
As we try to focus on cross sectional time horizon, we have only looked at literature dated back from year 2008 to current time (2020). These include, articles, case studies, blogs, and reports. We have managed to ensure and accumulate a relatively census of relevant literature. We believe that our review has come to a completion, as we no longer can identify new concepts in our data sets.

As a result, we have managed to identify the key concepts which will help us establish the context around our topic. Although public transportation has existed for about 200 years and much literature has accumulated, it is rather difficult to find literature appropriate to the specific context of our research topic. Thus, the identified literature covers information within public transportation from various countries and regions. Since public transportation has developed for the better in the recent years, it is not relevant to use literature that dates back for more than approximately twelve years.
As this is a design research, we find it relevant and helpful to use literature that consists of both empirical and non-empirical research. Figure 3 shows the structure of the overall literature, from first round of identification, to synthesizing relevant literature, to the amount included in the literature review.

[1] A web search engine for scholarly literature, Retrieved from: https://scholar.google.com/
[2] A comprehensive database of full-text articles and bibliographic literature covering computing and information technology. Retrieved from: https://dl.acm.org/
[3] A German online portal for statistics. Retrieved from: https://www.statista.com/

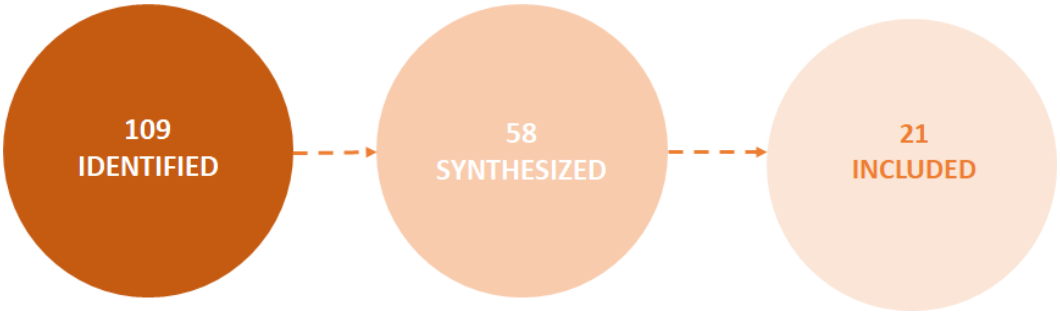

Figure 3. Literature identification and processing

2.1.2 Evaluating the review

Public transportation systems have operated in the cities since the early 1800's. Now, these services have evolved to incorporate a range of operating vehicles across different surfaces, elevated and underground routes. What has been achieved so far in the engineering of public transportation networks is extensive and significant. Some large cities are even defined by their public transportation systems as the New York Subway, Paris Metro or London Underground attest (Dodson et al, 2011).

The future always includes some degree of uncertainty and lack of control when it comes to public transport. Disruptive innovations, public demand, and infrastructural changes, all play a huge role when adapting and optimizing the landscape of PT. Reducing uncertainty is of special importance for not only decision makers, but also researchers and developers, especially in the context of public transport. However, the subject is comprehensive and public transportation literature investigates issues from many different perspectives. (Souliotis, Tsadimas and Nikolaidou, 2014) (Polat, 2012)

Most of the current studies either heavily focus on designing and creating the best PT network through mathematical approaches or they are quantitative driven describing demand, opportunities and challenges in PT (Webb, 2019). However, it is rather clear that most current literature, despite their research approach somehow place emphasis on aiming for a more sustainable future and at the same time meeting user needs and satisfaction.

A great amount of the current literature agrees, that securing public transportation ridership is critical for developing a sustainable future (Holleczek, Yu, Lee, Senn, Ratti, and Jaillet, 2014) (Imam, 2014) (Webb, 2019). Another visible factor is that of user experience, also termed as customer satisfaction. Plenty of literature considers user experience as one of the most important factors in any industry or service, but especially in PT due to its direct relation to user retention (Imam, 2014).

Country and even cities have their own particular infrastructures, resources and different means of transport. Additionally, each traveling passenger has his or her own preferences for a good user journey with minimal uncertainty, stress and frustration as well as lack of control. Hence, there are many factors that can affect the travel experience for passengers (Souliotis, Tsadimas and Nikolaidou, 2014) (Mikkelsen, 2015).

The last few years, digital technology has been extensively used within public transportation, both as transportation resources, but also as websites and applications that provide information about timetables, routes and time estimation (Souliotis, Tsadimas and Nikolaidou, 2014).

Literature states that communication is crucial to the coordination and efficient operation of public transportation systems (Doering, Pögel, and Wolf, 2010). To create the best user experience, communication is required to assist with different information and thus giving the users the support and insights needed. Information that simplifies travel, creates security and increases the number of options during the journey. Users who are well-informed are happy passengers as effective and efficient communication makes public transportation more attractive and reliable (Souliotis, Tsadimas and Nikolaidou, 2014).

In all cities it is essential to have a good public transportation system that facilitates the travellers mobility, which involves: regular networks of different type that flow through the entire city, connections between the lines of all these means, continuous service, good frequency and constant information to passengers, destinations or last minute changes affecting their journeys (Teltronic, 2015). It is not just about the specific services offered such as buses, trains, and metros. It is also about our perceptions and norms, and about our competencies and abilities to use the opportunities that exist (Thuesen, 2018).

A lot of literature focuses on the user experience and satisfaction with the current public transportation system in cities around the world. Literature indicates that the overall average of satisfaction reflects that generally all users are not sufficiently satisfied with the PT systems (Imam, 2014). Literature also shows that poor information to travellers is one of the main issues in public transportation services, which is an important reason for allocating substantial efforts to implement a powerful and easy to use and access information tool (Bruglieri, Bruschi, Colorni, Luè, Nocerino and Rana, 2015). It is also an opportunity for service providers and decision makers to utilize these facts to focus on the attributes which are important for the users of public transportation (Imam, 2014).

As we have not been able to identify any research which investigates our particular research area, we find it rather interesting to reach a solution that will increase the user experience through improvement of existing and new digital features.

2.1.3 Factors influencing user experience in public transportation

In the following we will describe, evaluate and discuss the different concepts which have manifested through the literature review that affect user experience in public transport.

A concept matrix (Table 1) has been created to summarize the influencing factors based on relevant literature review. Four concepts have been identified in total. However, we have deliberately excluded concepts that have been stated throughout the literature due their relative unimportance for our overall research such as; price and better resources for people with disabilities. In the following, each concept will be described briefly according to its effect on user experience.

CONCEPT MATRIX	
Concepts	Articles
Communication	- Doering, Pögel and Wolf, 2010 - Kirkegaard, 2017 - PRIMETIME, 2017 - Catapult, 2015 - Webb, 2019 - Thuesen, 2018 - McMahon, 2018 - Rejseplanen, 2019 - Teltronic, 2015 - Souliotis, Tsadimas and Nikolaidou, 2014
Delay	- Fajstrup, 2014 - Souliotis, Tsadimas and Nikolaidou, 2014 - Kirkegaard, 2017 - PRIMETIME, 2017 - Imam, 2014 - Mikkelsen, 2015 - Evans, Werner and Phillips, 2002 - Bruglieri, Bruschi, Colorni, Luè, Nocerino and Rana, 2015
Connectivity	- Fajstrup, 2014 - Kirkegaard, 2017 - PRIMETIME, 2017 - Souliotis, Tsadimas and Nikolaidou, 2014 - Rosenkilde, 2017 - Polat, 2012 - Catapult, 2015 - Bruglieri, Bruschi, Colorni, Luè, Nocerino and Rana, 2015 - Webb, 2019 - Holleczek, Yu, Lee, Senn, Ratti and Jaillet, 2014 - Teltronic, 2015
Reliability	- Sorratini, Liu, and Sinha, 2008 - Chakrabarti, 2015 - Souliotis, Tsadimas and Nikolaidou, 2014 - Carrel, Lau, Mishalani, Sengupta, Walker, 2015 - Holleczek, Yu, Lee, Senn, Ratti and Jaillet, 2014 - Webb, 2019 - Bruglieri, Bruschi, Colorni, Luè, Nocerino and Rana, 2015 - Ceder, 2016

Table 1. Concept Matrix

Communication

The communication within PT, consisting of information distributed to users about any kind of changes, irregularities or general announcements as well as user's input towards the service provider, is a reappearing concept in the literature. Although there have been improvements in the communication through information technology and travel applications, such as *Google Maps*, *Apple Maps* or Denmark's *Rejseplanen*, users of PT are still unsatisfied by the current characteristic of communication (McMahon, 2018). According to Bruglieri et al. (2015), *"poor information to customers is one of the main issues in public transportation services, which is an important reason for allocating substantial efforts to implement a powerful and easy to use and access information tool"* and that travellers want to be updated and feel as if they can rely on what is being communicated to them. Doering et al. (2010) also adds that communication is one of the most important attributes when it comes to PT.

Different travellers experience different challenges when it comes to communication in context of PT. Literature shows that on the one hand frequent travellers who are accustomed, expects to be informed about delays in particular (Bruglieri et al, 2015). On the other hand, people who rarely use public transportation and suddenly must travel on a route, which they have not been on before, have difficulties to navigate and being fully oriented. Especially if something unexpected happens along the way; if the train does not run or the bus takes a different route than it usually does. (Thuesen, 2018). Literature also indicates that users would be satisfied, if they could rely and trust the communication conveyed about disruptions. PT must be attractive and trustworthy for it to be a real alternative (Kirkegaard, 2017).

In the recent years, digital technology has been used to inform about communication in PT. There are websites and applications developed to facilitate and provide information about everyday schedules and disruptions such as the; timetables, routes, departures, arrivals, suggestions and much more. (Souliotis et al, 2014). Souliotis et al. further introduces the concept of crowdsourcing. They suggest that a technique to provide the best communication, is for the

public to contribute information and thereby giving them the opportunity to become both service providers and recipients at the same time (Souliotis et al, 2014).

For many users, public transportation applications, such as *Google Maps* or *Rejseplanen* is a great tool to become adjusted to the practice of public transport. But the itinerary can be even more intuitive to use and users need more efficient and real-time updates when there are operational or natural disruptions, and route changes (Thuesen, 2018). Another study, which investigates user's perception of public transportation information systems, has observed that communication about delays should be more comprehensive, meaningful and need detailed instructions for the users (Bachok, 2007). Despite the applicability of communicated information on delays, the travel decisions of the study respondents did not get affected by the information and continued with their original travel plans. However, it did generated frustration (Bachok, 2007).
Further, the communication speed is another issue. Slow or delayed responses to user requests or updates on changes or irregularities lead often to missed or wrong connections and consequently to dissatisfaction of the users (Butkevičius & Lingaitis, 2005).

Delay

The literature presents the concept of delay in two different ways. First, delay in communication, this will be explained later as part of reliability, and the delay of the PT resources arriving on time. The latter considers both how the user experience is impacted, but also a more holistic view on the cause of the problem.
Kim, Lee, Kim, Lee, Park (2010) describe issues in the context of bus delays by analysing bus information systems. They found out, that the issue of delays is rooted in the estimation of bus arrival times and caused by the dependency between identifying bus locations and updating this information in the system.
Gershenson and Pineda (2009) define the *Equal Headway Instability* as common and widespread phenomenon causing inefficiency and finally leading to delays of public transportation resources. They see the cause of the problem in vehicles either going faster or slower than expected triggered by "*heavy traffic, poorly synchronized traffic lights, and passenger behaviors*" (Gershenson and Pineda, 2009). This effect is closely related to the known issue of *bus bunching*,

where "*two successive services of a single line arriving at stops with shorter than designed headways"* (Schmöcker, Sun, Liu and Fonzone, 2016). It is evident that the infrastructure of public transportation systems is prone to many external factors such as traffic congestion or passenger behaviours that easily can lead to delays.

The literature further place emphasis on how delays are conceived by the users and how it affects their overall user experience. Delay is described as one of the most problematic attributes of PT, as "*nearly 80,000 train passengers were delayed every day in 2016"* (Kirkegaard, 2017, own translation). This results in not only late arrival, but can also have various negative consequences for the users. This includes missing connections, late arrival at any kind of obligations or users being forced to switch to other forms of transportation (Kirkegaard, 2017). This does not only affect their journey as users, but it also affects their everyday lives. In close connection to this, some users try to circumvent preventively these issues by adapting to delays and cancellations: "*I will probably leave a bit earlier, because I want to arrive on time, just to be safe. I do not want to bother others and waste their time.*" (Thuesen, 2018, Own translation). In addition, through several case studies, users have expressed that the accuracy of the timetables is crucial for them, if they are dependent on PT resources (Kirkegaard, 2017).

However, it is difficult to imagine an entire transportation network to run with absolutely no complications and delays, especially when unpredictable and external factors, such as traffic or passenger congestions, can affect the PT system. Though the literature shows that delays affect user journey and thereby user satisfaction, it becomes the job of researchers and designers to enable and secure that information and comfort is being emphasized. (Evans, Werner and Phillips, 2002).

Further, as a consequence of delays and cancellations, users have difficulties in planning their trip. Changes, irregularities and caused waiting times distract users and create concerns. Evans, Werner and Phillips (2002) elaborate that this unpredictability and unreliability while travelling leads to elevated stress.

Connectivity (Transit)

Alongside *Communication* and *Delays*, literature emphasizes *Connectivity* (sometimes also referred to as *Transit)* as another factor influencing the user experience of travellers in the context of PT. With connectivity we understand the interconnection of different means of transportation as well as the cross-linkage of the involved information systems. Connectivity enable users to switch between different systems and consequently chose the preferred travel connection.

According to a study from 2014, conducted in Denmark, users of PT wish a *"(...) better coordination between the various transportation companies (...)"* (Fajstrup, 2014, own translation). Further, interviewees criticized the coordination of timetables and wished for more efficient timelines, which would lead to an increasing use of PT (Fajstrup, 2014). One user within this study elaborates further on the issue of connectivity in nowadays PT: She highlight a "good connection" as determining factor for her choice of transportation (Fajstrup, 2014, own translation).

Furthermore, users of PT want more departure times. This also implies the need for more PT vehicles in use. This is one of the highly requested demands of users who do not think that PT meets their needs (Fajstrup, 2014). Thus, regularity and frequency are crucial to the experience of quality, especially when it comes to long distance travels outside of the city (Fajstrup, 2014).

Suburban commuters express that available travel options are limited, and the connections are poor once they leave the inner city. These particular commuters are also afflicted by transit connections between different transportation means. In the inner-city users have the option or benefit of taking the next bus or the next train by sacrificing a few extra minutes, but once leaving the rich network of the inner city it becomes a bigger problem and commuters are left annoyed and tiresome. (Østergaard, 2014). In general, some cities are simply poorly connected to the suburbs.

In summary, the connectivity of PT resources can be seen as a crucial requirement for most modern cities. It is a great responsibility, as citizens are highly dependent on public infrastructure such as PT. Decent transportation makes the everyday life of people easier and well connected. Municipalities and regions are responsible for local and regional public transportation in buses,

railways and flex traffic. This is important because it is the local and regional transportation that binds trains, metros and buses together. (Petersen, 2018)

Reliability

Further when reviewing relevant literature related to issues and problem areas within the context of public transportation, *reliability* was a reappearing concept. Sorratini, Liu and Sinha (2008) define it as the probability that a user is able to carry out a journey with PT resources "according to the expected trip characteristics, such as travel time, comfort and cost".

Studies and surveys show that reliability plays an essential role when observing the quality of user's travel experience. Users rank unreliability as one of the top inconvenience costs connected to public transportation (Chakrabarti 2015). By improving the reliability, PT service can reduce the total travel time, lead to more satisfaction of the user with the service and attract additional users. Furthermore, many of the user's decisions, regarding the time of arrival or choice of means of transportation are heavily affected by the reliability of PT resources (Carrel et al. 2015).

The importance of reliability of PT resource is evident when considering user's perception. Ceder (2016) describes a British study from 2004, where user of PT rank their perception of local bus services in weights (By illustrating the ranking with the use of a total of 100 points): Reliability (34), Frequency (17), Vehicles (14), Driver behaviour (12), Routes (11), Fares (7) and Information (5). As indicated by the numbers, reliability is the most importance factor of the user's travel experience.

All in all, the literature concludes that it is essential to have a good public transportation system that facilitates the travellers mobility, which involves: regular networks of different type that flow through the entire city, connections between the lines of all these means, continuous service, good frequency and constant information to passengers, destinations or last minute changes affecting their journeys (Teltronic, 2015)

2.1.3 Part conclusion

It is important to note that the literature review often elaborates and discusses these concepts in relation to each other as they in some way or another affect each other depending on the specific context.

Studies about influencing factors on the user experience in PT can be conducted with different focus depending on the research objective. Nevertheless, certain key concepts will appear frequently when researching the problem space of PT.

As presented in the previous review, *communication*, *delay*, *connectivity* and *reliability* are some of the factors to consider when proceeding with our research. Although factors such as price, safety, handicapped-accessibility and others appear during the review as well, we argue for the four previous mentioned concepts to be the most applicable for the research scope and overall objective.

As digital technology plays an important role in the context of PT, using it for communication is a critical and essential medium to facilitate good flow and practice not just for users but also in general. Literature shows that digital applications demonstrate ambiguity when it comes to conveying information to users. We therefor consider communication to be one of the most important factors. For example, when a *delay* occurs, it can affect the coordination between the different PT services so that the traveller is not able to reach his or her next connection (*Connectivity*). This results in trains and busses being completely full as people start to accumulate and create crowdedness. These delays create unpredictability and unreliability which eventually can lead to elevated stress, as regularity and frequency are crucial to the user's experience of quality. Thus, reliability plays an essential role when observing the quality of user's travel experience. These disruptions need to be communicated through the available communication channels. The communication medium should be digital, as this is the most omniscient form with its biggest capacity of reach. When a disruption is not communicated through proper channels, it leads to confusion and stress based on the substantiality that lack of knowledge is more tedious than being enlightened.

Prior to this literature review, an explorative user research in the form of user interviews took place. We identified the area of *Communication* within the domain of PT as conspicuous, since most interviewees mentioned it during the research. Additionally, a strong impact of *Communication* on the other concepts has been identified. Consequently, we chose *Communication* as our area of interest within the domain of public transportation as we can conclude that the transportation system puts pressure on users and routinely creates stressful situations which we want to elevate through communication.

With this literature review it has been possible to identify concepts that are well suiting and create the foundation and context of our research topic. We have not yet recognized particular design research that shares the same research objective as ours. Hence, this research will attempt to answer a novel question and thereby address a knowledge gap that can contribute to the literature.

2.2 Theoretical framework

2.2.1 Coping

As public transportation systems are critical infrastructures for cities, it is a necessity for users that the network is well planned, coordinated, and convenient (Dodson et al, 2011), otherwise users end up feeling frustrated or stressed.

Users of PT tend to feel frustrated, stressed, and ultimately experience a lack of control, when they suddenly realize that the train is delayed, cancelled or that the bus takes a different route caused by road construction (Richards, 2015). Research also shows that travelling for longer periods of time to get to work leaves users of PT more susceptible to chronic stress, or 'burnout', and can often get more cynical (Richards, 2015).

What is the first reaction in the face of sudden stress using PT? Do we immediately plan to overcome it? Do we call our friends or family to guide us? Do we become more social and ask random people around us for help? Or do we avoid confronting people and go straight to digital

technologies for help and guidance? We all react differently when it comes to specific events and, therefore we also cope differently when we feel stressed, frustrated, confused or annoyed. There are many ways of handling and adapting to a stressful situation. *Coping* is the conscious and unconscious efforts we as individuals put in to solve problems and thereby reduce stress. Lazarus and Folkman *(1984) define coping* as "*constantly changing cognitive and behavioural efforts to manage specific external and internal demands that are appraised as taxing or exceeding the resources of the person."* (Lazarus and Folkman, 1984, page 19).

In psychology, coping skills or strategies are adaptive tools that we proactively administer to minimize or avoid burnout. These tools can be our own thoughts, emotions, and actions. These tools depend on who we are as individuals and our personality patterns. (Chowdhury, 2019). For example, and extrovert or a sociable and friendly person is more likely to use solution-focused and communication-based coping skills for minimizing or getting rid of troubles. Where on the contrary, an introvert or a timid person will most likely use defensive and self-oriented coping strategies for adjusting (Chowdhury, 2019).

Lazarus and Folkman elaborate that successful coping mechanisms depend on the emotional functions related to the problem. Lazarus classifies several functions that most individuals use for active coping.

According to Lazarus and Folkman, the way in which people cope depend upon the resources that are available to them, such as; financial, material, physical, psychological, cognitive, and social. They believe that individuals cope with disruptions by using two key subprocesses that continuously influence each other. The first one being individuals evaluate the potential consequences of an event (appraisal). They do so by assessing the nature of a particular event and its personal importance and relevance (Beaudry and Pinsonneault, 2005).

Second, individuals perform different actions to deal with a particular situation at hand (coping efforts). They rely on a combination of cognitive and behavioural efforts both of which are categorized as either problem or emotion-focused coping (Beaudry and Pinsonneault, 2005).

Emotion-focused changes one's perception of the situation but does not alter the situation itself. It tries to regulate personal emotions and tensions, restoring or maintaining a sense of stability, and reducing emotional distress. It is oriented towards one's self and includes minimizing the consequences of threats while maintaining hope and optimism (Beaudry and Pinsonneault, 2005). Problem-focused coping aims at managing the disruptive issue itself. It is oriented towards dealing with the specific aspects of the situation by changing the environment such as altering or alleviating barriers or changing the one's self by developing new standards of behaviour or learning new skills or procedures (Beaudry and Pinsonneault, 2005).

In other words, emotion-focused coping is about getting sympathy, moral support, or understanding from others and try to see the situation from a different light to make the overall situation more positive. Emotion-focused coping occurs mainly when individuals feel that they have limited control over a situation (Beaudry and Pinsonneault, 2005). Problem-focused coping, however, takes steps to remove the stress or decrease its effect, such as initiating direct action to solve a problem (Wong and Wallhagen, 2014). Problem-focused coping mainly occurs when individuals feel that they are in control of a situation (Beaudry and Pinsonneault, 2005).

The coping process consists of three stages which are; *Anticipation* (before an event occurs), *Impact* (as the event happens), and *Post-impact* (after the event has taken place). The combination of problem-and emotion-focused coping efforts depends upon the individual appraisals of a given situation. Therefore, Individuals tend to choose the coping strategy that promises the greater chance of success and restoration of a sense of well-being. (Beaudry and Pinsonneault, 2005).

For this research we want to focus on positive coping strategies such as having a support system. Lazarus and Folkman (1984) indicate, that having someone during tedious times can help in overcoming stress and frustration with more ease. Supportive coping works well for people who are both in the category of emotion-focused and problem-focused. Techniques such as texting a friend, having a group discussion, or sharing a problem with online communities, can help in

adapting to life stressors and frustrations, and thus manage them without it affecting individuals every day. (Chowdhury, 2019)

Part of the objective of this research is to reach a solution that will benefit users, who have tedious and stressful experiences when traveling with PT. We want to help individuals by providing various coping strategies and leverage them with the use of digital technology. However, to develop technology that supports users of PT, we initially must find a procedure for the process of creation as well as practices, that help us to understand the user. For that reason, the next chapter will introduce *Design* as our overarching approach within this project.

2.2.2 Design

Over the past several decades, many views and understandings has been presented on the meaning of design. The following paragraph presents three possible approaches to define the term *design* in general, based on the theory of Daniel Fallman (2003). He discusses the three competing accounts from design theory which provide different attempts to conceptualize what design really 'is' (Fallman, 2003).

With a clear focus on the development of a solution by using a defined process *the conservative account* (1) has its foundation in structured methodological guidelines. By going gradually from abstract to concrete the following process is applied: First the problem is identified and analysed. After that a solution is developed and finally evaluated.

In contrast to the conservative account (2) *the romantic account* provides an importance to the role of the designer as a creative and imaginative genius. Its focus is placed on design being related to art, furthermore, design is not only about creating useful artefacts but to create beautiful artefacts (Fallman, 2003). The account also suggest that the design process involves a mystical element that does not necessarily need to be uncovered. Hence, it trades in creativity over control and aesthetic over transparency and reasoning (Fallman, 2003).

Fallman's third account, *the pragmatic account* (3), introduces the design process as a reflective and hermeneutic dialogue. The aim is to solve a specific problem iteratively by using resources, which can be found in the specific design situation (Fallman, 2003). This latter account will be used as definition for design in context of this thesis.

Following this pragmatic account, the process is seen as non-linear procedure, contrary to a concatenation of tasks. During the design process the designer enters different phases - problem analysis, synthesis of a solution and an evaluation of the problem. Without being obliged to a specific sequence of tasks, the designer has the ability of switching between the phases. By abandoning its linearity, the designer is left with various activities, which are inseparable and intertwined.

Kolko (2010) describes design as a way of finding clarity and organizing complexity in context of a problem. He describes this understanding as *Abductive Thinking and Sensemaking* and elaborates further that the considered problem can be solved by organizing, structuring, filtering and finally connecting the research data. This sense-making process and creation of meaning should be externalized and consequently documented by various tools. A pen and sticky notes on a wall are simple but the most common tools for this externalization process. By visualizing the design process the designer can reduce the mess of collected content and bring structure in it. "*By taking the data out of the cognitive realm (the head), removing it from the digital realm (the computer)*" (Kolko, 2010, p. 19), the designer can widen his/her understanding of the problem and come up with possible solution.

Further, it is important to mention, that this thesis follows a user-centered approach. Throughout the whole design process, it is crucial to involve users into the various design phases and methods (Norman, 1999). In connection to that, the user's needs and interests should be considered and thus influence the design. This involvement is a so-called *user-centered design*. By putting the emphasis on the user, the design needs to focus on his or her convenience and reduce complexity of the user's task.

By involving the users into the design process and in the development of a solution, a clear understanding of the user's needs and goals can be guaranteed. Consequently, a more appropriate, more useable product can be developed (Preece, Chapter 9.2). Preece et al. further elaborates, that by involving real users, their expectation will be met or even exceeded.

Considering the real users and their needs, goals and pain points as the main force behind the creation of a product, Gould and Lewis (1985) stress the early understanding of the users as crucial. By studying and observing the users and understanding *who* they are, the foundation for an easy and useful product is provided.

Also, Kolko (2014) emphasize the design process as user-centered. Throughout the whole process every decision regarding the design should target the support for the user and create a form of improvement, so the user can accomplish his or her goal and achieve his or her aspirations. Kolko titles this process as *Design Thinking*. Instead of being just "passive audiences", the users should become "active players" (Frow et al, 2015).

Further, user-centered design is also important when considering the value creation of a product or service. The fundamental requirement to create value is that users are actually using the product or service. For this reason, the users need to be involved in the design.

In practise, user-involvement can be achieved by using a variety of methods and activities. Interviews, observations, use of questionnaires or even having users as co-creator in workshops are just a few to mention.

In addition, Kimbell (2009) investigated the shift in design, from solely being an activity of solving problems or finding solutions to adding actual value to users. On the same notion, users get value from the experiences which build up how they communicate, interact and work (Preece et al., 2015).

2.2.3 Service design

Service design is a principle that can be traced all the way back to the 1920's to the tradition of industrial design (Polaine et al, 2013). A concept that was defined by a group of Americans whose drive was to use new technology to improve the living standard of people (Polaine et al, 2013). They focused on satisfying the fundamental human needs and created products in more efficient ways, such as cars and trains to expand people's range of travel. (Polaine et al, 2013).

With modern development and high living standards, we have reached a natural plateau where focus has been shifted from efficient production to lean consumption (Polaine et al, 2013). Our human needs have changed, as we now experience challenges around sustainability, good

health, and even development of leaner transportation solutions. It is evident that the value set has moved from standard of living to quality of life.

However, designing a service differs from designing a product. (Polaine et al, 2013) explains that by *"applying the same mindset to designing a service as to the design of a product can lead to customer-hostile rather than user-friendly results"* (Polaine et al, 2013 p. 19, l.3-4). This is mainly due to products being objects, meaning that companies tend to be divided into silos specializing in one area of function (Polaine et al, 2013). Operating in silos, staff tend to focus on efficiency of their step in the value chain, rather than placing the focus on the quality of the complete customer or user journey (Polaine et al, 2013), as it is done when designing a service.

Is service design the same as other concepts such as interactions design, and user experience (UX)? No, it is not the same, but Polaine et al (2013) describes all these concepts as *cousins*. They are related but not the same. Service design is an activity carried out by a multidisciplinary group of people that may include Web and graphic designers, interaction designers, user experience designers, business strategists, ethnographers, information architects, project managers and many more (Polaine et al, 2013).

This research will therefore touch upon areas within user experience, user-centered design and service design (Figure 4). Hence, it is important to be familiar with different concept and terms as it will have an impact on the understanding of this research.

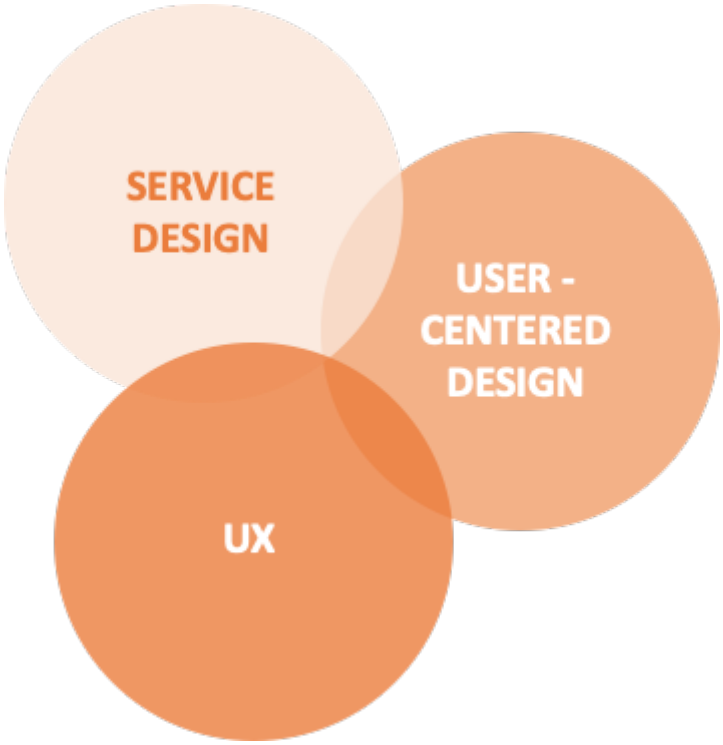

Figure 4. Areas of design

Interaction and user experience design are often understood as designing for screen-based interactions. However, service design covers a broader spectrum of channels than these. When projects have strong digital components, interaction and user experience design have an important part to play, but so does product design, marketing, and graphic design (Polaine, 2013 p. 7). It suddenly involves an entire ecosystem where each component becomes important to project success.

2.2.4 Design thinking framework

The Design Thinking methodology (Figure 5) from the *Institute of Design at Stanford University* provides (Stanford University, 2010) an outcome or solution-based approach to improving challenges or solving problems (Dam and Siang, 2019). It is used by many cross functional teams as a mean when undertaking complex challenges that are vague or ambiguous, by understanding the human needs concerned. This is carried out by reframing challenges in a human centric way by empathizing with users, brainstorming, and moreover, by adopting approaches such as prototyping and testing (Dam and Siang, 2019).

design thinking framework consists of five activities: Empathise, Define, Ideate, Prototype and Test (Stanford University, 2010).

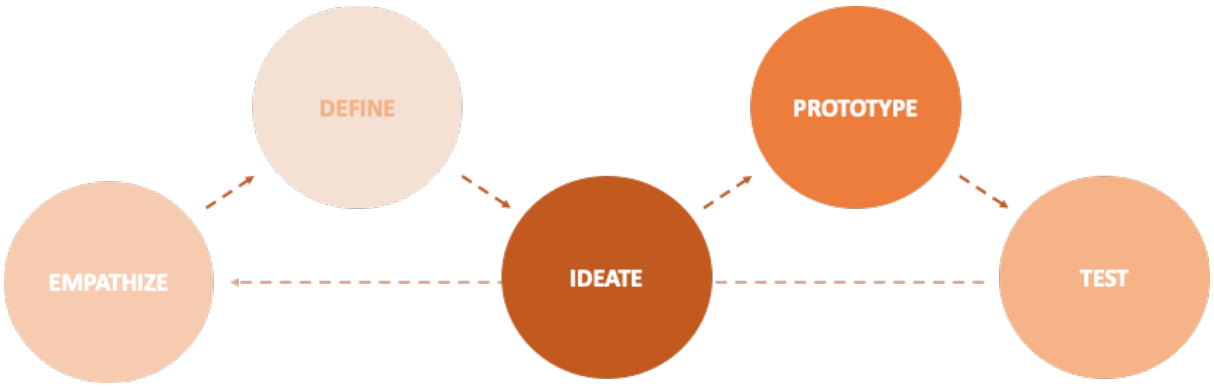

Figure 5. Design Thinking Framework

Empathize

Empathizing with users is crucial to a human centric design approach as is allows the researcher to gain an empathetic understanding of a problem that needs to be solved. This activity involves observing and engaging with users to understand their experiences as well as immersing in the physical environment to gain a deeper personal understanding of their problems. This activity allows design thinkers to reserve their own assumptions and thereby place emphasis on users and their needs. (Dam and Siang, 2019)

Define

Once enough data is gathered during the empathize activity, it becomes possible to draw patterns by analysing and synthesising them to define a core problem or several problems (Dam and Siang, 2019). In order to be consistent in a user-centered manner, this study will illustrate the problem statement by focusing on users. This may be done with a *How Might We* method that allows looking for ideas and solutions. During this activity designers will also be encouraged to gather ideas to establish features and functions or elements in general that will assist solving the issue at hand (Dam and Siang, 2019).

Ideate

At this point designers have, identified and understood the users, analysed and synthesized data and thereby ended up with user-centric problem statement. During the ideate activity, designers, with or without users, are ready to generate ideas, through methods such as brainstorming, *Worst Possible Idea* to stimulate free thinking and thereby expand the problem space (Dam and Siang, 2019). It is always helpful to get as many ideas out, as this will eventually be narrowed down by more techniques and tools.

Prototype

At this point the designers may have one or several ideas to prototype. This may start as inexpensive scaled down prototypes of the service or specific features found within the service to investigate the solutions generated from the ideate phase (Dam and Siang, 2019). It is a way for the designers to test but also for the stakeholders to comment on features, functions and design and the "*extent to which it meets the user's characteristics and needs.*" (Howard, 1998) Prototypes should be tested and revised in several iterations as this is an experimental phase and the objective is to identify the best possible solution.

By the end of this activity, designers will have a clearer view of what the final solution should function and look like (Dam and Siang, 2019).

Testing

In this final activity, evaluators will rigorously test the final and complete service. The outcome generated during testing will be used to revise or redefine problems that support user's needs. Alterations and refinements may happen until the end to ensure all problems have been ruled out. Testing can be carried out internally by the design and development team but also by the actual users of the service. It is important to consider both system testing and usability testing as they test two different aspects of the same service. But testing can also be carried out as an evaluation through user interviews. Thus, testing the value that a prototype or a solution gives

the intended user. As we will focus on improving the experience by helping users to cope, it is important to us that we measure or capture that value. (Dam and Siang, 2019b).

Although these five phases are presented as a cascade (Figure 5), it is not always sequential and does not need to follow a specific order (Dam and Siang, 2019). It can occur in parallel and be repeated iteratively which is why the phases are also referred to as *activities* instead of *phases* or *stages*. We have chosen to deductively follow the design thinking framework, as it gives us clarity and structure for the research. It also guides us in an unrestricted manner by giving us the space to make our own choices and decide our own iterations. The main benefit is that the knowledge acquired at the latter phases can feedback to earlier ones, while information is continually used both to inform the understanding of the problem space as well as the solution. This creates a perpetual loop, in which we continue to gain new insights, develop new ways of viewing the outcome and its possible uses, while developing a far more profound understanding of the users and the problems they experience (Dam and Siang, 2019).

2.2.5 Design methods and practices

Personas

"User characteristics capture the key attributes of the intended user group" (Preece, Sharp, and Rogers, 2018, p. 357), and to design the best suited service for the users, it is wise to base these design decisions on personas. Personas are rich descriptions of a typical user of a service which is under development that designers can focus on and design the service for (Preece, Sharp, and Rogers, 2018). They are to communicate user characteristics and goals based on extensive user research. It is important to state that personas do not describe a real user, but instead represents a synthesis from several real users. Personas are characterized by a unique set of goals relating to the service, which is being developed, a description of the user's skills, attitudes, tasks, and environment (Preece, Sharp, and Rogers, 2018). Usually it requires a small number of personas rather than one, but having one primary persona to represent a large section of the intended user group is helpful (Preece, Sharp, and Rogers, 2018).

In contrast to designing services and solutions based on the preferences of the design team, it is more common within the user-centered design disciplines to organize research and personify trends and patterns in the data as personas (Dam and Siang, 2019a).

As many people uses public transportation, users can be segmented in many ways. Personas will help us narrow down our target group as we are not able to solve problems for every user of public transportation. By creating personas, we will understand our users' needs, behaviours, goals, and experiences. It will help us recognize how different users have different needs and expectations, and to identify the specific users that we are designing for. Furthermore, it guides our ideation processes and help us achieve the goal of creating a good user experience for our target group. (Dam and Siang, 2019a)

However, we will first exploit the concept of proto-personas which is a non-research but assumption-based description of the user group. Once more and more factual data is collected, it is imperative to evolve the personas from hypothesis to certainty to validate their accuracy (Gothelf, 2013).

User stories

User stories originated as part of the *Agile* and *SCRUM* development methodologies (Domingo, 2019). User stories are representations of minor instances in people's lives to capture their intentions with a short description of a feature leading to a goal-centric design (Alexander and Maiden, p.214, 2005). These goal-centric scenarios are to enable empathizing with the target group by focusing on activities, thoughts, and emotions, and thereby generate ideas that fit into the user's life. To create user stories, a rich fund of information based on qualitative research is necessary (Domingo, 2019). Ideally as researchers, we should take the lead when defining the user stories, these can even be based on personas. However, users can also be a part of creating their own user stories and as a co-creation activity with designers (Domingo, 2019). When all information is collected, the most relevant insights can be selected and presented as written stories or visualized story boards (Domingo, 2019). As designers, we use these stories not only to empathize with the intended users but also to use as inspiration when creating and designing solutions that will fit the users' needs. User stories gives us what we need to create a realistic,

concrete, and shared view of our users. It provides guidance and focus on placing emphasis on the right places rather than going too broad and thereby lose focus and move out of context.

Journey Mapping

Journey maps are a common UX tool which come in all shapes, sizes, and formats. Depending on the context, they can be used in a variety of ways. Journey mapping is a visualization of a user's relationships with a product or service over time and across different touchpoints. Often it is represented as a timeline of touchpoints between a user and service, which accommodates information about the channels that users use to interact with a service (Babich, 2019). It is a tool that allows to understand the interaction from a user's point of view rather than the designer's assumption. It cultivates a user-centric approach to service design which may excel in better user experience (Babich, 2019).

Regardless of what a journey mapping visually looks like, they all incorporate the same five elements. (1) An actor, who is the persona or user who experiences the journey. The actor is who the journey map is about and therefore it will be presented from the user's point of view. For this research we find that providing one point of view per map will give us a stronger and clearer narrative. (2) The scenario and expectation describe the situation that the journey map addresses as well as the actor's goal or need, and specific expectations. Journey maps are beneficial for scenarios that involve a sequence of events such as taking a trip, that is also why we find it relevant to use to break down the sequences of using PT. (3) Journey phases are the different stages in the journey and vary from one scenario to another. (4) Are the behaviours, thoughts, and feelings the actor or user has throughout the journey and these are mapped within each phases of the journey. It accounts for the behaviour and steps that the user takes, thoughts developed with each step which are the user verbatims from our research. Finally, emotions or feelings are added signalling the emotional frustrations and content of the experience. (5) Are the insights and opportunities that we gain in the end that will helps us to draw knowledge from the mapping. (Gibbons, 2018)

This study views this method as a conversation starter as well as an aligned mental model for the

researchers. The insights resulting from the journey mapping will be exploited to communicate an understanding of the users or the service to all involved (Gibbons, 2018). It is also a basis for decision making when uncovering moments of frustration and content throughout the series of interaction. The journey map will help us reveal opportunities to address the users *"pain points, alleviate fragmentation, and, ultimately, create a better experience"* for users (Gibbons, 2018).

Prototyping

According to Preece et al. *"a prototype is a limited representation of a design that allows users to interact with it and to explore its suitability"*. It can help stakeholders and designers to choose between different design alternatives, and test technical aspects to clarify requirements and usability (Møller and Tollestrup, 2013). Preece et al. places prototypes in two different categories; low-fidelity and high-fidelity.

Low-fidelity prototypes are often simple, cheap to create and fast to produce by using materials like paper or cardboard. They are not to be kept and integrated into the final design but rather as an artefact laying the base for further prototyping. High-fidelity prototyping is more in line with the final design. They are more time consuming and therefore also more expensive to produce than a low fidelity prototype as they are made of the same material as the final design (Møller and Tollestrup, 2013).

Bødker and Buur (2002) stresses the importance of tangible prototypes as tools to try potential future situations by interacting with the prototype and thereby get hands-on experiences (Møller and Tollestrup, 2013). Kolko also emphasizes the importance of giving tangible form to the reflections, ideas and thoughts as "*they become something that can be discussed, defined, embraced, or rejected"* by any number of users (Kolko, 2010). However, prototypes have a limit in the meaning it conveys. It does not by itself express the reasoning behind any particular feature or alternative that might have been considered. Hence, a prototype makes a statement about the nature of what is envisioned and allow these to be tested in a particular context (Møller and Tollestrup, 2013).

In addition, Lim et al. (2008) proposes three principles about prototypes; 1) the *fundamental principle*, which views prototyping as an "*activity with the purpose of creating a manifestation that, in its simplest form, filters the qualities in which designers are interested, without distorting the understanding of the whole*" (Lim et al, 2008, Page 7:2). 2) The *economic principle* conditions the best prototype to be the one that, "*in the simplest and the most efficient way, makes the possibilities and limitations of a design idea visible and measurable*" (Lim et al, 2008, Page 7:4). 3) The *anatomy principle* articulates that "*prototypes are filters that traverse a design space and are manifestations of design ideas that concretize and externalize conceptual ideas*" (Lim et al, 2008, p. 7:4).

As designers we communicate the rationales of our design decisions through prototypes. Prototypes stimulate reflections, and designers use them to frame, refine, and discover possibilities in a design space. However, this view differs from other approaches depending on the context. For example, in software engineering prototypes are used to identify and satisfy requirements (Lim et al, 2008). These are called requirement-oriented approaches and have their limitations as "*design activities are flexible rather than rigid, reflective rather than prescriptive, and problem-setting rather than problem-solving*" (Lim et al, 2008, Page 7:2). Thus, a design idea that satisfies requirements does not necessarily mean that it is the best design. It is therefore important to know where the focus and emphasis is when prototyping is framing, rather if it is on exploring a design space, or satisfying requirements (Lim et al, 2008).

For this research, we use prototyping to capture and share ideas that will otherwise not come across through simple text. It is a tool for the participants of this research to explore the design space, be flexible as well as reflective. It is also a tool for us to make our ideas tangible instead of working theoretically.

In order for us to be able to measure rather our potential solution improves user experience, we must extract user insight that is credible and valid. We believe that to do so we need to provide the participants involved in this research, a tangible prototype in order to get real thoughts and emotions towards our solution.

Competitor analysis

By conducting a competitive research and analysis we get to explore the marketplace and find opportunities to create unique value (Levy, 2015). We also use it to compare our solution to those of our competitors. When benchmarking competitors, we are analysing how digital services offer alternative ways to solve problems (Levy, 2015). We look for trends, patterns, gaps, and an overall sense of the landscape. A competitor analysis will help to see if patterns are being repeated across different services and products, and we might realize that they are all overlooking an especially useful capability that could be of importance for the value proposition (Levy, 2015). Hence, benchmarking on existing competitors allows for opportunities to create value by either innovating or optimizing on the best service out in the market (Levy, 2015). As we will develop a prototype to support the research, a competitor analysis is suitable to assess which other products or services that are already available which solve similar or same problem and needs. After analysing the market and identifying competitors, we will create logical groupings for comparison. Levy (2015) refers to this as "*housekeeping*". By using logical groupings, we can place the competitors with common traits into *"buckets"*. Two of these buckets already exist as they are direct and indirect competitors. Other traits can be as simple as; mobile vs desktop, content type, horizontal vs vertical markets etc. We are looking for commonalities and differences so that we as researchers can understand why some services or products are more successful than others. Thus, understand which factors give the most competitive advantage (Levy, 2015).

Brainstorming

The concept of Brainstorming, by Alex Faickney Osborn (Faste et al, 2013), is often used to trigger and generate ideas about a scenario or potential solutions. It enables the ability to generate ideas as part of a creative design process (Faste et al, 2013). These ideas can be captured without disrupting or constraining a creative and unstructured process (Monk and Howard, 1998).

Brainstorming is essential to our research as it opens up for "Free-wheeling", *the wilder the idea the better; it is easier to tame down than to think up"* (Faste et al, 2013 p.1344). Quantity is also something that we aim for as the *"greater the number of ideas, the more the likelihood of useful ideas"* (Faste et al, 2013 p.1344).

Finally, combination and improvement are sought, which means that in addition to contributing individual ideas, participants should also suggest how ideas of others can be turned into better ideas; or how two or more ideas can be joined into still another idea (Faste et al, 2013). This is particularly useful in user workshops. Osborn recognized the advantages of brainstorming in groups, not just for the sheer quantity of ideas produced but especially when solving problems. The brainstorming concept helps us with productivity, improves social dynamics, and enables sharing of ideas between participants and between us as researchers.

User workshop

For researchers or designers, it is an important part of any process to talk to real users. According to Preece, Sharp, and Rogers, 2018, the best way to learn what the users feel, think, do, and want, is simply to ask them. The purpose of a user workshop is to collect sufficient, relevant, and appropriate data, so that a set of stable requirements can be produced (Preece, Sharp, and Rogers, 2018). The new data collected can expand, clarify, and confirm those initial requirements (Preece, Sharp, and Rogers, 2018). It is also an efficient way to collect multiple viewpoints, to highlight areas of consensus and conflicts, and encourage contact between the designers and users.

User workshop sessions can vary in their format as by being structured with a set of topics for discussion, or unstructured. The latter requires a facilitator who can keep the discussion on track and can provide the necessary focus or redirection when appropriate (Preece, Sharp, and Rogers, 2018). However, when being new to facilitate user workshops, a structured format is the best way to guarantee creative outputs and ideas, as sessions might tend to go unfocused, and lack direction. Hence, it is our responsibility to ensure that time is spent efficiently and that we manage to uncover insights needed to move the research forward (Chang, 2019).

3. METHODOLOGY

Whether we are aware of it or not, we often have set of beliefs and assumptions when approaching a research (Saunders et al, 2016). These may be about our assumptions and realities that we encounter at every phase of our research, which inevitably shape how we understand the research question, the methods that we apply, and how we interpret our findings (Saunders et al, 2016).

There are three types of research assumptions to distinguish research philosophies and these are; ontology, epistemology and axiology. *"Ontology refers to assumptions about the nature of reality"* (Saunders et al. 2016, page 127). The ontological assumptions shape the way in which we view and study our research. The ontology therefore determines how we see the world of design research and our choice of what to research.

Epistemology however concerns assumptions about knowledge, what constitutes acceptable, valid and legitimate knowledge, and how we can communicate knowledge to others. Researchers may adopt different epistemologies in their research which can give a much greater choice of methods. *"Axiology refers to the role of values and ethics within the research process"* (Saunders et al. 2016, page 128). This entails questions about how we, as researchers, manage our own values and those who are involved in our research. We demonstrate axiological skill by being able to articulate our values, as a basis for making judgements about what research we are conducting and how we go about doing it.

To give a simple explanation of the research design of this study, we have been inspired by Saunders et al. (2016) '*research onion*' and created our own version of this model to present our overall research methodology and design (Figure 6). The following layers of the research onion visualizes a structure of the different stages which we as researchers need to go through when framing the methodology of the study.

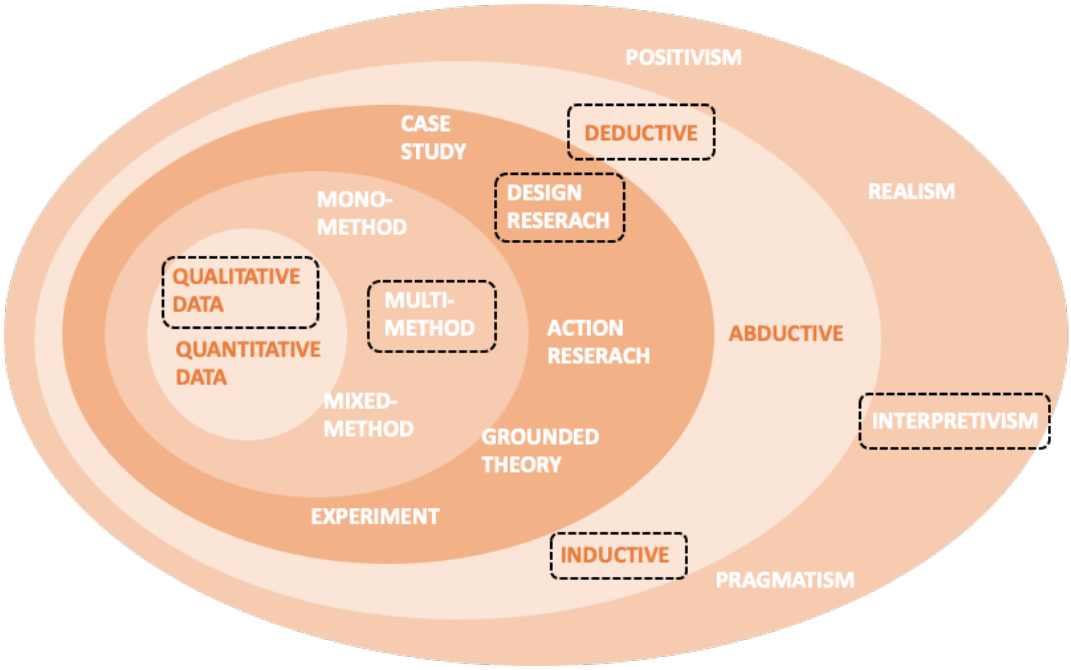

Figure 6. Research Onion

3.1 Research Philosophy

This research adopts the assumptions of relativism. According to Stanford Encyclopedia of Philosophy, relativism is *"the view that truth and falsity, right and wrong, standards of reasoning, and procedures of justification are products of differing conventions and frameworks of assessment and that their authority is confined to the context giving rise to them."* (Baghramian and J. Carter, 2019). Relativism in philosophy means that there is no ready consensus on any one definition, which is also why the foundation of this research is placed within the epistemology interpretivism.

The philosophy of interpretivism argues that human beings and their social worlds cannot be studied in the same way as physical phenomena (Saunders et al, 2016). Hence, social sciences research needs to be different from natural sciences research, rather than trying to emulate the latter (Saunders et al, 2016). Interpretivist is critical of positivists ground to discover universal laws that apply on everything as people make different meanings, and create and experience different social realities. Interpretivists rather believe that research is to create new, richer understandings

and interpretations of social worlds and contexts (Saunders et al. 2016). Therefore, there is no "*right*" way, but instead multiple ways of interpreting the world.

3.2 Research approach

The research approach discusses whether the study should take a deductive or an inductive approach to the theory development. While a deductive approach requires to identify a clear theoretical position in the beginning of a research, an inductive approach does not (Saunders et al, 2016). The inductive approach does not require to identify an existing theoretical position. However, with this approach it is likely that we still need to familiarise ourselves with theory within the research topic (Saunders et al, 2016). The inductive approach does not mean disregarding theory, but rather allowing meanings to emerge from data as we collect them, in order to identify patterns and relationships to build a theory. Thus, it does not prevent from using existing theory to formulate research question and identify concepts that we wish to explore (Saunders et al, 2016).

However, there is not a firm block between the two, which means that it is possible to combine the two within the same research. Sometimes a research unconsciously uses both and this can often be advantageous, though one approach is always more dominant.

Although induction is the most common approach for interpretivist, this research finds itself taking a deductive approach as it uses and follows the *Design Thinking Framework*. However, we can argue that our research also incorporates induction as we also aim to identify patterns and relationships, which is exploiting the inductive approach.

3.3 Methodological choice

The methodological choice is whether a research follows a quantitative, qualitative or mixed methods research design. While quantitative research often exploits or generates numerical data and statistics, qualitative research uses a naturalistic and emergent research design to build theory or to develop a richer theoretical perspective, than already exists in the literature (Saunders et al, 2016).

Qualitative research also studies participants' meanings and the relationships between them, using a variety of data collection techniques and analytical procedures (Saunders et al, 2016). As user-centered design is a discipline within this study, it is essential to exploit the benefits of qualitative research approaches, to gain physical access to participants but also building and demonstrating sensitivity, to have cognitive access to their experiences, feelings, and opinions (Saunders et al, 2016).

Furthermore, we will also use more than one data collections technique which is referred to as multi-method. By utilizing this method, we are able to triangulate our data to confirm the validity, credibility, and authenticity of research data, analysis and interpretation (Saunders et al, 2016).

3.4 Research strategy & setting

Research Strategy describes the ways in which the research project will be carried out. This can take many forms, such as case studies, action research, and or ethnographic studies (Saunders et al., 2016).

However, as this research is based on design principles, we cannot place it as either a case study or an action research or any of the other strategies mentioned by Saunders (2016). It would not give it justice, as neither of these strategies truly embraces the design element of this research. Consequently, the strategy of this research is applying design science in the context of public transportation. Hevner et al. presents a set of guidelines for design science research. Their first guideline states, that *"Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation."* (Hevner et al. 2004, page 83). He explains, that when working with *design science research,* it is required to end the research by creating an innovative, purposeful artefact for a special problem domain (Hevner et al., 2004). Our objective is therefore to develop a prototype that will support the problem areas of this research. Through iterations, we will seek to understand the design problems and place emphasis on creating a better experience for our users.

Furthermore, as this research will be using a user-centred approach in several design processes, it is evident to reach users of public transportation and base the problem space on their experiences.

Hence, this research will operate in the context of public transportation rather than engaging with specific stakeholders such as service providers or public institutions. Further, the users which will participate in this research will also reflect this by being randomly selected with the only requirement of being a user of public transport and within a specific age range. A more detailed description of users involved is described in *Chapter 4: The Study*.

3.5 Data Collection Methods

Data collection methods include the techniques and procedures concerning the practicalities of the research.

This research will only be using qualitative data, it will however use both primary and secondary data sources. Secondary data will be used with the purpose of gaining a full understanding of the context of public transportation in Denmark. Furthermore, it will also be used to identify current problems that users of public transportation experience in their everyday lives. Thus, secondary data will support our preliminary review of establishing a concept matrix (see literature review).

The primary data for this research will be collected with the specific purpose of supporting the research problem. The advantage of extracting and using primary data is the specific and relevant knowledge that derives from interviews and workshops - data that cannot otherwise be found within secondary data sources. By extracting or generating primary data, we have the ability to; formulate interview questions and construct workshops, ask follow up questions or choose different formats. This will ensure that we gain a full understanding as well as the competencies to find underlying problems and assumptions which may prove beneficial or even crucial for the quality of our research.

The following paragraph will present, how the data was collected during different design methods:

Interviews

The preliminary interviews were not audio recorded as we did not look for any specific wordings or truths. It was mainly to get inspired and extract as much information as we could by creating

a relaxed environment for the participants. However, we did conduct member checking with each participant to enhance the trustworthiness by filling out a user journey template (Birt, Scott, Cavers, Campbell and Walter, 2016). Hence, this allowed for immediate member checking and a nod of validation. A more detailed description of the preliminary interview is elaborated under *Chapter 4.2.1 User interaction 01.*

The second round of interview were conducted in hopes of gaining thoughts and opinions from users on the low-fidelity prototype. These interviews were audio recorded by consent of the participants as it was important for us to have access to user's thoughts and opinions about the low-fidelity prototype, and also to make it easier to find statements to support the analysis. We also took pictures to capture the moment and to document the process. A more detailed description of the interviews along with the takeaways are elaborated under *Chapter 4.5.2 User interaction 03*.

The final round of interviews was conducted in relation to measuring the success of the high-fidelity prototype and to see if our prototype and its features actually help users of public transportation to cope with a lack of control when relying on public transportation resources. Most of these individual interviews were audio recorded while also filling out a *Feedback capture grid*. For those who did not want to be audio recorded, we simply filled out the grid, so that we later could identify the relevant data needed. A more detailed description of the interviews along with the takeaways are elaborated under *Chapter 4.6.1 User interaction 04*.

User workshop

The user workshop was audio and video recorded, but not transcribed. As the workshop facilitated four participants as well as us, the researchers, transcribing would not create any added value. Thus, it is more beneficial to review the video recording and make notes rather than fully transcribe six people being in dialog.

Research Participants

The table below (Table 2) shows a list of all participants in our research. In total, we have had 45 participants, that have either been part of the individual interviews, the workshops, or both.

Type	Number of Participants	Location
UI 1: Interview	15	Denmark & Germany
UI 2: Workshop	4 (+ 2 Designer)	Copenhagen
UI 3: 1st Testing	10	Copenhagen
UI 4: Final Testing	16	Copenhagen

Table 2. Overview of research participation

Reliability and Validity

Data quality from participants conducted through interviews and workshops must be taking into consideration, as issues can arrive in relation to reliability, bias, validity and generalisability. Reliability can be related to that the questions are not fully standardized. Bias within data quality can be related to interviewer or researcher bias, where we as researchers can make the participants perform in a particular way. Generalisability must be taking into consideration, as only a limited sample of participants are involved in this research. (Saunders et al. 2016).

However, as this research is based on the interpretive epistemology conducted through qualitative methods, we must assume that the data gained from the interviews and workshops are reliable, since the interviewees are describing their own thoughts and feelings about the experiences within public transportation, as well as their interaction with different tangible artefacts. Furthermore, the objective of this research is to reach an understanding of the issue and finding a solution rather than reaching a truth or an objective reality.

3.6 Ethical consideration

Questions and concerns about the ethics of research practice have grown substantially. Consequently, we need to think carefully about how we gain access to undertake our research, and about potential ethical concerns that could arise throughout the conduct of the research project (Saunders et al. 2016). Ethics are also a critical aspect for the success of any research project, whether we use secondary or primary data.

Especially when involving human participants, ethical concerns arise, regardless of whether the research is conducted, person-to-person, in focus groups or via questionnaires (Saunders et al. 2016). And as a design research almost inevitably involves human participants, it is rather important for us as researchers to place emphasis on the matter.

When conducting the in-depth interviews (User Interaction 01), as well as the user workshops (User Interaction 02), all participants were informed and assured about their right to anonymity and to retrieve from the research at any time. All participants have been informed of the purpose of the study, what we wish to accomplish, and their role in the research. All data utilized in this research has been handled with respect, both during collection and processing.

4. THE STUDY

This following chapter will start by giving a complete visual overview of the entire project structure by going through the different phases of the *Design Thinking Framework*. Furthermore, it will take the reader through the journey of developing a digital solution in close collaboration with the intended users by describing the design, including how the mentioned design methods and practices were applied and what the outcome were.

4.1 Overview of the design process

As we are deductively following a framework with several iterations, it can be helpful to understand the process by giving the reader a visual overview of the processes and iterations of the research. By following the *Design Thinking Framework* by Stanford (2018), it helps to initiate the process with a starting point referred to as *Empathize*, and a finishing up with *Testing*. Although the framework gives a vibe of a linear process, in practice it is much more iterative and some of the design methods can also overlap into several phases. Figure 7 shows an overview of the applied design methods and practices in relation to the phases that we go through as researchers.

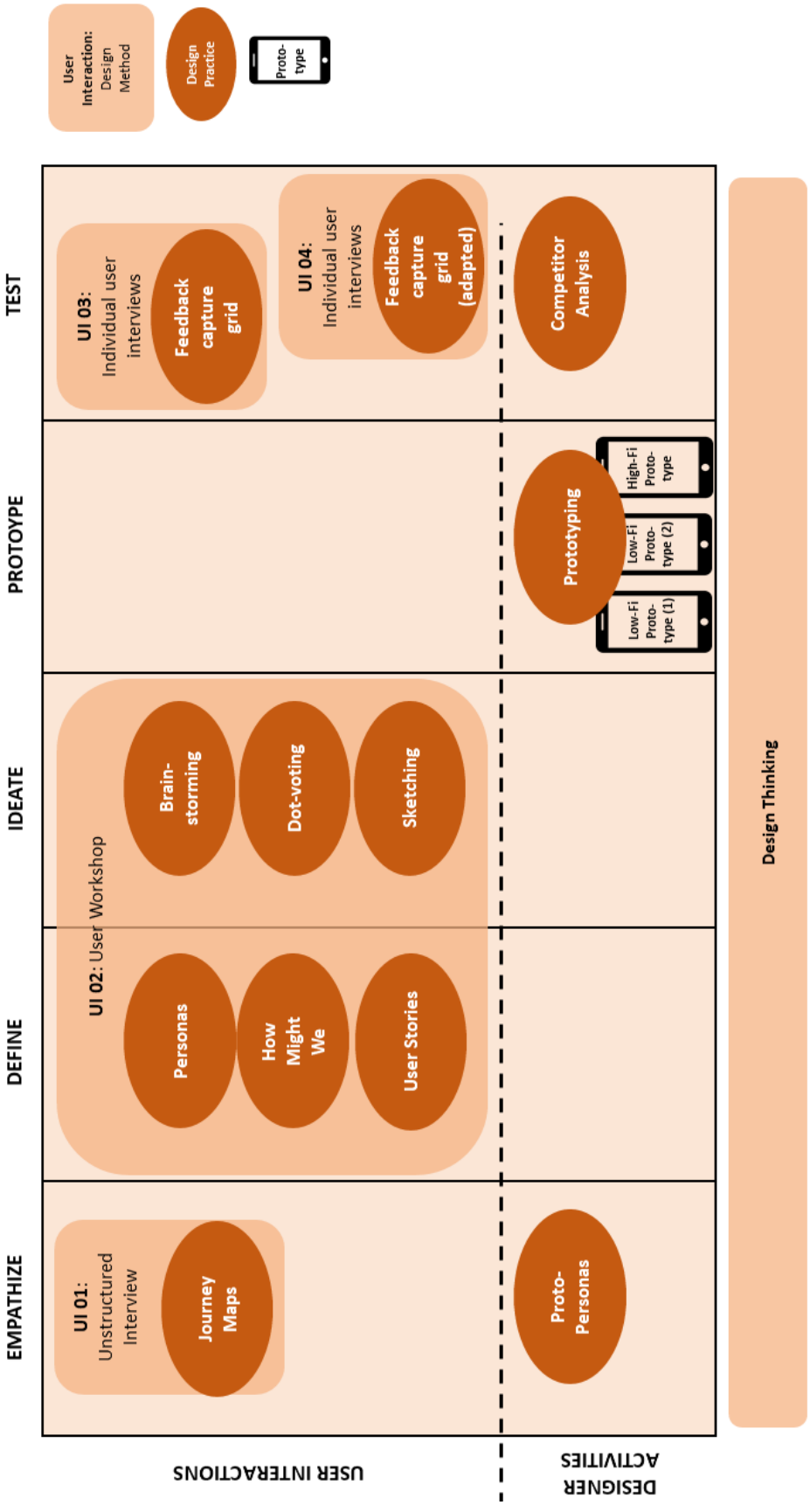

Figure 7. Design process

4.2 Empathize

We begin the research by empathizing with users to gain an empathetic understanding of a problem that needs to be solved. We have done this by observing and engaging with users to understand their experiences and gain a deeper personal understanding of their problems. By searching literature and conducting user interviews, we can create personas which captures the key attributes of our intended user group and it also helps us designing the best suited service for the users in the end.

4.2.1 Proto-Personas

To have a base for the design decisions made during the early process, proto-personas were created, which then were verified and corrected with the insights gathered during the first user workshop in a later iteration. In contrast to the final personas, the proto-personas were based on existing studies about usage of public transportation. An analysis of the public near distance transportation within the "Region Hovedstaden", published in August 2017 from PRIMETIME, investigated in the age distribution of users dependent on their means on public transportation. Comparing different age distributions, the grouping of users of 30 years and younger is with 39 percent the biggest grouping that uses public transportation the most.
Since this data didn't give insight into the usage behaviour according to the distribution between women and men, a similar study looking at the usage in Germany was used, where the general distribution between women and men is nearly balanced.
These numbers of age and gender distribution were used to create three proto-personas and completed with user quotes from the PRIMETIME study and further assumptions. Figure 8 shows one of the proto-personas. [Appendix 4] illustrates all three Proto-Personas

The purpose of creating these Proto-Personas was to set a foundation for the following iterations, by defining the user group.

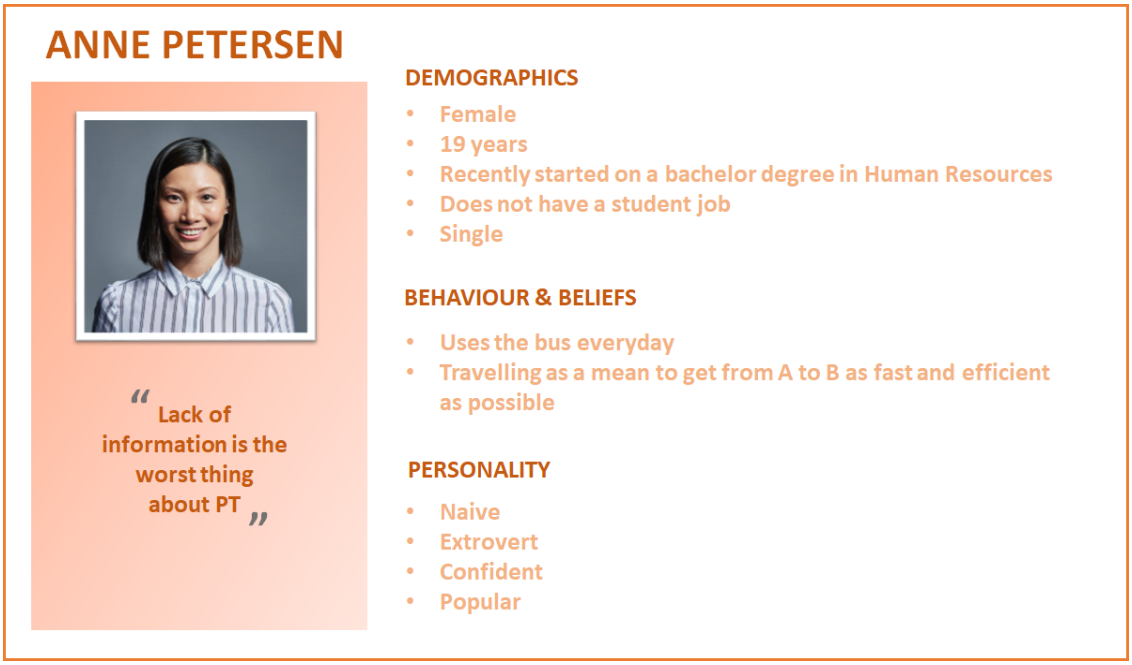

Figure 8. Proto-Persona

4.2.2 User Interaction 01

- *What problems are out there and which one is interesting to work on?*

Date: 08. - 19.07.2019

Design Method: Unstructured Interviews

Design Practice: Journey Maps

Duration: 10 to 20 minutes per user

Location: Copenhagen (Denmark) and Stuttgart (Germany)

Participants: For this user workshop we had eleven users in total. The only user requirement for the selection of interviewees was that she or he has experienced unpleasant events and inconveniences in the context of public transportation. Furthermore, the goal was to interview people with different backgrounds, age and from different location, to enhance the variety in experiences, needs and expectations from users.

Purpose: Based on *Theoretical Sampling* (Glaser and Strauss. 1967). The Discovery of Grounded Theory: Strategies for Qualitative Research, p.45) these eleven initial interviews were used to

identify key concepts which might create the foundation of the research. The general intention was to capture interesting issues and pain points, that people have experienced while using public transportation. Thus, these interviews focused on the way the participants felt in these situations and why they felt in this specific way.

The execution: We asked the participants about one or more specific personal experiences, where they were unhappy with a service, that was provided by public transportation. The interviews were unstructured and conducted without any guideline to give the interviewee and ourselves the flexibility and freedom around the overall setting. When finding it necessary, we asked short questions like "*How did you feel in that particular situation?*", in case the interviewee did not mention it by her or himself.

At the end of the interviews, we created journey maps about the unpleasant events and inconveniences in collaboration with the interviewee, to document the findings with a strong focus on the user's feelings in a particular situation.

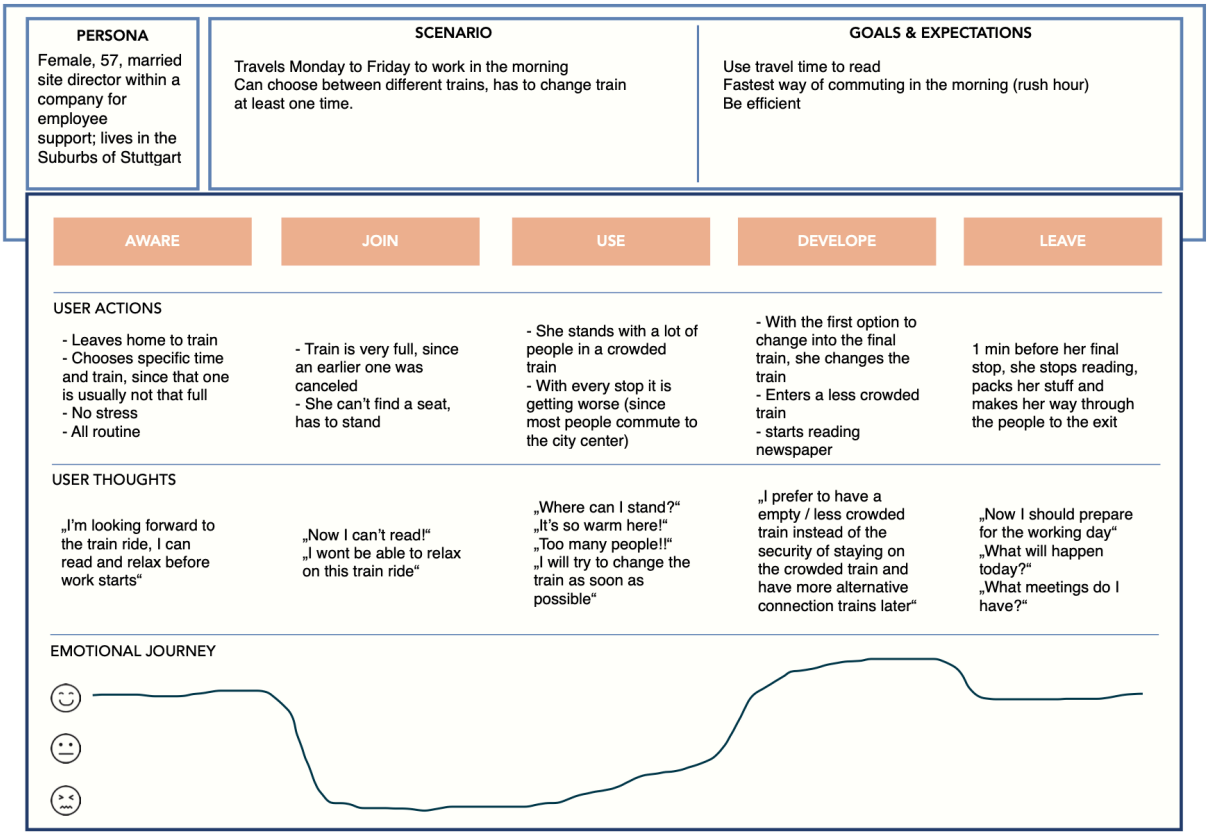

Figure 9. Journey map

Figure 9. shows one example of the gathered journey maps. We chose not to record or transcribe any of these eleven initial interviews, because of the following reasons: Main purpose of this first user interaction was to explore issues within the field of public transportation. Thus, we wanted to create an atmosphere where interviewees continuously talk about their experience. By renouncing to record, we supported this atmosphere. Additionally, we used these interviews to explore issues and get inspired by users. Hence, it wasn't necessary to document the whole interaction. Important user statement, especially concerning their feelings and pain points were documented in the journey maps.

The takeaways: The fifteen interviews gave insight into a wide range of experienced problems and issues from users. This pool of identified issues lay the foundation to define the problem spaces. Most users talked about experiences in connection with delays, cancellation or crowdedness on trains or buses. Further many interviewees complained about the lack of control, that they experience during their trips, since the PT service limit the users in their flexibility and force users to compromises and can cause deprivation.
Besides that, some users mentioned their dissatisfaction about the way information in the context of public transportation is communicated, especially for unexpected changes and irregularities. These findings correlate with the previously mentioned literature review about general issues in public transportation.
In addition, some users mentioned issues in connection with the tickets, ticket controls, check-in/check-out function, price and externa or sessional dependencies. But as this is out of our research scope, this will not be included when continuing our design process. As the conclusions from this user interaction corroborates with the factors identified in the literature review, we set the focus of this project on the communication within PT.

4.3 Define

Now that we have empathized with our intended users, it is possible for us to draw patterns by analysing and synthesising them to define a core problem or several problems. The core of this

phase was a user workshop where design practices such as *Personas*, *How Might We,* and *User Stories,* and were utilized to define problem areas.

4.3.1 User Interaction 02 (Part 1)

- *What are the problem areas and goals of the users, and how might we find a possible solution?*

Date: 09.10.2019

Design Method: User Workshop, partly co-creating

Design Practices: Personas, How Might We and User Stories.

Duration: 1,5 Hours

Location: Copenhagen Business School

Participants: User A (Age 33), User B (Age 21), User C (Age 29), User D (Age 27). User requirement for participating in the workshop was a frequent use of public transportation. Further the participants got selected based on their age. According to the proto-personas, participants should mainly cover the user group with the most usage of public transportation - age 29 or younger. Additionally, one participant represented the age group with the 2nd highest usage of public transportation (30-39 years old). The gender distribution was equally balanced between women and men. For a co-creation brainstorming activity we joined the workshop as participants as well.

Purpose: The objectives of the workshop were to define problem areas and generate several *'How Might We´* statements as well as '*user stories'* to build on the foundation for the following ideating practices. Furthermore, we used the workshop to verify the proto-personas and turn them into the final personas.

The execution: Prior to the workshop we prepared a deck of slides to give an introduction to the workshop, the topic of public transportation and additional information about the used design practices. The workshop was held in a neutral meeting room, to provide an unbiased

environment. Since we wanted the participants to feel included and open-minded, we gave them time and space to get to know each other. Additionally, we provided food and drinks to set an enjoyable and relaxed working atmosphere. We prepared the table with paper, pens, sticky notes and printed wireframes, both mobile and desktop versions, to give the participants several options to create ideas, which then could be pinned, collected and clustered on the walls of the meeting room.

Figure 10. Images of User Workshop

The whole interaction was divided into separate parts: introduction, creation of personas, creation of user stories, ideation, Dot-voting and sketching. However, the last three are conducted and elaborated in the second part of the user workshop, which is allocated to the design phase *Ideating*.

The takeaways:

Personas

The user workshop started with an introduction of the invited participants, including their habits, behaviour, goals and objectives in context of using public transportation. This information was used to form the two final personas. We decided to create two different personas for the following reasons: Two of our invited participants uses PT on a daily basis to travel to and from work or university. Thus, they follow a clear routine and can be seen as experienced users of PT. The other user group does not solely use PT as their main way of travelling. While using PT in a more varying way for work or free time activities, they also consider bike or the car as alternatives to PT. These two differentiations of user behaviour are also supported by the previously mentioned literature review. The general goal of using public transportation showed similarities amongst all workshop participants. They want to travel from one point to another in the most efficient way. Differences in age and occupation, such as full-time and part-time, were also considered by differencing between two personas. Figure 11 and 12 display the two final personas:

Figure 11. Persona A

Figure 12. Persona B

User Stories

To add concrete statements to the personas and to shift the focus more on possible solutions to our identified problem space of communication within PT, we asked the participants to phrase their user stories, by flowing the wording:

As a < type of user >, I want < some goal > so that < some reason >.

The following statements were formulated within the workshop:

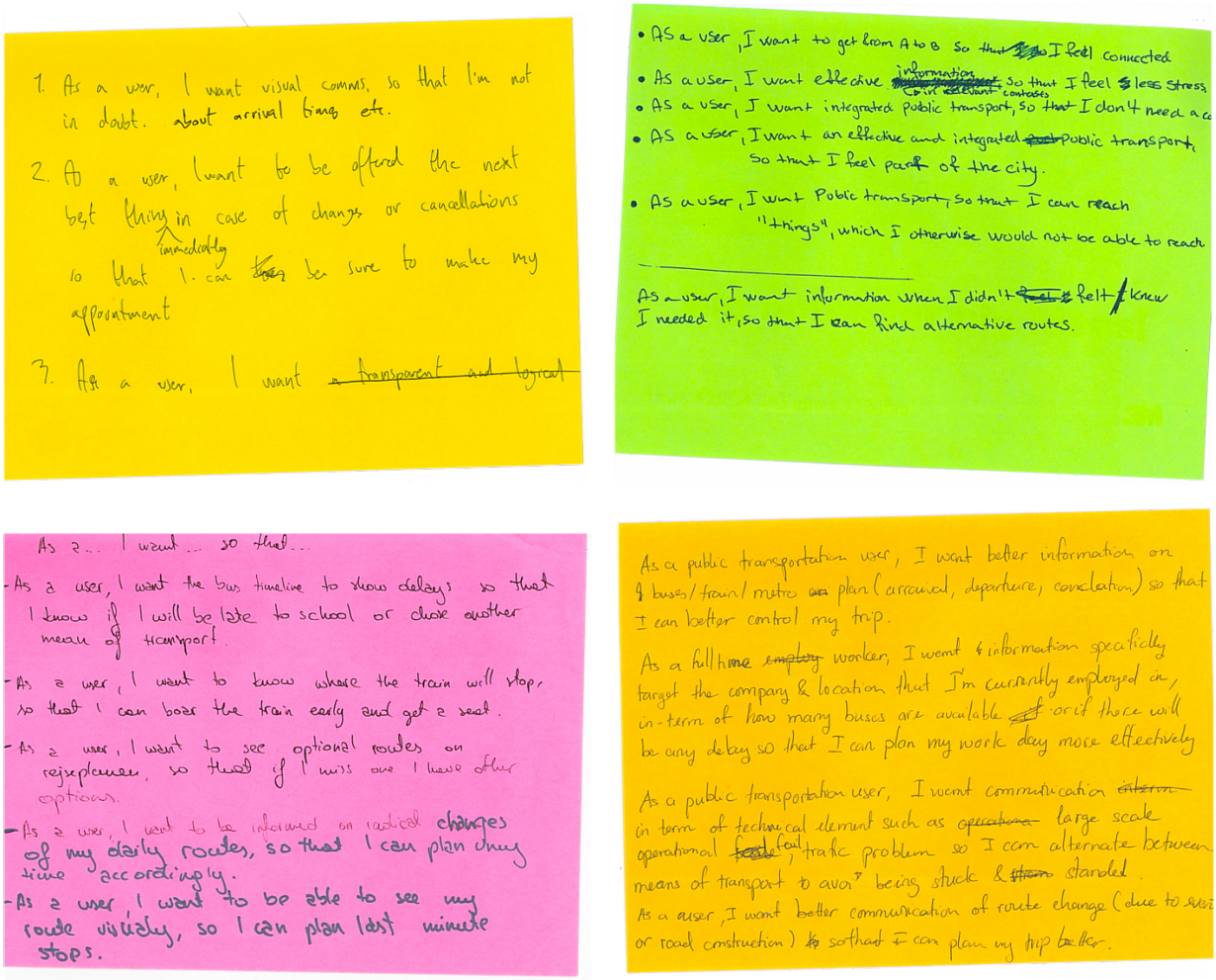

Figure 13. Collection of user stories by the four user workshop participants

We choose the following three user stories, since these were the most suitable to our problem space and within the scope of our possibilities of this project: (See research delimitation under *Chapter 1.2.2*)

- *As a user of PT, I want to receive information and get informed about changes and interruptions (I otherwise would not have known about), so that I can still arrive as planned.*
- *As a full-time employee, I want information specifically targeting my company and or the location I usually travel to, so that I can plan my workday most efficiently.*
- *As a user of PT, I want to be able to see my route(s) visually, so I can plan last minute changes.*

To finalize the define phase, together with the users we ended up with a common understanding of the problem space and initiated the following prototyping phase. We phrased a *"How Might We"* statement together will workshop participants:

How might we provide a means of communication for users of public transportation to interact and coordinate in case of (unexpected) changes and irregularities to regain control.

4.4 Ideate

At this point we have identified and understood the users, analysed and synthesized data and finalized a user-centric problem statement. During the ideate phase, we generated ideas and sketched together with the users by using practices such as Brainstorming, Dot-voting and Sketching.

4.4.1 User Interaction 02 (Part 2)

- What possible solutions could fix our identified problem and how could these look like?

Date: 09.10.2019
Design Method: User Workshop, partly co-creating
Design Practices: Brainstorming, Dot-Voting, and Sketching
Duration: 2 Hours
Location: Copenhagen Business School
Participants: User A (Age 33), User B (Age 21), User C (Age 29), User D (Age 27). These are the same participants as in User Interaction 02 part 1.

Purpose: The objectives of the workshop (part 2) was to ideate on possible solutions and features, by involving the actual users into this process. We exploited the method of brainstorming both individually as well as in groups on possible solutions, voted and finally sketched paper-prototypes.

Execution: As this user interaction is a continues workshop of the *User interaction 02 part 1* the same execution applies.

Take away:

Ideation and Dot-voting

The ideating phase of the workshop mainly contained brainstorming activities. By using pens and sticky notes the participants had ten minutes to come up with as much solutions or helpful features according to this *"How might we"* statement. The participants were instructed to encourage weird, wacky and wild ideas, to aim for quantity and to be visual during this ideation. After that, everyone presented and explained all their ideas and at the end, the group clustered all ideas and possible features to various areas. This first brainstorming round was followed by a second one, but this time the whole group, including us, ideated together in co-creation for 15 minutes.

A lot of sticky notes were pinned to a wall, where then the whole group could decide on their favourite ideas. By marking an idea with dots, everyone could give up to three votes to her or his favourite idea(s). Figure 14. displays the most voted ideas including the amount of received dots.

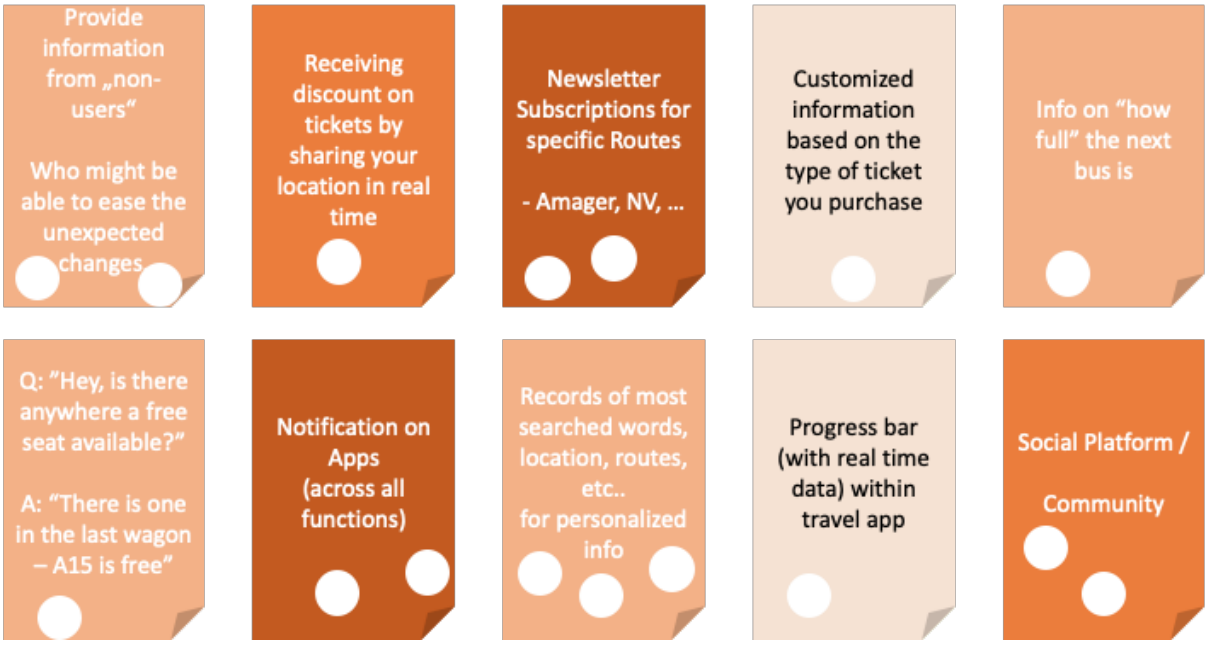

Figure 14. Dot voting

A lot of the ideas, which came up during the brainstorming, touched the topic of connecting users with each other to cope with changes or irregularities within PT. This form of communication could also be extended by involving "non-users", which primarily not using PT in the specific situation, but consequently create an advantage for other users of PT. Another way of creating an advantage by connecting users could be the access to "most searched words / locations / routes etc".

Some other ideas touched the area of personalized or customized information on changes within PT, communicated by notification, push-up or with subscription functions. But also, different ways of visualizing the personal journey, updates on the occupancy of trains or buses were favourited ideas.

Sketching

Finally, all workshop participants started a 20-minute prototyping session. Based on the brainstormed ideas and features, that received two or more dots during the voting, we created individually sketches on printed wireframes. The participants tried to consider some or even all ideas and features in their sketches. These sketches can be seen as the first of a total of four *Prototype* iterations during the whole design process.

Figure 15. Image of user sketching

Sketch 1 presented an information service, where users can submit information on incidents or specific happenings on PT to the service provider. The user's idea was to connect this to external service provider, which are not usually involved in PT, but could create a benefit for the users (such as car sharing or bike renting services).

Sketch 2 showed a social platform, where users can communicate and interact with each other. The discussions are separated in different topics and locations. Users also have the option to have direct conversations with specific users.

Sketch 3 displayed a travel assistant application, customized for a specific use case, such as travelling to work or university. The application suggests connections and alternatives for the user's regular routes, but also displays an interactive map with current delays and irregularities for the user's regular routes.

Sketch 4 presented a service model, where users get discount on ticket purchases, when in return they share their current location with the service provider. This data could then be used to make information for users more accurate, such as updating the train or bus schedule as well as arrival times.

Sketch 5 combined almost all features from the outcome of the dot-voting. The sketch showed a web application that included a social communication platform, where users can connect and interact with each other, a travel planner and a progress bar, that indicates delays and estimated time of arrival.

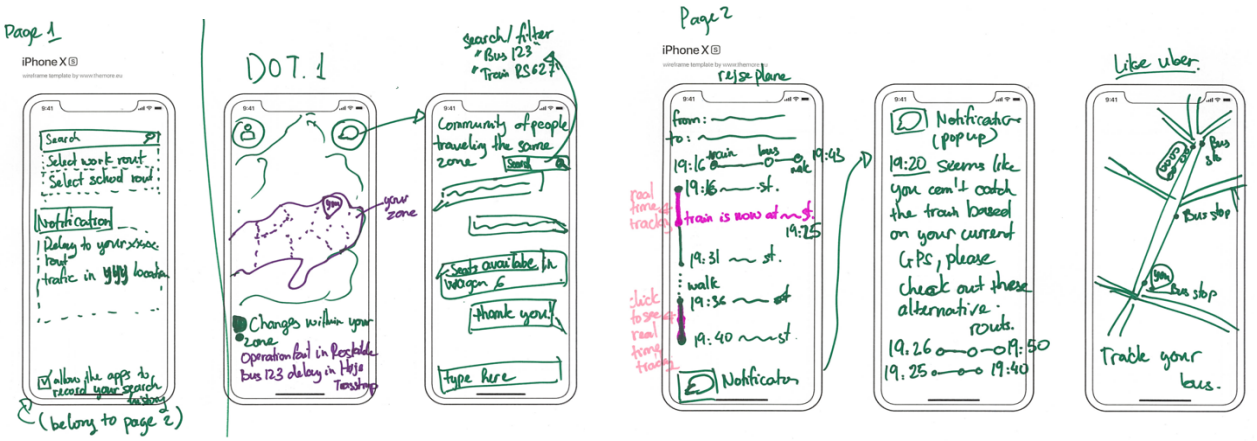

Figure 16. Image of sketches

Finally, the participants presented and explained their sketches to the rest of the group. Once more, the participants were invited to comment, ask questions or develop the presented ideas further.

4.4.2 Possible Prototype Features and first System Specification

The user workshop helped us to emphasize with our users, understand their needs and pain points when using PT. Thus, the workshop provided us with possible ideas for the first low-fidelity prototype.

After the workshop we reviewed the brainstormed ideas, solutions and features with the objective of creating the first low-fidelity prototype. We collected the following features primary based on feasibility and on the value, which it will create for the users:

- Focus on Peer-to-Peer
- Defictionalized sections, concepts, areas, form of PT
- Chat-function / Blog
- Overview of Disruptions / Changes / News / trending / Categories
- Log in / Anonym vs Profile
- Partner APIs - DriveNow[4] / Voi[5]
- Interactive Map / Dashboard
- "Pin yourself to a location"
- "Report something"
- Function to connect users
- Route subscription / Notification on specific routes

[4] DriveNow was a carsharing service owned by BMW.

[5] Voi is an electric scooter sharing service

Based on this collection we agreed on the following system specification for the first low-fidelity prototype:

Log-In

- Insert Email/ Username & PW
- Help Button
- Link to Sign-Up Page

Listing of Info (based on User Input)

- Categorized Info (divided by means of transportation, saved, most trending, "Lets share a cab"), option to customize / subscribe
- With click on section → Enter Topic. Here a list of user posts, the most-voted posts at the top. With click on one of them a detailed view is shown (maybe with comments, map, related issues etc.)

Interactive Map

- Interactive Map of selected area (Maybe with live tracking of buses or trains), display of bottlenecks, indicated by symbol, by clicking on symbol, detailed info (based on user input) comes up. Possibility to share GPS position with other users

Chat function

- Option to connect with specific user ("Hey let's share a cab" etc.)

4.5 Prototype

At this point of the process we have an idea what to prototype. We started by developing a scaled down low fidelity prototype with wireframes which was then tested with users in a form on interview. Based on the user insight gathered as well as a competitor analysis, we developed a high-fidelity prototype that was closer to the users wants and needs.

4.5.1 Low-fi Prototyping

Before the *User Interaction 03* took place, including testing and receiving user feedback on the ongoing development process, we went through two iterations of low-fidelity prototyping by

ourselves. With the previous system specification, we created individually the first prototypes. To keep the development process as simple as possible we used the software *Microsoft Powerpoint* in combination with smartphone wireframes, screenshots from existing applications and icons found online. The two series of screenshots below present our two versions of this first low-fidelity prototype:

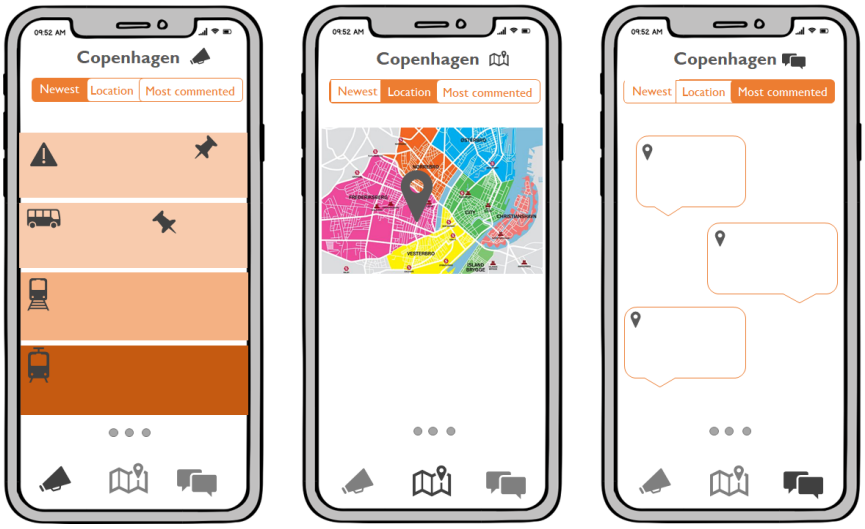

Figure 17. Draft of designer (1)

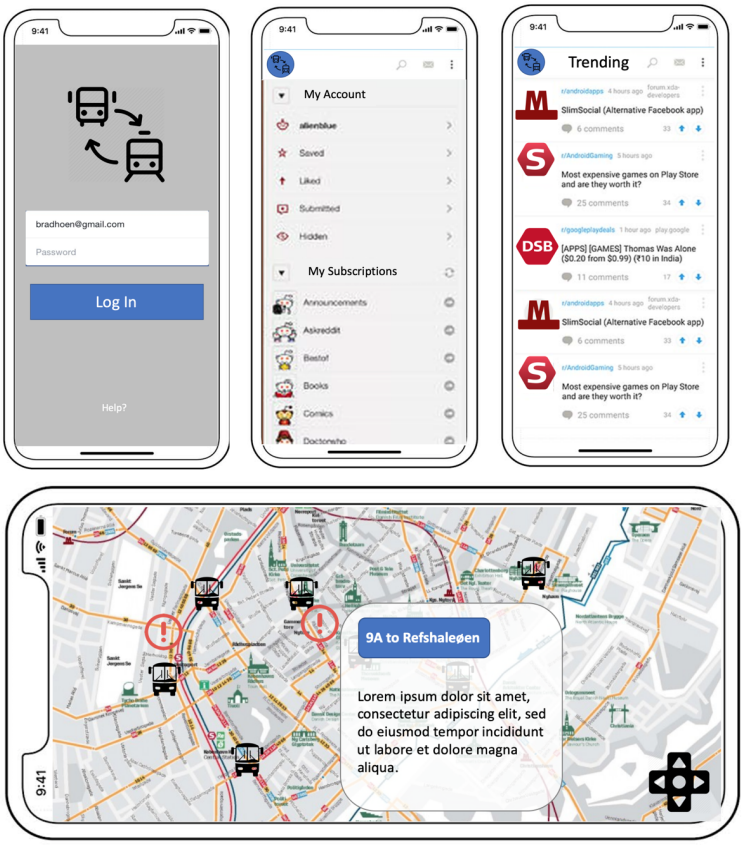

Figure 18. Draft of designer (2)

The decision to create this first draft individually was based on the objective to have a wider range of possibility and ideas, how the features could be implemented, and to avoid affect the other's creativity.

The second iteration of low-fidelity prototyping included the presentation of our first drafts, our discussion on what features and design elements to keep or change and the collectively creation of a second draft, before involving the users in the design process once more.

With the perspective of presenting this draft to the users, we used the prototyping software *Flinto* for creation, since this tool gave us the option to easily present the designs on a mobile device. Thus, we were able to simulate the prototype in its determined environment. By presenting a tangible and externalized prototype on a mobile device instead of using printed interfaces, we should according to Kolko (2010) receive a more sincere and true feedback from the users in the

next user interaction. Further we implemented clickable functions to the different interfaces, to give the user a basic understanding of the functionality and how the screens are interconnected. However, this second draft is still considered as low-fidelity, as it only shows possible core-features, limited content and is only partly interactive. Figure 19 presents this second draft of our low-fidelity prototype:

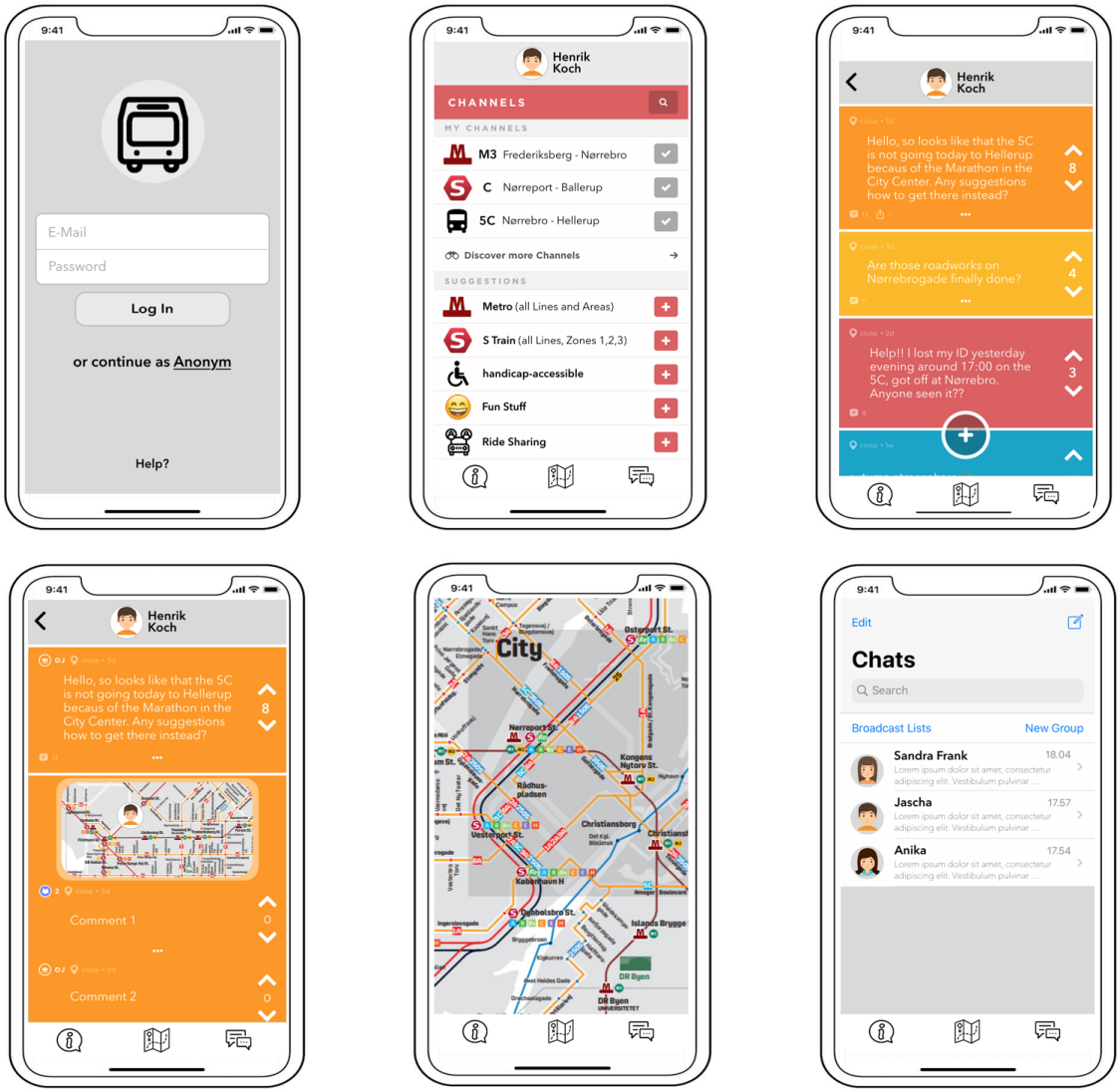

Figure 19. Second iteration of prototyping

Besides the log-in interface, the prototype consists out of three main functionalities. The *Channels* section displays the user's subscribed channels and a list of suggested channels, by

clicking on a channel, the user gets directed to a listing of user posts, ordered according to the most votes by other users. With another click on a specific user post more details are visible, including the accordingly location of the posting and other user's comments.
Next to *Channels*, an interactive map presents an overview based on real-time data in form of a map. The user's current location is visible as well as user input pinned to a specific location. The user can navigate through the map by scrolling up and down as well as from left to right. The third core function of this prototype is a simple peer-to-peer chat, where users can communicate direct to a concrete person.

4.5.2 User-interaction 03: 1st user feedback on Low-Fi Prototype

Date: 10., 11. and 12.12.2019
Design Method: Individual user interview
Design Practices: Feedback capture grid
Duration: 30 min per interviewee
Location: Copenhagen Business School
Participants: For this feedback session, we had a total of ten participants, ranging between the ages of 21-31 years old. Five of the ten participants were selected since they already participated in the *User Interaction 02* and thus were familiar with the topic and our problem space. The remaining participants were selected based on the same criteria as used in *User Interaction 02* - being of age 31 or younger.

Purpose: The purpose with the feedback session was to gather feedback and user thoughts about the low-fidelity prototype and thereby maximise learning in the context of coping with a lack of control when relying on public transportation resources.
We omit from testing techniques, such as think aloud and other usability tests. Instead we place emphasis on the user's opinions and thoughts towards the overall prototype and its specific features in form of a semi-structured interviews.

Execution: The feedback session was audio recorded but not transcribed, as we did not find it necessary due to having filled out a feedback capture grid. We did however take pictures for our own documentation. [Appendix 1] lists some examples from the filled feedback capture grids.

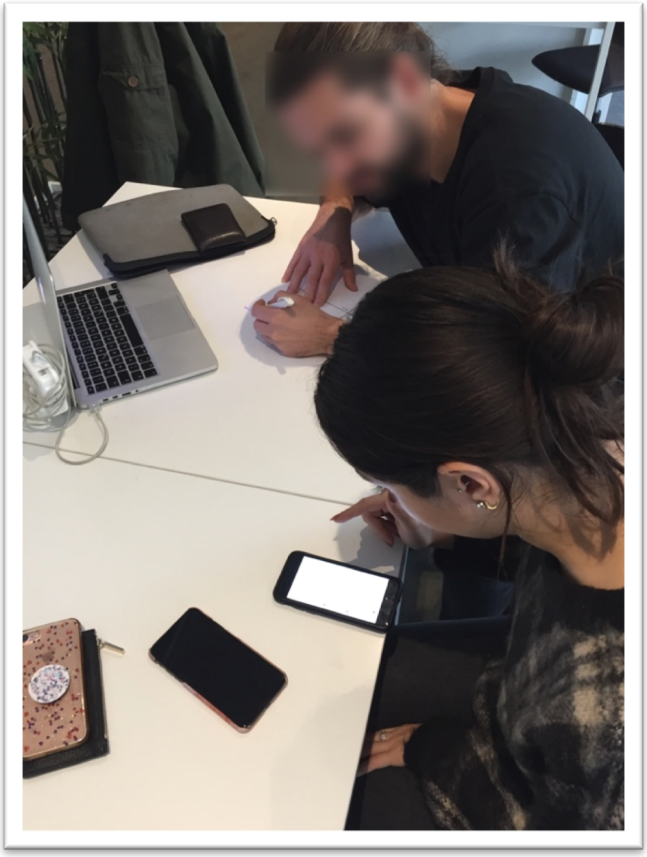

Figure 20. Image of feedback session

Furthermore, we explained to each user that our service intends to help users to cope when experiencing lack of control when relying on public transportation resources. It was important for us that the users had that notion in mind when interacting with the prototype when providing feedback.

When presenting the prototypes to the users, we tried to be as objective as possible. Both positive and negative aspects of the prototype were a part of the conversation. All in all, we made sure, that the feedback session was used to find ways to improve our solution and not sell our idea.

During the feedback session, we allowed the users to contribute ideas that built on our prototype. For instance, we asked the users how our service could be improved for them. By that, we encouraged the users to provide useful feedback as well as insight to improve our solution.

We did so by using the feedback capture grid which provided structure and organization to the feedback-gathering process.

With the feedback capture grid, we divided a sheet of paper into four quadrants and label each quadrant with; *"Worked"*, this is where we noted down positive feedback. *"Change"*, is where we captured negative feedback and criticisms about the prototype. *"Questions"* is where we wrote down questions that the users were asking as well as new questions the feedback session raised. Lastly, *"Ideas"*, where we noted down any ideas that the feedback session sparked (Dam and Siang, 2019). We also tried to steer the conversation towards quadrants that were not receiving enough input. Most important, we asked them how this service or the features help them cope when experiencing lack of control when relying on public transportation resources.

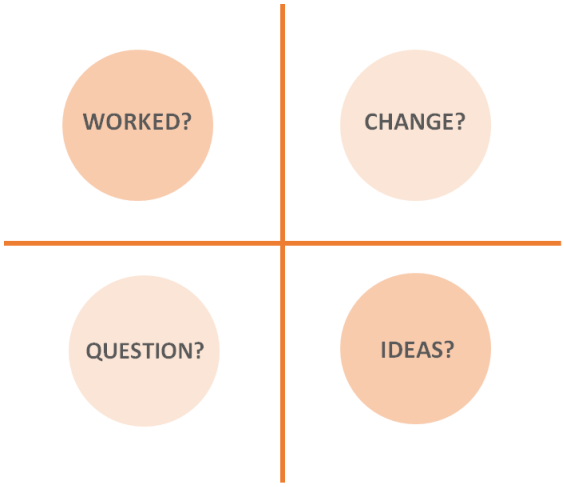

Figure 21. Feedback Capture Grid

The takeaways:

Table 3. shows a general picture of the users liked and criticized, and also the questions they had, as well as ideas that manifested throughout the interview. The main question we ask ourselves and our users is *What are the features that help our users to cope when something does not go as planned or as expected.*

What worked	What could be improved
• Subscription to channels • Subscription Suggestions • Map • General separation between Posts and Map • Profile vs Anonymous	• Change wordings, *Channels* to My *travels* • Too much info on the start UI • Some buttons features are redundant • Chat function not really useful • In the detail view of a post, separation line is confusing • Information button (i) is confusing • More details about incidents • Highlight relevant information • Home Button should be in the middle • More icons instead of text
Questions	**Ideas**
• What's the fun stuff? • How are the posts structured? • How can you make sure that posts are not overlapping (same content)? • Why should someone share their location? • How fast will questions be answered & approved? • How can I trust this information? How much personal information will be published? • What would I use the private chat function for?	• Filter for the interactive map • Add push notifications (select time frame and areas) • Suggest alternatives • Filter option (based on location) for posts • dedicate a function to ridesharing (add E-Scooters or Bikes) • On-Boarding screens

Table 3. Overview of findings in the Feedback Capture Grid

User generated content & Trust

The concept of user-generated content received some criticism through the conducted interviews. The criticism addressed issues of; quality, privacy, and trust. *"How can I trust the information that a random user puts in, if it's not regulated or confirmed by authoritative people?"* (user A). They also stated that they would feel more comfortable if the data or information was approved by an authoritative entity, as this will help them to cope better.

Some also raised questions or concern around the amount of personal information that the application would need, *"How much are we supposed to share?"* (user C).

Structure & wordings

Structure and wordings showed to be rather important in order for the users to cope: *"If I'm already stressed about a situation, I do not want to be even more stressed and confused by wordings and not being able to find the correct information"* (user E)

Structured and deliberate notifications was another feature that was important to the users, they didn't want to be constantly bombarded with information not relevant to them, *"I want to be able to filter and let the app know that I only want relevant push notification between 15pm to 17pm"* (user A).

The users liked the customized profile with subscriptions to the different means of transportation and specific lines. it helps them cope better when information is tailored to them, which is also related to structured and organized information.

Many of the users shared the confusion of what the private chat was for. They were quick to say that this was not a feature that they would use. Texting with a stranger privately is not something they felt comfortable with, and that it would not help them cope better.

Visuals

All the users were positively aligned when elaborating on the visual features of the prototype. They clearly expressed that is was important to them to have a perceptual map over the city in order to understand and cope. We learned that visuals are an effective way of passing information because the human mind processes things in images. The users shared that they respond quickly to visual images instead of text.

4.5.3 Competitor Analysis

As mentioned previously, a competitor analysis allows for an overall overview of who our competitors are how we can benefit from their competitive advantages. The competitors were analysed by creating logical groupings. This is a simple format which has enabled us to use tables and visual displays.

Rejseplanen

The closest, as well as a direct competitor, to our solution is *Rejseplanen*, one of the most used services in Denmark. Approximately 90% of the Danish population are familiar about *Rejseplanen*, and data shows that the service has about one million daily users. *Rejseplanen* A/S was founded in 2003, and with almost 20 years of traffic history, *Rejseplanen* has a solid foothold in the dissemination of traffic information (Rejseplanen, 2019). The service helps users to find the fastest or cheapest mode of transportation across bus, train, subway, car, or city bike. Despite being the most used transportation application, it does have its flaws and critics (Figure 22).

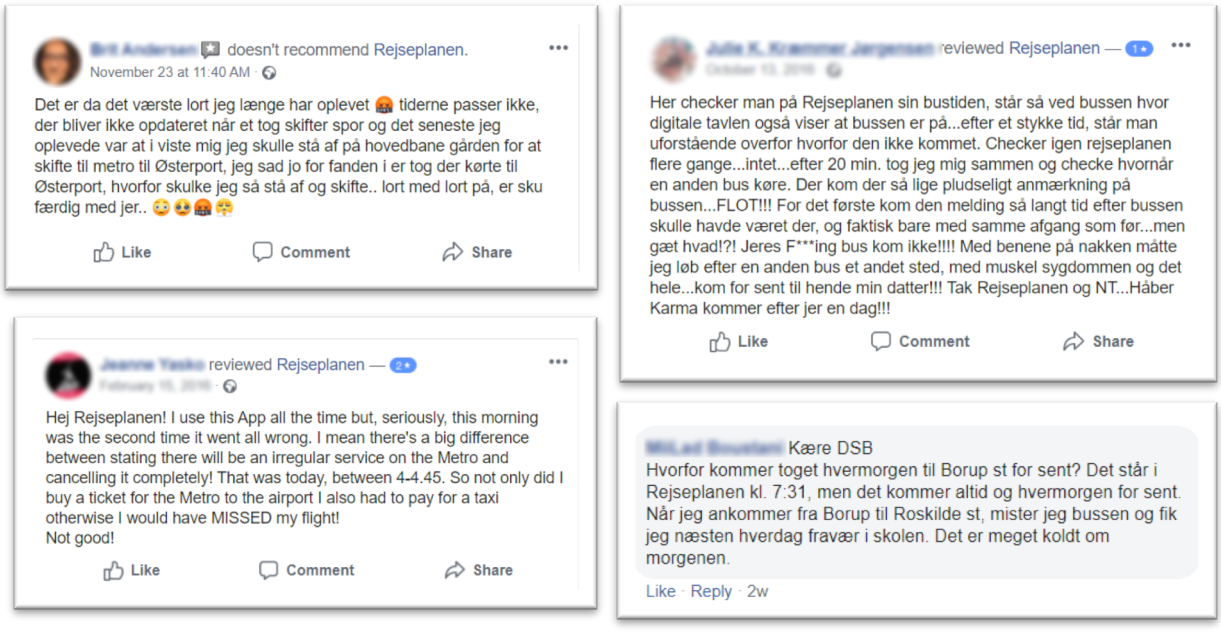

Figure 22. Negative statements from users of Rejseplanen and DSB

Moovit

Moovit is another service that resembles Rejseplanen in combining different transportation options into an application. It does however, set itself apart bey being used in more than 3000 cities worldwide. It was founded in 2012 in Israel. (Apple, 2019)
Moovit offers its users a real-time journey planner to navigate public transit networks with GPS navigation across transit modes (Kim, 2012). However, this service is not so popular in Denmark, although it receives good feedback on diverse platforms.

Google Maps

Google Maps is an online mapping service developed by *Google* itself. It offers satellite imagery, aerial photography, street maps, 360° panoramic views of streets, real-time traffic conditions, and route planning for traveling by foot, car, bicycle and air, or public transportation (Rijo, 2020).

Overall all three of the mentioned competitors can be considered both direct and indirect. They can all be viewed as direct competitors as they too exist to aid travellers with better user journeys and experience, which we also tend to do with our solution. However, they can also be considered as indirect competitors as we do not give users the same complete features. Their focus is on giving users directions when going from A to B, where our solution focus on helping users to cope when something interferes with their journey when going from A to B, hence, when something unexpected occurs that they cannot control.
Besides fast and real time updates our solution also creates a community which the other competitors have not. It gathers all the people who uses public transportation onto one platform, where users can help each other out.

As it can be sees, most currently available solutions, do not fulfil the user needs, that were identified for this research. Most users complain about *Rejseplanen* not being accurate when informing users about their travels and that it lags on updating changes close to real time.
Our solution is different, as the main focus is not getting travellers from A to B, but rather provide them with support to cope with the loss of control, in case the user journey gets affected by

something unexpected such as; delays, cancellations, miscommunication. Furthermore, our solution is a platform based on user content user generated, also referred to as *user-created content* (UCC), which allows all people that can access to the Internet to publish content in different platforms, such as text (e.g. blogs), photos or video (Baeza-Yates, 2009).
Hence, our value proposition differs, as we offer a specific type of value compared to our competitors.

The target group for *Rejseplanen* and *Moovit* are all users of public transportation, while *Google Map* is for a broader audience such as people driving cars, looking up addresses and other purposes. Therefore, *Rejseplanen* and *Moovit* appeal to our user segment. The successful features of these competitors are providing instructions of going from A to B, including a visualisation of the journey.
However, it is still evident that the competitors do not cover the specific needs of our users. This leaves space in the market for our solution, as we offer different features than of our competitors.

To conclude this competitor analysis, the following passage will exemplify two possible use case for our solution, to demonstrate the difference to the mentioned competitors.

Use case 1: Travelling on usual route

A user, called *Henrik*, commutes on a daily basis by bus from home to work in the morning and back home in the afternoon. As he has an important meeting in the morning, he wants to make sure to arrive on time. Before leaving to work he checks the application for updates, which could affect his commute. Accordingly, to his previously set preferences the applications shows him other's content. Ten minutes ago, a user has published content, that relates to Henrik's trip and informs him, that there are some delays on his usually bus route through road constructions. Based on this update he changes plans, uses a train to go to work and is still able to arrive on time for the meeting at work.

Use case 2: Travelling on unfamiliar route

Henrik and a friend agree spontaneously to meet for dinner at a recently opened restaurant. He wants to make sure to arrive on time. That is why before leaving, he checks the application. On an interactive map he can see a visualisation of user-generated content in real time. With the visualisation he immediately recognizes that there are some minor delays on the bus route, that he was planning to take to the restaurant. Impulsively he changes plans and takes the bike instead, as he is afraid that the bus delays will affect his arrival time. With the help of the application he could quickly get an overview of all current happenings in relation to public transportation resources and adjust his trip plans based on user-generated content.

With the insights gained from user stories, the user interaction feedback, as well as the competitor analysis, we can go further in the design process and develop our high-fidelity prototype.

4.5.4 High-Fi Prototyping

Based on the input from the *User-interaction 03* and the *competitor analysis*, we created the final high-fidelity prototype. Similar to the procedure of the second iteration of low-fidelity prototyping, we wanted to create a prototype that can be used on a mobile device. Further the objective was to prototype an application that is highly interactive and conveys the feeling of using the final product, to be able to use the prototype for the following testing.

This final high-fidelity prototype was created by using the previous low-fidelity prototype, by adapting, changing and extending it. As in the iteration before, we used the prototyping software *Flinto* again.

With the overarching objective of supporting users to cope with a lack of control when relying on public transportation resources, we prototyped the features of the application according to the user feedback from the *Feedback capture grid*. We considered all of the feedback for this iteration, however, due to limitations, not every opinion and suggestion of the users could be included in this final prototype.

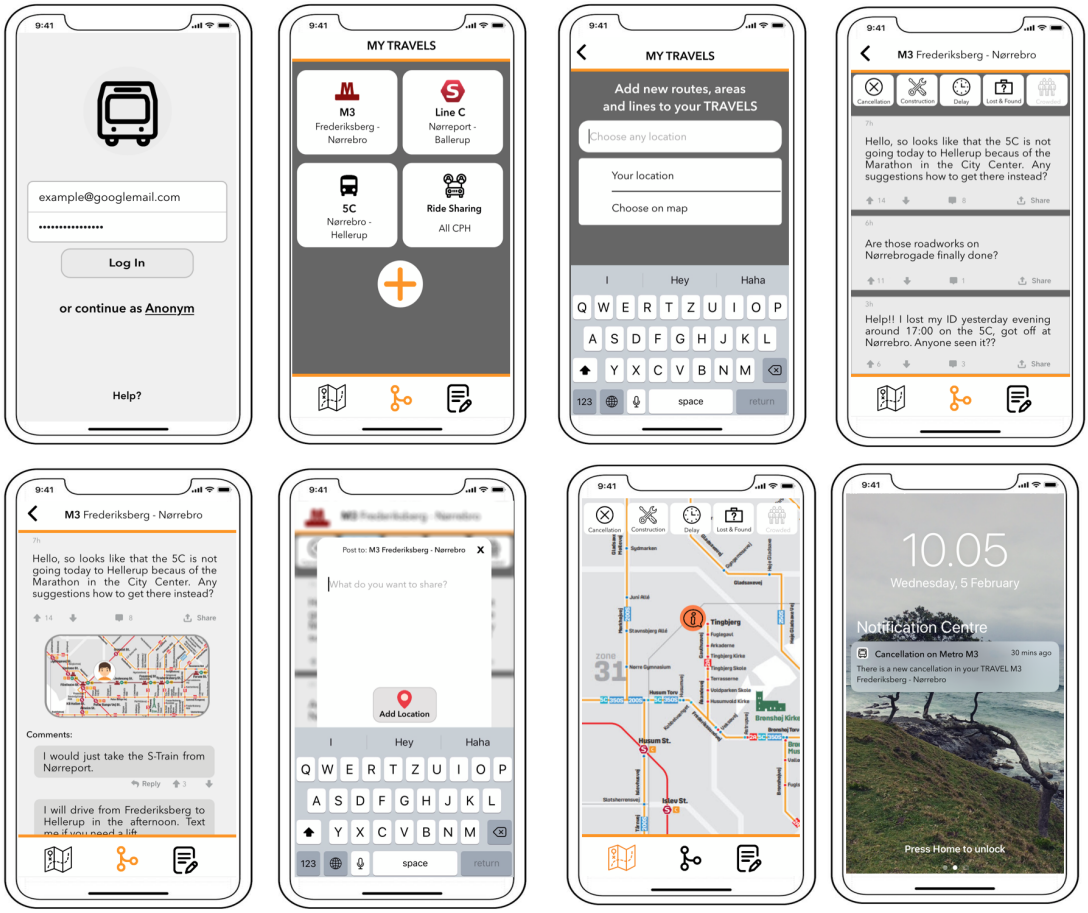

Figure 23. High fidelity Prototype

The final prototype consists out of several features, which are implemented to help users to cope with a lack of control when relying on public transportation resources. These features are partly based on the findings from the previous user interactions or on identified literature. The following paragraphs will explain the functionalities and features of this final prototype, including their objectives. At the end of this subchapter a table will illustrate all the implemented features, their objective and sources, to set the foundation for the final testing.

The log-in interface stayed unmodified, as the users were satisfied with this feature and it didn't raise any questions, critic or suggestions during the interaction. The interface provides the option to choose between a conventional user account or an anonymous account. By providing the

option to choose between the two, this ***Feature 6*** incorporates the user's concern about personal data, but also the trustworthiness of created content.

Further the information load on the home screen got reduced by removing some text and icons, and the interface got simplified. We also renamed this app section from previously *My Channels* to *My Travels*, since the prior name caused confusion and the new name was suggested by a user during the interaction. Besides that, the user can now "Add new routes, areas and lines to *My Travels*" to customize the user's *My Travels* home screen. This home screen and its functionality to subscribe to specific routes represent ***Feature 1***. By providing this feature, the user can customize the application to his or her needs and consequently find information or help faster.

By clicking on one of the user's *Travels*, an overview of user posts is listed. Based on the user feedback we added filters to this interface, such as *Cancellation*, *Construction* or *Delay*, so the content can be structured and customized to the user's needs. The filters illustrate the ***Feature 2***. As the users during user interaction 03 were overchallenged with the information load and called for a functionality that would reduce the amount of information, we implemented this feature.

As the interactive map received positive feedback during the user interaction 03, we did not change it extensively, however we added the optional filters, similar to the overview interface of user posts. This interactive map can be presented as ***Feature 3*** with the objective to provide a visualisation of the accumulated user-generated content.

Further we created a wireframe of a pop-up notification as part of this final high-fidelity prototype. This notification shows an example of how a user gets notified about a cancellation in one of her or his *Travels.* Representing ***Feature 4***, this functionality was highly requested during the user interaction 02 and 03 to inform users independently on unplanned or unexpected events.

While the detailed few of a specific post of the previous low-fidelity prototype caused some confusion for the user, we redesigned the interface by adding a clearer separation between the actual post, the map and the user comments. With the help of different background colours, the difference between a post and a comment should be now more distinguishable. A user post, as well as the comments related to a post have a number below, indicating the amount of up- or down-votes. Consequently, the total number creates the order, in which the posts are listed on the overview screen. This form of feedback on posts by rating illustrates ***Feature 5***. This

functionality indicates the quality of the content based on user input and thus creates a structure and hierarchy within the content.
Furthermore, we added a new screen for creating a user post. This ***Feature 7***, called *reporting*, lets the user seek from or provide help for other users of the application.
As the final functionality of the application, ***Feature 8***, represents the general idea of a "social community", that is based on user-generated content and the idea of "users helping users".
We removed the chat function for direct messages between users completely, as most users found it confusing and once the concept of it was explained to them, they were fast to express that they disliked it and did not find it useful in order to cope with a lack of control. when relying on public transportation resources. Also, as a basic principle, we replaced some icons and their arrangement in navigation bar. Further, throughout the whole application we reduced the use of various colours and instead use one colour to highlight specific features of the application.

As the insights gained from the user interaction 03 showed that users were positively aligned when elaborating on visual features such as the interactive map. We made sure to place emphasis on this feature. This feature is also based on the interactive map provided by *Google Maps*. One of the issues that *Rejseplanen* has, is that their map is not interactive, hence, it does not show the user their location on the actual map, as It is only a mapped-out picture. We also made sure to incorporate the notification function as most of the users found this useful, and it also works well for *Moovit*.
However, one thing that all of the three competitors are missing, is the social aspect of our solution. None of the competitors are offering this particular feature that enables a many-to-many approach by allowing user generated content to be the primary source of content input, while simultaneously be self-managed.

Feature	Objective	Source
1. Subscription	Allow customization and reduce noise	User interaction 03
2. Filter	Allow for preferences and reduce noise	User interaction 03
3. Interactive Map	Provide a visual medium and visualisation of the accumulated user-generated content.	User interaction 02, Competitor analysis
4. Notification	Inform users independently on unplanned or unexpected events.	User interaction 03
5. Rating of Posts	Quality indication of the content based on user input. Creates structure and hierarchy of the content.	Designers (on request by users)
6. Account vs Anonymous	Incorporate the user's concerns about personal data & trustworthiness of created content.	User interaction 03
7. Reporting	It lets the user seek help or provide help	Designers
Social Community	providing a platform for user-generated content connecting users with users.	Designers and Lazarus and Folkman (1984)

Table 4. Overview of features

4.6 Test

In this final phase, we test the final and complete features. The outcome generated during testing will be used to discuss how certain features impact the experience of users to cope better and redefine problems that will support the user's needs. Alterations and refinements may happen until the end to ensure all problems have been ruled out.

4.6.1 User-interaction 04: Final Testing

Date: 09.02.2020 - 20.02.2020

Design Method: Individual user interview

Design Practice: Feedback capture grid (adapted)

Duration: 30 to 50 minutes per interviewee

Location: Copenhagen Business School

Participants: For the final testing we had a total of 16 participants (A - P). Five of them were from the previous *User Interactions 02* and *03*. Thus, they were already familiar with the topic and our problem space. The remaining participants were selected based on the same criteria as used in *User Interaction 02* and *03*: They needed to be of age 31 or younger and regular users of PT.

Purpose: Features must be evaluated in order to ensure its utility for the specified problem. Testing can be performed in many different ways. Ultimately, it depends on what we are testing; if It is the interface design, usability of the prototype, or if it actually provides any value for the end users. The purpose for this final testing iteration is to test whether the developed solution in fact helps our users to cope with a lack of control when relying on public transportation resources.

Figure 24. Image of user testing

We want to gain insights on the users' thoughts of the high-fidelity prototype and thereby maximise learning in the context of coping with a lack of control when relying on public transportation resources.
We place emphasis on the user's opinions and thoughts towards the overall prototype.

Execution: In the final iteration of testing, we placed the focus on the individual users' feelings, emotions, thoughts and opinion regarding coping. Each individual was asked questions related to the several features of the prototype.
All interviews were audio recorded and together with the interviewee we filled out a feedback capture grid to summarize their answers to our questions. The grid was adapted in the way, that it consists out of eight boxes, including the questions *How?* and *Why?* and a rating scale. Every box refers to a specific feature. [Appendix 2] lists some examples from the filled feedback capture grids.
Before the questioning took place, we first explained the application with all its functionalities to the interviewees, to make sure that they understand it entirely. As it is difficult to measure or test how our solution or the features impact the users experience, we conducted a test simulation by asking the participants about specific scenarios in which they had to cope with a lack of control when relying on public transportation resources.
We made sure that the participant commented on each feature and asked questions such as; *How does this impact your experience? How does this help you cope? To what extent do you like the system/solution*? etc. We also made sure to make them rank each feature from a scale of from 1 to 10, 10 being the most positive to what degree a specific feature will actually help them cope. This rating system will give us an overall view of the findings through a visual medium and further to help us record the helpfulness of the features both visually and numerically. Moreover, it will be helpful when entering the discussion chapter.

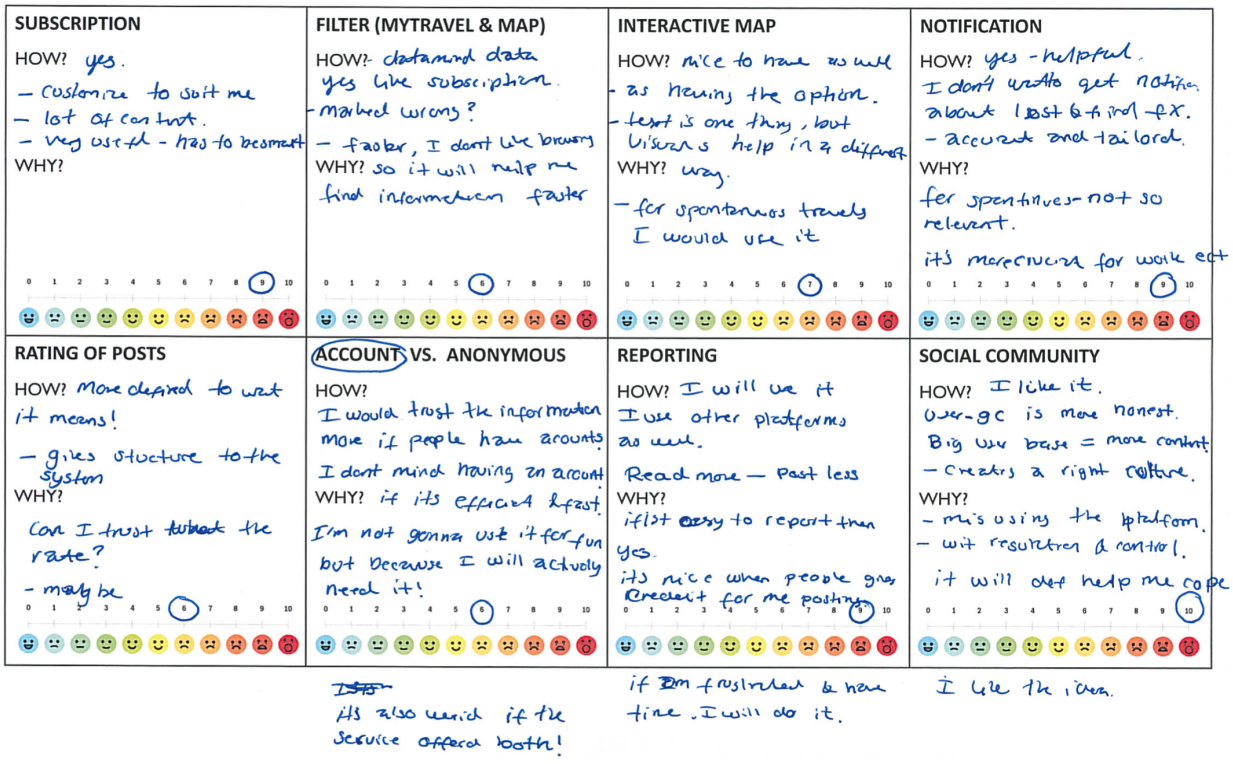

Figure 25. Image of feedback grid on final testing

Takeaways: Unlike in the previous user interactions, the *takeaways* from this final interaction will be presented in chapter 5.

5. FINDINGS

In the following we will provide a summary of our findings. The final evaluation and its outcomes will be presented and analysed. As described below, three iterations of prototyping were followed (Figure 26), that led to the development of the final application and its features. Furthermore, due to the product-oriented research conducted within this study, our main focus will be put on the evaluating the final solution, conducted in the last user interaction iteration through semi-structured interviews.

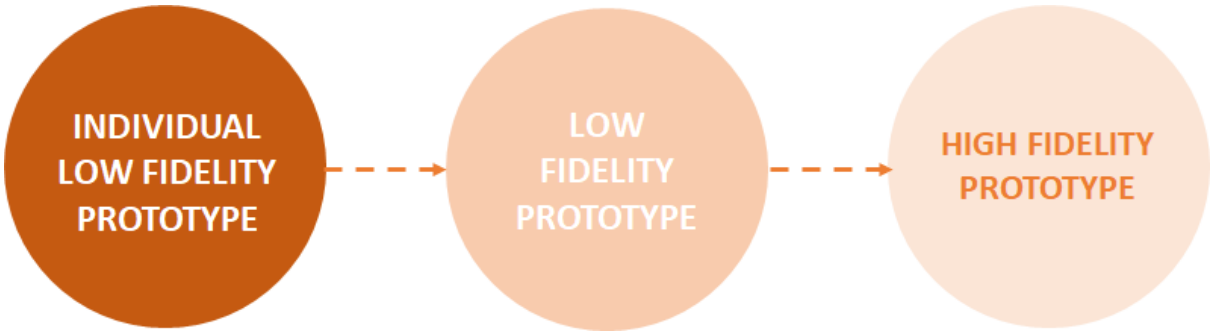

Figure 26. Prototype iterations

5.1 Summary of findings

As a final summative evaluation of the designed artifact, this analysis is based on the insights gathered throughout all prior iterations and evaluations conducted through the workshop and interviews.

5.2 Feature 1: Subscription

The Subscription feature provides the user with the option to customize the application to his or her needs and consequently find information or help faster.

When asking the users about this feature, we received only positive responses. It was evident that this is our most liked feature in our solution.

The interviewees appreciated this feature, as they wanted to be presented with information only relevant for them, which means less clutter and noise for the user. They clearly expressed that they do not want to be pushed with all different kind of information, they only want information, which they will actually need and use (Users A, B, C, D, E, F, G, H, I, J, K, L, N, M, O and P). They were also very clear about not wanting to constantly search and look for the needed information. They expressed that this feature helps them to save time, and that it is more efficient for their use. Another interviewee liked the functionality, of being able to add and remove routes accordingly to personal preferences (User L).
Some of the users expressed, that being without this feature would make them more stressed (User H, I, M, P, N). Further one interviewee added that in stressful situations she has short attention span, consequently reduced and customized information is useful (Use J).

This feature worked in the way as we expected and as we had it intended from the start. The objective of this feature was to enable customisation for users to make their experience better by not having to search and look for the information that they need. The interviews definitely confirmed this when they were asked to what extent this feature will impact their experience and thereby cope better in particular situations. The reason for the positive outcome of this feature relies on the fact, that users expect services to be customized. Thus, they view this feature as an obvious feature and a matter of course (A, C, E, H, I, and L). On a scale from 0 -10, the average rating of this particular feature is 8.5.

5.3 Feature 2: Filter

The filters support the user in structuring and customizing the content to the user's needs and reduces the information load.

Most of the interviewees were familiar with the general functionality of filters and have used them in other contexts before. For our specific use case of the feature, users had mixed opinions. For some users this feature could provide some support by excluding unnecessary information and consequently making the coping process more efficient (User A, H and F). One user elaborates on this, that this helps, as it provides exactly the support he was looking for (User F). Another user

elaborates on this, that without this functionality, there would be irrelevant information, that consequently causes stress for the user. "Having information on my screen not relevant to me, gives me more stress. (User H)".

Other interviewees see only in some of the provided filters a helpful tool to cope with a lack of control when relying on public transportation resources (User B, C and D). Moreover, the filters' contextual overlap caused some confusion for these users. Another interviewee commented on this feature, that he would like to be able to customize the features (User L).

Finally, two users didn't find this feature helpful for coping (User G and I). As '*feature one'* already customizes the information accordingly to the user's need, the two interviewees expected to receive only relevant information, that does not need any filter functionality.

As this feature received a mixed review, it is not as straightforward to conclude, if filtering helps people cope better. For some of the individuals it was clear that it was a liked and helpful feature (User A, F, H). For some it was depended on the particular scenario (User B, C and D) and for others it was hard to see how it could help them (User G and I). Thus, the average rating of this particular feature is 7.2.

5.4 Feature 3: Interactive Map

This interactive map offers the users a visual medium and visualises the accumulated user-generated content.

Some users expressed that this is the most important feature, especially in the context of traveling (G and H). And as maps makes them feel at ease, it helps them to understand and comprehend better in stressful or unexpected situations that are out of their control (User H).

However, one user felt like it was nice to look at, but that it did not help to cope (User A). All in all, this feature received positive feedback. Several of the users expressed that they prefer visuals over text (G, B, D). Furthermore, some users also made a natural relation between traveling and an interactive map (Users G, N, J). Another interviewee elaborated on this with "*I connect travelling always with a visual map, if it would not be there, something would be missing"* (J).

This feature did in fact help our users to cope better, which was also something that we had expected. Of all of our user interviews, only one individual claimed that it wouldn't help (User A). However something that we learned, is that our users had the tendency of wanting the interactive map to actually work as it would in real life. So we often felt as if their answer was depended on what the prototype was able to do. *"If it's good like Google Maps, than yes for sure, it help me cope better "* (User O), hence, we experienced a lot of "*If*"' questions which made it a bit difficult to get genuine answers, as most of their answers started with *"it depends on"*. We believe that this the natural outcome of doing simulation testing.

The average rating of this particular feature is 7.4.

5.5 Feature 4: Notification

The notifications inform users automatically on unplanned or unexpected events.

Apart from one user (User B), all other interviewees stated that this feature would help them to cope in the context of PT a lot and improve their travel experience. As the notification would provide updates automatically, without the user actively searching for them, this functionality would support the user by saving time and provide the user with relevant information, when it is needed (User A). Thus, the notification functionality can eliminate the uncertainty or even the fear of missing out on information, that is of importance for the user. Interviewee (User L) even states, that he would like to be notified about "*everything being fine on my route*".

As most of our interviewees seem to plan their trips in relation to a specific time or schedule, they want to be updated in case this plan might be affected by changes or irregularities (User D).

However, the participants emphasized that this feature is very helpful, but only if it provides relevant information for the user. Hence, many of the users impose requirements on the notification to be useful, such as only be active in specific timeframes (I, H and C) or generally notify prior to the user's trip (User G). Furthermore, one user limited the usefulness of notification to their level of details, frequency and amount. *"They are very helpful when I plan my day in advice, as long as I do not get swamped with unnecessary information. They should be accurate to be helpful"* (User F). Another user (User P) mentioned that he doesn't want to be spammed.

Only one user expressed a general dislike towards this functionality and questioned its ability to help coping. *"I personally hate notifications, they cut through my personal barriers. I want to actively search for something, it should be my decision"* (User B).

From all participants, only one user disliked the notification feature and expressed that it would not help with coping. We can conclude that this feature did work and for the reasons that we had intended, as every other participant reacted with positive feedback and providing uses cases of how it would help them to cope better. The average rating of this particular feature is 8.4.

5.6 Feature 5: Ratings

The rating of posts indicates the quality of the content, based on user input and thus creates structure and hierarchy within the content.

Generally speaking, some interviewees couldn't see how the rating feature creates added value to cope better. While users were familiar with the general use and functionality of '*likes*' of user-generated content (User C), they had difficulties to relate this concept to content about PT issues (G, I, D, A). *"What is the need for people to rate a post up or down? Is the rating for relevance? And how can I be sure, that it is relevant for me?* (User D)". On the other hand, some other users confirmed, that this feature is helpful, as it creates a structure of relevance and *"false or irrelevant info gets eliminated quickly"* (User F). Further one interviewee described this feature as a "*filtering system, based on user-generated content*" and as "*loop of giving feedback*" (User P). These users stated that this feature might help to cope in an indirect way. Consequently, they evaluated the feature not as relevant as others. However, one user said that this functionality supports the content quality (User B).

As this feature received confusing respond, we can state that it did not work for the reasons that we thought it would. When analysing their opinions and thoughts, we could see how this feature can be related to what ideas and experiences each participant have had with user generated content or services similar to this. The average rating of this particular feature is 5.8.

5.7 Feature 6: User Account vs Anonymous

This feature provides the option to choose between a conventional user account or accessing the application anonymously. We asked the users which approach would make help them cope better.

Generally speaking the majority of the interviewees liked to get the option to choose between a conventional user account or accessing the application anonymously. They preferred the anonymous option (User D, B, F, G, H). Reason for this decision was in most cases, that the interviewees were concerned about the use of their data (User B, F, H). One user was confused about the advantages, which the user account might provide in comparison to staying anonymous (User G). Furthermore, one user preferred the anonymous log-in, simply because it would speed up the process and provide support to cope in a faster way (User A).

However, one interviewee (User I) stated, that the user-generated content in connection with an identifiable user account would be more trustable, as content would always be connected to a specific and identified user. *"Information will be more trustworthy, when people have user accounts"* (User I). User P complements this statement with "*Identification gives Credibility*". Another user stated, that having the option is rather confusing, and that it should either be having an account or being anonymous. *"It is strange to have both, as it will create two different classes and just a strange vibe"* (User K). Others simply do not want an account because of the hassle to create one, *"I really do not want to go through the whole procedure of setting up an account (...) It would be great if I could just use my Facebook or Google credentials instead"* (User J). This relates to convenience. Using your *Facebook* and *Google* credentials, as login saves the users a lot of time and it also saves them the pressure of having to remember yet another username and password, which users already have so many of.

For this particular feature we did not have any expectation to what the participants would think and feel. However, it was intended to figure out what was preferred in order for them to cope better. While others preferred to stay anonymous due to not being willing to share personal data, others did not mind as long as they can see the benefits of the service, or if the login is a fast and quick procedure. The average rating for this feature is 7.5.

5.8 Feature 7: Posting

With the posting functionality users can actively seek help from other users or provide support for others by creating a post.

When asking about the posting features, the majority of the interviewees stated that their general use of the application would be more passive and focus their use on reading other users' content, instead of actively being involved in the community by creating and interacting with content. Many interviewees elaborated on this, that they miss an incentive for using, to be actively involved in the community (Users G, B, D, I, P, L) *"What do I get out of it?"* (User L). Further a user (User B) recognizes the importance of this feature for the system and the community, *"but it is not enough motivation for me"*.

Additionally one user (User D) mentioned another reason for a more inactive user behaviour: *"I might be too concerned that my input is wrong or not relevant for others."*

Another interviewee (User I) expressed that in nature, people are always more willing to get than to actually give, which can be a concern for this service. If people are not willing to give, they will not be able to get anything in the end.

Nevertheless, three users see an incentive in being actively involved in the community by reporting issues around the use of PT. The three interviewees mentioned the connected feeling, that a user gets when posting something. *"Giving something back to the community feels good as well"* (User A). Another interviewee (User F) mentioned *"this nice social media high of people voting for your post"* and compares it with a *"little pat on the back"* as a symbol of recognition. User J adds that she is already informing other users of PT in real life, in case of occurring issues (User J). Thus, she applies this functionality already in her daily life and would simply transfer this behaviour to an online environment.

We expected the general passive approach towards the activity within the application of our interviewees. From our experience users consume more user generated content, than actually creating it and hence, are more passive. The average rating for this feature is 6.2

5.9 General functionality based on user-generated content

This functionality represents the general idea of a "social community", that is based on user-generated content and the idea of "users helping users".

The social community concept of our solution received a lot of scepticism. As soon as we mentioned user-generated content, users got rather worried and immediately expressed their opinion and thoughts about trust. *"Can I trust the information?"* or *"How can I be sure that the platform won't be misused?"* (User D, C, G).

Although a few participants saw the social community as something positive and helpful in some ways (User H, B, A and C), *"overall it will help me cope better, as none of the travel apps gives u any of this … it's always pull and no interaction"* (N), the majority questioned the trustworthiness of this feature, as most of the content will be user-generated. Another aspect that came across, was how the quality of the content can be ensured and how it can be assured, that conversations stay true and relevant. *"It's important the objective of the platform is very visible so that conversations do not take a turn to irrelevant stuff"* (User I). Another interviewee supplements this statement with the wish for a mediator in the system. "*The information can be very subjective and unreliable. I would like to have some form of authority*" (User P). Another user would like to have an administrator (User L).

Nonetheless, some of the interviewees describe, that they expect the user-generated content to be more honest and *"straight to the point"* compared to information by an authority (User F, K, D). They assumed that content by an authority, like *DSB*, could be "*whitewashed*" (User K). Further he added to this assumption, that he expects that there would be generally more content with this social community, compared to posts by an authority (User K).

In addition to this, one interviewee compared the level of trust on a geographical level: "I think generally speaking there is more trust in Denmark, comparing it to other countries." (User L).

The overall response for this functionality is probably not what we had expected, as many of the participants raised the questions about trust, trustworthiness and quality of content. It came as a bit of surprise as almost all of the participants are using platforms such as *Facebook*. But it lies in the fact that they are not obliged to trust the information on *Facebook* and have through

experience learned to trust it, because they know how it works. Perhaps it relies on the perception that they have on trust, as each individual have different criteria for trust. What we definitely learned about this feature is that in order for individuals to cope with a lack of control when relying on public transportation resources, they have the need to regain control and trust. Hence, it is important that we somehow manage to establish trust or at least give the users the perception of reliability and trust. The overall rating for the general idea indicated a **7.6**.

We have inserted the user ratings into the following graph, to gain an overview of what features help our users to cope the most, and to conclude our findings with the main contribution generated from our research. [Appendix 3] displays the detailed collection of all user ratings.

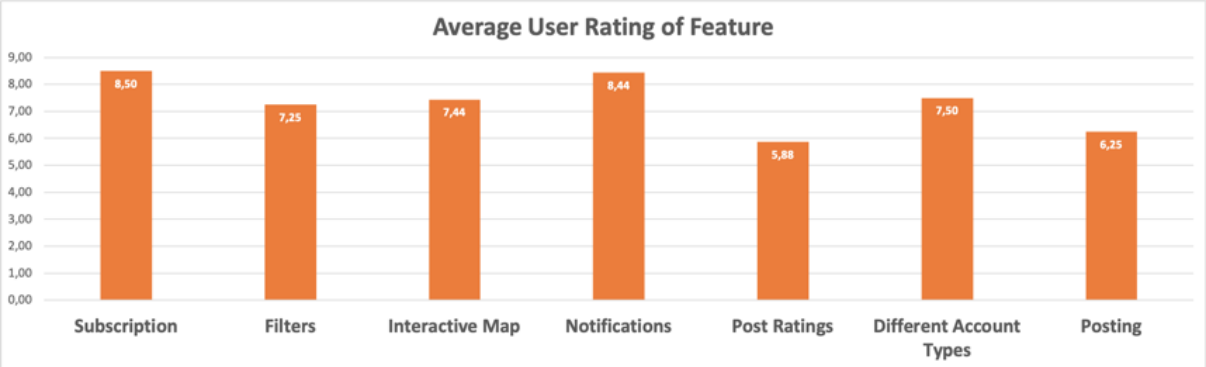

Figure 27. Average rate of features on a scale from 0 to 10

It is clear by the graph that *Feature 1* and *4*, which are *Subscription* and *Notifications*, have received the highest ratings, while *Feature 5* and *7* have received the lowest ratings. Though overall, no feature has gone below 5, which is considered mediocre.

Our suggested features for enhancing coping has been proven successful in supporting users. Hence, implementing these features can be successfully translated into already existing applications or for developing a new application. However, not every feature was equally successful in supporting the users to cope better.

We can finalize our findings by stating the main contributions found within this study.

5.10 Main Contributions

In order for users to cope and give users control in a setting that is out of their control, we have reached the following contributions:

Principle 1: Rather than providing prepared and tailored information, users need to be oversupplied with content, that they can then adapt to their needs.

Principle 2: Rather than focusing on parsimony task specific information, superfluous visual information should be used to support emotional coping.

Principle 3: Rather than building genuine trust, it is necessary to provide signals of oversight and validation for user generated content.

6. DISCUSSION

Having analysed the research outcomes, we have learned that different features does in fact help users to cope in certain scenarios, when experiencing lack of control. Figure 28 shows the dependencies between the features, coping and user experience.

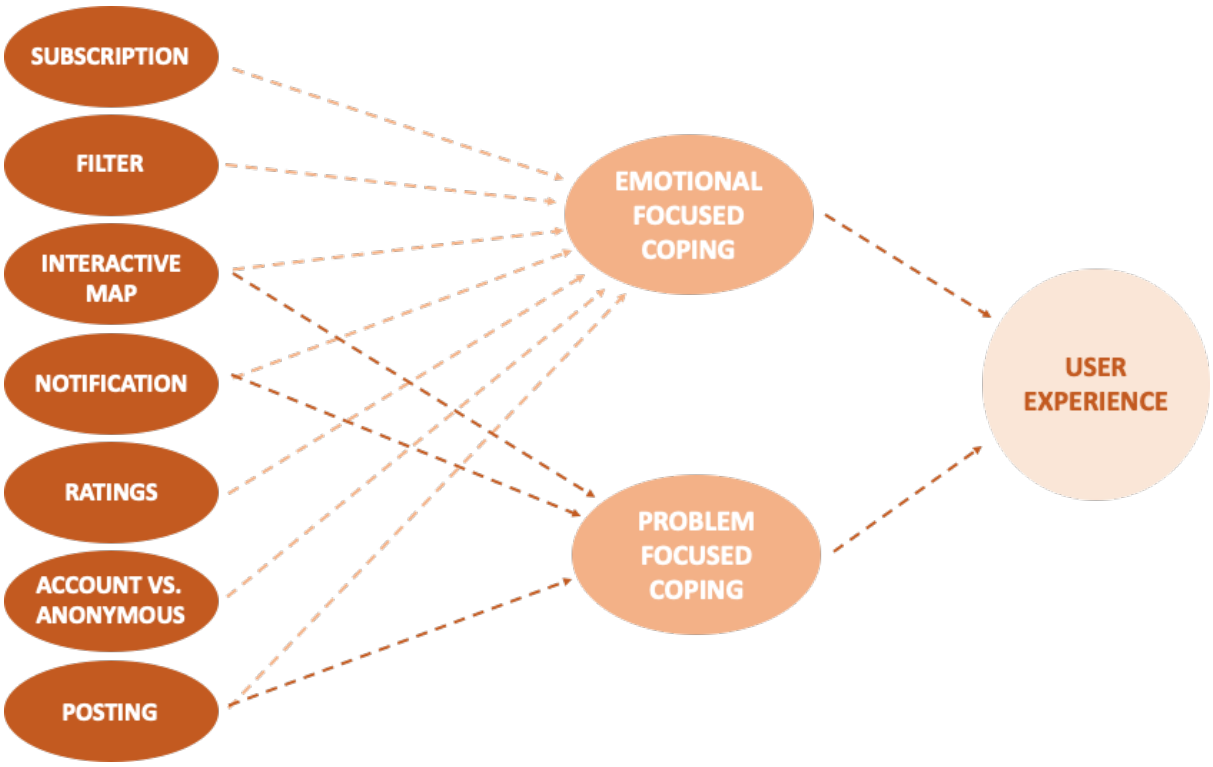

Figure 28. Relation between features, coping theories and UX

Based on Lazarus and Folkman's (1984) categorization of coping approaches, we can draw a connection to our application Features. According to our findings, individuals have different attitudes and act differently when it comes to coping. While some users explained that they would use features of the application to cope in what Lazarus and Folkman (1984) refer to as emotional-*focused coping*, others' described behaviour towards a more *problem-focused* type of coping. Considering the data from our findings, we can draw the conclusion that all implemented features (1-7) is associated with emotional-focused coping, as they do not provide a direct solution to the user's problem but provide support by giving users a sense of regaining control.

On the contrary, only a few of the features (3: Interactive Map, 4: Notification and 7: Posting) are associated with problem focused coping, as they can provide a direct solution to a user's problem.
However, as the study never intended to change the environment of PT itself, we have reached our objective towards impacting the user experience by giving them sense of control and flow.

It is clear by the findings that some features help our users more than others, however we can conclude that 1) rather than providing prepared and tailored information, users need to be oversupplied with content, that they can then adapt to their needs. Furthermore, 2) rather than focusing on parsimony task specific information, superfluous visual information should be used to support emotional coping. Finally, 3) Rather than building genuine trust, it is necessary to provide signals of oversight and validation for user generated content.
These contributions will now be viewed in the light of suited literature to discuss similarities and contrasts. Furthermore, we will discuss additional research implications, and finally, elaborate on research limitation and future research.

A fundamental issue when considering innovation is that we rarely invent new knowledge. Most things are made out of something else or build on previous ideas and artifacts (Gregor and Hevner, 2014).
A research has the potential to make different types and levels of knowledge contributions depending on its starting point in terms of problem maturity and solution maturity. According to Gregor and Hevner, the goal of innovation is not necessarily to invent something completely new, it can also be an *improvement* of something that already exists. They refer to this as *"developing new solutions for known problems"* in their Knowledge Innovation Matrix (Figure 26) (Gregor and Hevner, 2014).
The goal of innovation in the *improvement* quadrant is to create better solutions in the form of more efficient and effective artifacts, products, processes, services, technologies, or ideas (Gregor and Hevner, 2014). We must face the known context for which useful solution artifacts either do not exist or which in our case are suboptimal. By using design research methodologies,

we have accumulated an understanding of the problem environment and have reached a solution that help users to cope and give them control in a setting that is out of their control.

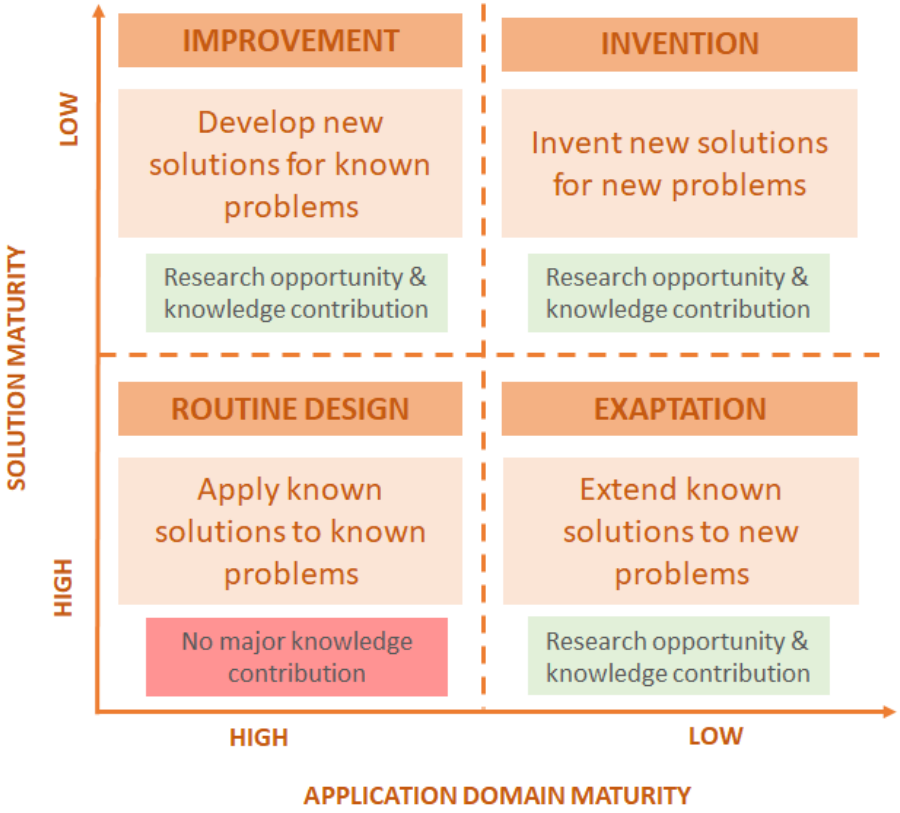

Figure 29. Knowledge Innovation Matrix (Gregor and Hevner, 2014)

According to Lazarus and Folkman, the way in which people cope depend upon the resources that are available to them, such as; financial, material, physical, psychological, cognitive, and social.

They believe that Individuals cope with disruptions by using two key subprocesses that continuously influence each other. The first one being individuals evaluate the potential consequences of an event (appraisal). They do so by assessing the nature of a particular event and its personal importance and relevance.

Second, individuals perform different actions to deal with a particular situation at hand (coping efforts). They rely on a combination of cognitive and behavioural efforts both of which are categorized as either problem or emotion-focused coping. This is also why our users had different opinions in regard to what helps them to cope and not to cope.

Principle 1: *Rather than providing prepared and tailored information, users need to be oversupplied with content, that they can then adapt to their needs.*

During the testing of the final Prototype, the topic of *customization* occurred frequently and seem to have a positive effect on the user when coping with a lack of control when relying on public transportation resources. *Feature 1*, the functionality of subscribing to various routes, gives the user the ability to adapt the application to personal travel preferences and commuting habits. Next to this, *Feature 2,* a number of filters, provides the user with a tool to reduce the content by selecting or excluding specific topics and themes. As a result the user only sees content according to the set preferences. Lastly, *Feature 4*, the notification functionality automatically gives updates on routes, areas and topics, which the user has subscribed to. Only information according to the user's pre-sets will pop up.

Although these three features fulfil different purposes, they all have one thing in common. They provide a set of options, let the user choose from them and in this way customize the application corresponding to the user's needs and preferences. To ensure a general understanding of customization the following paragraph will define the term.

Customization can be described "*as the mechanisms that allow users to adapt their personal software environment without writing code, with changes that persist across sessions*" (Kyng and Mathiassen, 1997). Further they elaborate that customization can make software "suitable to specific user needs", such as setting preferences and automated activities in context of an application (Kyng and Mathiassen, 1997).

All three functionalities support users when coping by limiting and reducing the information load of content according to the user's preferences. However they do not provide direct help related to any issues in the context of PT. Hence, these forms of customization only add marginal value to the system in terms of speeding up a search process or reducing the amount of information.

However, our findings did indicate that these forms of customization help the users to cope and improve their user experience, although these features only provide marginal and indirect help. Overall, customization leads to a stronger engagement with a system according to Wang, Tan and Clemmensen (2016). They elaborate on this by stating that customization positively influences the "*users' perceptions of system usability and flow experience, leading to*

engagement with a system". The features of our application, which incorporate customizing functionalities, does improve the user's experience and leverage the engagement with our developed system. Furthermore, notifications can offer a promising strategy for enhancing engagement between a service and its users (Yoon, Lee, Lee, and Lee, 2014). As engagement is proven to have positive effect on the user's psychological well-being (Dijkstra and Homan, 2016), we do see the support for coping in our customization features. In addition to that, disengagement can harm the user's experience by conveying a "lack of control", which can lead to lower mental health (Dijkstra and Homan, 2016).

Summing up, while the customization features themselves do not directly help users to cope, they do lead to engagement with the system, provide the user with a "feeling of control" and as a consequence support the coping process. By giving the users control over the content, these features "enhances a sense of autonomy" (Bol, Høie, Nguyen, and Smit, 2019). These functionalities make the user feel less helpless and thereby gives the control back.

Additionally, as presented in the previous literature review, enabling communication is crucial to satisfy the user's needs during the use of PT resources. While these three features do not directly enable the communication between users, they do improve the communication and thus, contribute to an improved user experience.

Principle 2. *Rather than focusing on parsimony task specific information, superfluous visual information should be used to support emotional coping.*

All individuals face different challenges related to orientation and mobility. They also react differently to certain situations based on personality type, prior experiences, and the resources available to them (Lazarus and Folkman, 1984). According to Lazarus and Folkman (1984), successful coping mechanisms depend on the emotional functions related to the specific problem.

Accessible geographic maps are helpful for travel preparation, especially when exploring unknown routes and cities, which can be stressful and nerve wracking for some travellers (Brock, 2013). Feature 3, the *Interactive Map*, aims to provide help in this context. As this feature provides

an overview of user-generated content in visualized form, the objective is to support users in an efficient way, when exploring unknown routes or areas.

Research shows that the combination of text and visual elements is the most effective way to communicate and support users in performing tasks. Visual mediums are more effortless to recognize and process than words, but also easier to recall (Dewan, 2015). Research has also shown, that we do not remember decorative images as well as we do informative ones. And just as we recall pictures better than concrete words, we also remember concrete words better than abstract ones. Hence, if we want users to remember something, we should use words and pictures together (Dewan, 2015). Our users expressed that a common association when thinking of traveling is a map. They indicated, that it is effective with text for support when feeling stressed because, an event has occurred that is out of their control. But at the same time, the interactive map gives them support as well as the emotional coping that they need.

Emotional coping changes the user's perception of the situation, but does not alter the situation itself (Beaudry and Pinsonneault, 2005). The interactive map will help them to regulate personal emotions and tensions, restoring or maintaining a sense of stability, and thereby reducing emotional distress. With the interactive map, we tend to minimize the consequences of threats while maintaining hope and optimism (Beaudry and Pinsonneault, 2005).

Our users acknowledge this, when moving in unknown areas and routes especially, or when something happens, and the user is no longer in control of their own journey. Users stated that they would need this feature especially for unplanned and spontaneous trips. Hence, they will use the interactive map in order to gain back this sense of control, by figuring out where they are and what is close to them. Further, to help them navigate and give them better orientation.

Thus, although task specific information can help many users, superfluous visual information should be used to support emotional coping. The interactive map will be used for users to manage thoughts, feeling and actions when encountering tedious situations and give them a feeling of control.

Principle 3. *Rather than building genuine trust, it is necessary to provide signals of oversight and validation for user generated content.*

Trust and reliability are factors that manifested through almost all of our conversations with the participants - Trusting the other users and trusting that users will report honestly and share accurate, reliable and honest content. Trust is an important part of any social interaction, but can it evolve on digital platforms between strangers?

Trust is globally viewed as a social expectation that has to do with people's perception of the integrity, honesty, and competence of other people, services, products and systems. That is verified by experience. It is the willingness to rely or depend on something, it is the feeling of confidence in and support of (Alston, 2014).

The growing popularity of digital social networks and platforms has given rise to the need to build trust in communities which inspire members to share their experiences, feelings and opinions in an open and honest way. Although we use digital services that instigates social interactions, ensuring trust can be difficult. Especially when the product or service that is coming into the market is entirely new (Ismail, 2019) and you suddenly have to build trust among users in a completely new setting of context. Other applications within the context of traveling do not have a social community aspect to their service, it is a one-way communication service, so they do not need to build the same kind of trust as we do. While their focus will be on maintaining a trustable or reliable system, we need to build virtual trust among users. In our literature review we discovered that reliability is one of the key factors influencing user experience, and as reliability is close related to trust, we must make sure that both of these factors are present.

According to Philip Pettit, trust between virtual strangers is impossible (De Laat, 2005). He argues that only the *"naive or the foolish may imagine themselves to be able to trust their virtual counterparts, or to be trusted by them. Trust in cyberspace can only be fantasy."* (De Laat, 2005). The reason for this is the lack of evidence and identity about online users. At the same time, others believe that trust can be established through rules and regulations (Alston, 2014). However, the nature of free communication will always increase challenges with respects to trust

and reliability of online social communities. It can be difficult to ensure that users in large networks are familiar with one another and that they can interact without risk (Bo, Huan, Meizi, Qin, and Jifeng, 2017). Such online communities will always contain a possibility of risk and fraud, leaving users vulnerable.

Our users expressed that trust can certainly be built by a *rating feature*. The rating feature will help them to trust the information reported by other users. If ten users rate content as accurate, it immediately increases the trustworthiness and reliability of that specific user-generated content. What does this tell us? The type of trust which we need provides signals of oversight and validation for user-generated content. It is about creating a perception of trust which in our case is satisfying for the users. Another feature that also increases the perception of trust, is when users are to have an *account* in order to use the application. With an account, each user will be displayed with their name and potentially a profile picture, which build reliability for our users. In the end it is not about trusting each individual as a person but rather trusting the features that signals and validates trustworthiness.

A trust model by Surya Nepal, Wanita Shercha and Cecile Paris considers two important aspects of social interactions in an online community; these are *popularity* and *engagement* (Ardissono and Tsvi, 2011). *Popularity,* which can be related to the ratings, can indicate, that higher ratings equals popularity, which signals trust. The *engagement trust* captures the involvement of users in the community, which can relate to the potential champions within the community. If a user is very engaged it can also signal and validate trust. The social trust is therefore a combination of popularity and engagement.

However, some countries are naturally characterized by high degree of social trust while others are not. A country like Denmark is placed high on the trust distribution (Sønderskov and Dinesen, 2014), which begs the question, whether if social trust is a cultural trait or a manipulative characteristic that can easily be generated through ratings and transparency (Sønderskov and Dinesen, 2014).

In order for individuals to cope before, during or after traveling, they need to trust and rely on user-generated content. We can accomplish this by proving signals of oversight and validation through user accounts and ratings. It is natural for human beings to feel at ease when they are able to trust. The higher the feeling of trust, the better are the users to cope, and vice versa. Thus, creating a social community that is built on trust is essential for helping our users to cope.

6.1 Implications of research

The objective of *"building a better mouse trap"* has a profound call to individuals who want to improve ways and means of work and everyday human experiences (Gregor and Hevner, 2014). Theories fundamental to design science is very much relevant to the quadrant that we have placed our research in (Figure 26), as much of the work in this area has been framed in terms of "problem solving" and the possibility of providing improved solutions is evident (Gregor and Hevner, 2014). Though we have discussed the main contributions regarding coping, we further uncovered implications related to design methods and design practices.

According to (Roger, Preece and Sharp, 2016) Identifying usability and user experience goals is essential for making a product or a service successful, and that it requires understanding the users' needs. The more we have managed to understand our users' needs, the better has our design/prototype reflected this understanding. We have also through several iterations managed to make sure that this understanding occurs during all stages of development. This has allowed us to know where to keep our focus in the different iterations. Initial requirements get the design process started, but understanding requirements tends to happen by a process of negotiation between us as designers and our users (Roger, Preece and Sharp, 2016).

According to Kolko, it is important to give tangible form to the ideas, thoughts and reflections. *"Once externalized, the ideas become "real"—they become something that can be discussed, defined, embraced, or rejected by any number of people, and the ideas become part of a larger process of synthesis."* (Kolko, 2010). Through the research we learned that this is true depending on where in the design process you are.

In the first user feedback session, we saw that as our users experienced the design ideas and by reflecting on something tangible, they were able to give better and productive feedback. This enabled us to improve our design and features further (Roger, Preece and Sharp, 2016).
However, in the final iteration of testing or evaluation, we saw that the users had expectations to the prototype which was not fulfilled. These expectations where related to the overall design of the prototype, the functionality, the transition between interfaces, placement of icons and buttons and more. Hence, it was often evident that their answers were depended on what they could see and experience when going through the prototype.
Although, one of the most basic principles of making meaning out of idea and data is to externalize the entire meaning-creation process and making it tangible in the physical realm (Kolko, 2010), it is our experience that it is heavily depended on the iteration and where you are in the overall design process.

Another implication that manifested during our interviews with users, where that even though some users were reluctant to share information on the platform, they still very much wanted to benefit from it. *"I probably won't report anything, as I'm very introverted when it comes to stuff like that, I do not want to give but I would love to get (...)There should be a purpose or an incentive for me to go on the platform and post something"* (User I).
So rather than actively participating and interacting with others on the platform and be engaging, they simply want to access the information about other users' experiences and encounters with everyday issues using public transportation. This is further discussed in *Future Research*.

Finally, we also learned that rather than providing users with requested content, communicating unrequested content can give the feeling of control and thus eliminating the feeling of uncertainty. So although most of our users expressed that they only wanted or needed information when something was not working or when they needed to take action, one user expressed something contrary to this; *"I would even like to have notifications, about everything being fine on my route and not just when something happens"* (User L). Though only user

suggested or stated this, we still find it interesting to mention. Hence, even communicating that there are no current issues can improve the user's emotional state and comfort.

6.2 Limitation and future research

6.2.1 Limitation

Due to factors such as time and resource limits, this research is subject to limitations partly set by us and partly evolved throughout the research and research criteria.

First, as the domain of public transportation is enormous, allowing for different perspectives and approaches, there are many things we are not able to change or improve. According to Fajstrup (2014), "*price is especially a parameter for young people and for those traveling in groups"* (own translation). Though lower fares are one of the main wishes of the Danish users, it is not a possibility for PT regulators to set the price freely. Although lower prices could improve the user experience of PT, the regulators are not certain that it can result in more revenue. *"Of course it is true that we could get more passengers if we lowered the price. But partly we cannot set the price freely, and partly it is not certain that we could get more revenue from it"* (Fajstrup, 2014, own translation). As this is also out of our reach and ability to do so, we have been limited in touching upon pricing and have therefore excluded this from our research.

Second, even though, literature and user insights showed delays, and miscommunication as the biggest factors of inconvenience and stress for users, we were limited in how we could impact these factors directly. Instead we navigated towards placing emphasis on the actual experience of the users by giving them a tool to cope and thereby giving them a sense of control. Furthermore, this research is conducted independently of service providers such as; DSB, Rejseplanen, and Rejsekort, which may be regarded as decreasing its validity.

Third, in terms of the developed prototype, we can point out weaknesses regarding the look and feel and the limitation of the functionality, meaning that it only allows basic interactions. This stems in that none of us have the technical capacity nor the resource to build a fully functional application. However, since the prototype is a minimum viable product, it is not meant to be perfect.

As the final round of testing was done with only 16 users, the number of testers might be too little to derive generalizable results. We do however believe that it has given us meaningful and valuable results, nonetheless. Moreover, we believe that several more iterations could have been beneficial for the research so that we could have reach a point where real life testing could have been conducted rather than simply doing simulation testing where the focus is placed on the specific features in the context of using public transportation.
Although this research grounds its empirical study in the Danish market by involving users living in Denmark and using Danish public transportation, it can easily be applicable in other markets, cities or countries.

6.2.2 Future Research

There are a few interesting future research possibilities that can be exploited with our research as a starting point. In general, a range of prescriptive knowledge has been generated within this thesis, paving the way for researchers and designers to carry on.

First, sharing information or knowledge is a key element of our solution. And our users did not shy from the fact they are more willing to simply use the solution rather than to create content and help other users. As our solution will mainly run by user generated content, it is crucial for its success that users get the right incentives to engage with the application.
Incentives to encourage knowledge sharing have received considerable attention from the research community (Laitinen and Senoo, 2016). According to (Laitinen and Senoo, 2016), to increase information sharing and collaboration between users, understanding the reasons why individuals engage in information sharing activities is required. Understanding how the motivational factors of incentive systems link to the sharing activities is fundamental when designing new information sharing initiatives (Laitinen and Senoo, 2016). If the incentive is not evident from beginning or always visible, it will also be difficult to retain users.

Second, once we have reached the understanding, the research can be taken further my actually building the application and test it in its natural and intended setting over time as a longitudinal

research with a quantitative approach to expand its reach and thereby lead to generalizable and representative findings.

7. CONCLUSION

This study had the objective of designing features of a digital application to help users to cope when experiencing lack of control when relying on public transportation resources. By following a user-centered approach we explored the problem space with 15 initial user interviews and set the focus of this project on the communication of public transportation services. In close collaboration with the users we designed a digital application, that supports the user's coping process when lacking control.

On the basis of identified literature and our theoretical framework we followed a design thinking process to explore and fully understand the problem, ideate and prototype possible solutions, test and analyse the outcome - all with an iterative approach.

We conducted a total of 45 user interviews and one user workshop to ensure a user- and problem-focused process. We applied twelve different design practices through the five design thinking phases and created four prototypes - from hand drawn sketches up to a clickable high-fidelity prototype.

The final testing of the prototype, we learned how and why various features and functionalities helped the user to cope when experiencing a lack of control when relying on public transportation resources. Whereas some of the features, such as the ones, that incorporated customization, supported the coping process, we identified functionalities, that could not contribute to the coping process, as they did not facilitate trust regarding the content.

Next to some implications of our research, the following findings are our main contributions: (1) Users that seek to regain control need to be oversupplied with information, that subsequently can be adapted to their needs, instead of providing tailored information. Further (2) to support the users emotional coping, superfluous visual information should be communicated, rather than parsimony task specific content. And last, (3) it is necessary to provide signals of oversight and validation for user generated content. By following these conclusions, the users of public transportation resources can be supported and their experience be improved

From our practical approach in this study we were able to discover how design practices might enhance user-centered projects in the context of public transportation.

As these contributions are based on an exploratory and qualitative approach, this study sets the foundation for a more quantitative procedure, to test and verify our findings in the future with a representative study sample. With this research we have been able to identify and design features, that supported user's coping in regard to lack of control. Further, we hope that we have been able to generate knowledge on how a digital system can generally support users during coping processes.

While these findings might not able to disruptively change the system of public transportation resources entirely, we believe that they can eliminate pain points and consequently lead to an improved user experience.

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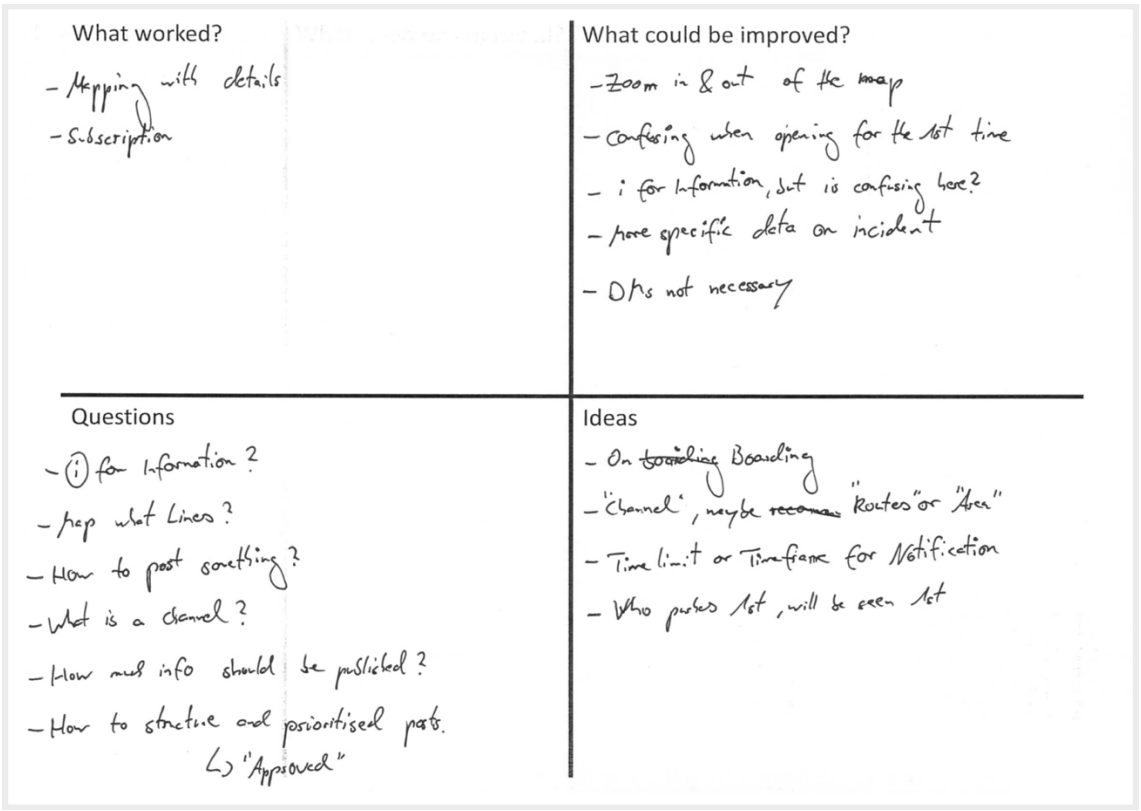
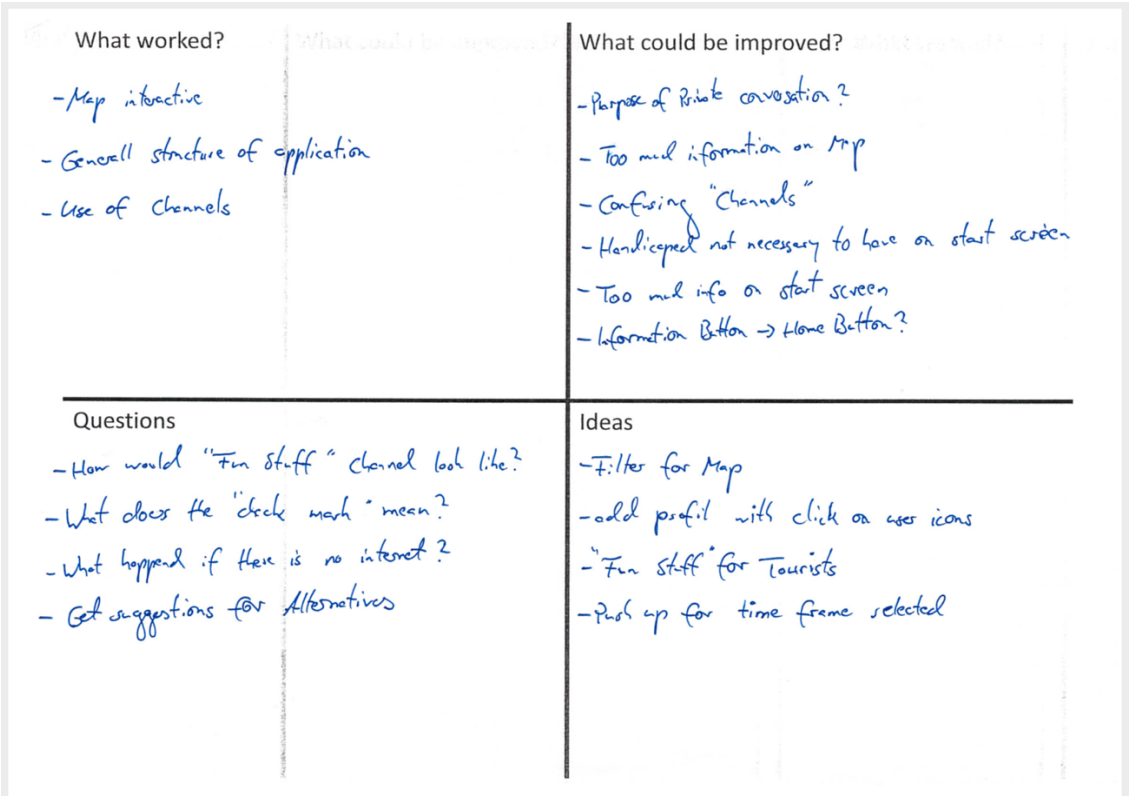
Appendix

1. Examples of Feedback Capture Grids for Low-Fi Prototype
2. Examples of Feedback Capture Grids for final Prototype
3. Tables of Feature Ratings
4. Proto-Personas (1-3)

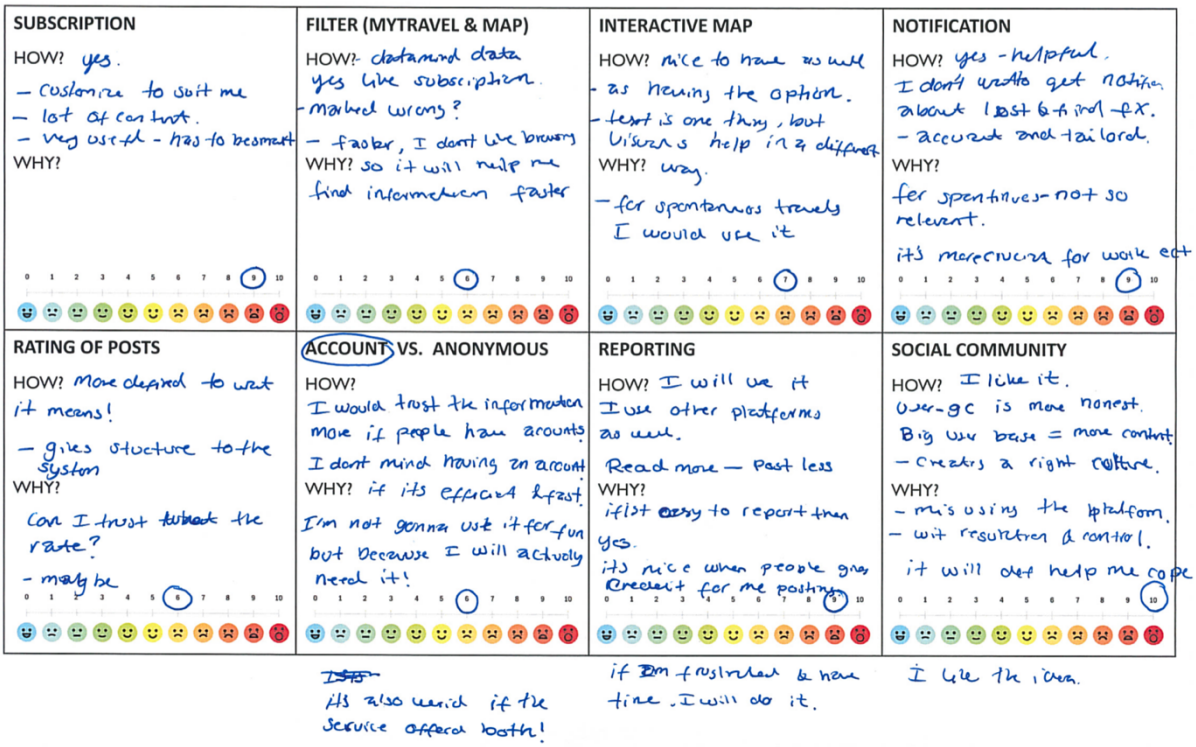
1. Examples of Feedback Capture Grids for Low-Fi Prototype



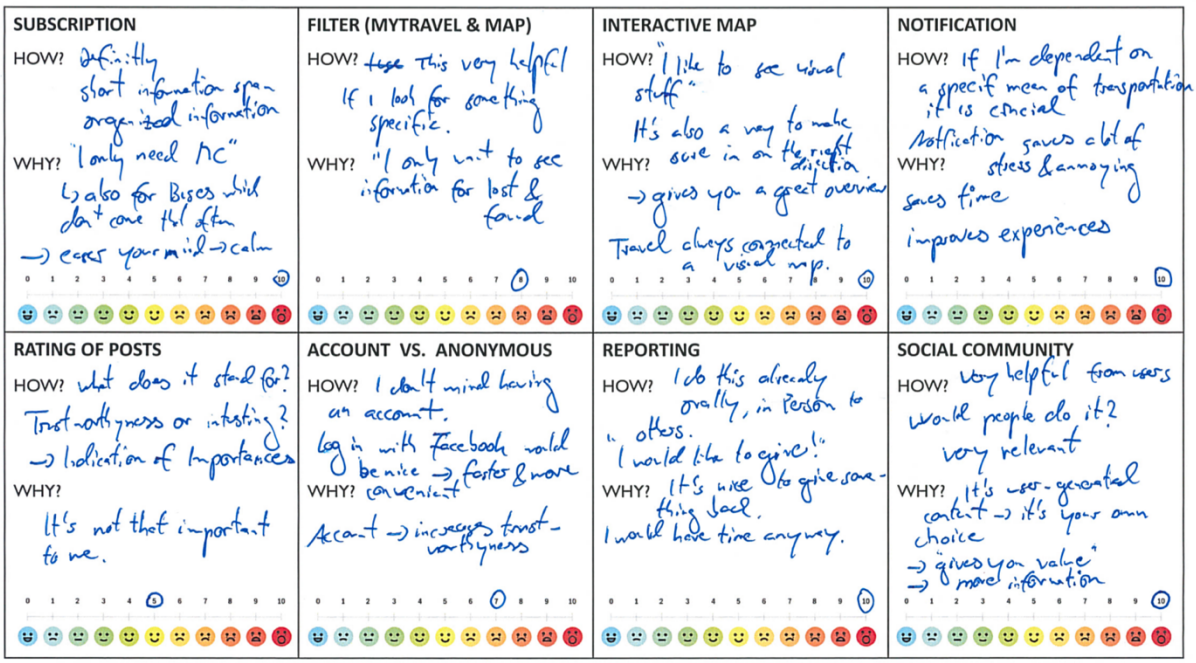


What worked?	What could be improved?
- Map - Subscription	- A lot of text > takes a lot of time to process & understand - On-Boarding necessary - more structure - Highlight relevant information. - Push up → Notification
Questions	**Ideas**
- Who approves? - For what would I use the chat function? - Trust of information? - How fast do I get a response?	- Sum up information next to user input - Categorization → "only what I need in that situation" - Route input: 2 locations instead of channels - Notification - Filter information - Dedicate chat function to Risk Sharing function only. - Map with filters

2. Examples of Feedback Capture Grids for final Prototype



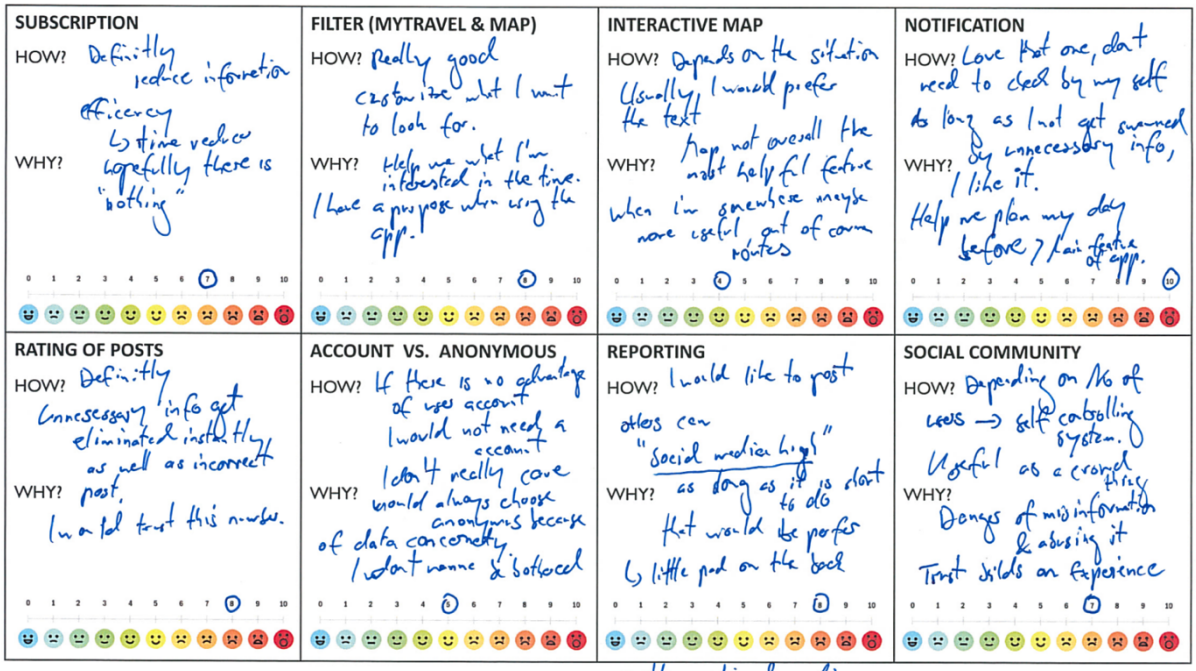
SUBSCRIPTION	FILTER (MYTRAVEL & MAP)	INTERACTIVE MAP	NOTIFICATION
HOW? yes. – customize to suit me – lot of content. – very useful - has to be smart WHY?	HOW? customized data yes like subscription. - marked wrong? – faster, I don't like browsing WHY? so it will help me find information faster	HOW? nice to have as well - as having the option. - test is one thing, but visuals help in a different WHY? way. – for spontaneous travels I would use it	HOW? yes - helpful. I don't want to get notified about last & find-fx. - accurate and tailored. WHY? for spontaneous - not so relevant. it's necessary for work ect
RATING OF POSTS	**ACCOUNT VS. ANONYMOUS**	**REPORTING**	**SOCIAL COMMUNITY**
HOW? More desired to use it means! – gives structure to the system WHY? Can I trust the rate? - maybe	HOW? I would trust the information more if people have accounts I don't mind having an account WHY? if it's efficient & fast I'm not gonna use it for fun but because I will actually need it!	HOW? I will use it I use other platforms as well. Read more – Post less WHY? if it's easy to report then yes. it's nice when people give credit for me posting	HOW? I like it. User-gc is more honest. Big user base = more content – creates a right culture. WHY? – me's using the platform. – wit restriction & control. it will also help me cope
	~~DISS~~ it's also useful if the service offered both!	if I'm frustrated & have time. I will do it.	I like the idea.



SUBSCRIPTION	FILTER (MYTRAVEL & MAP)	INTERACTIVE MAP	NOTIFICATION
HOW? definitly short information span- organized information WHY? "I only need this" ↳ also for Buses which don't come that often → eases your mind → calm	HOW? ~~use~~ This very helpful if I look for something specific. WHY? "I only want to see information for lost & found	HOW? "I like to see visual stuff" It's also a way to make sure in on the right direction WHY? → gives you a great overview Travel always connected to a visual map.	HOW? If I'm dependent on a specif mean of transportation it is crucial Notification saves alot of stress & annoying WHY? saves time improves experiences
RATING OF POSTS	**ACCOUNT VS. ANONYMOUS**	**REPORTING**	**SOCIAL COMMUNITY**
HOW? what does it stand for? Trustworthyness or interesting? → indication of Importances WHY? It's not that important to me.	HOW? I don't mind having an account. Log in with Facebook would be nice → faster & more WHY? convenient Account → increases trust-worthyness	HOW? I do this already orally, in person to others. I would like to give!" WHY? It's nice to give some-thing back. I would have time anyway.	HOW? very helpful from users would people do it? very relevant WHY? It's user-generated content → it's your own choice → gives you value → more information

SUBSCRIPTION	FILTER (MYTRAVEL & MAP)	INTERACTIVE MAP	NOTIFICATION
HOW? -Customized information -Only necessary info for me. WHY? -more efficient -saves time -excludes unnecessary info.	HOW? Similar to Subscriptions -exclude unnecessary info. WHY? -more efficient search	HOW? Does not really help to cope WHY? Nice to look at, but too much irrelevant info for me.	HOW? -saves time -get updates despites in-activity WHY? -provides updates by itself → no action needed → trust & relax
RATING OF POSTS	**ACCOUNT VS. ANONYMOUS**	**REPORTING**	**SOCIAL COMMUNITY**
HOW? Does not really help to cope. Filters already exclude ~~reduce~~ irrelevant info. WHY? redundant	HOW? By providing option to decide WHY? -saves time -Because I can choose	HOW? Helps in an indirect way → Hope to receive help. → Give something back WHY? Giving & Receiving Helping	HOW? By providing user info instead of Business/company info WHY? → more honest → more direct → "unfiltered" → more to the point

SUBSCRIPTION	FILTER (MYTRAVEL & MAP)	INTERACTIVE MAP	NOTIFICATION No!
HOW? Yes, quite a lot. I would use it on a day-to-day basis → routine WHY? → get a quick response → combining different means of transportation → customized	HOW? Some filters are useful/ helpful, especially when going through the posts (less on the map) WHY? → exclude unnecessary info → On the map I instantly see all I need, no need for filters."	HOW? Helps a lot! → you get a quick overview → Prefer visuals WHY? → Image over text → "I don't need to read!" → "I can dynamicly choose"	HOW? "I hate notifications!" "They cut through my personal barriers." WHY? → "I want to actively search for something, should be my decision."
RATING OF POSTS	**ACCOUNT VS. ANONYMOUS**	**REPORTING** Not really helpful	**SOCIAL COMMUNITY** 2 parts
HOW? Very helpfull Gives structure to the whole feed -supports the quality of content WHY? ↳ let's me know the most important info (accordingly to users) I would like to see the ratings on the map	HOW? Helpful! In general I prefer "Anonymous" I am always "data-concerned" WHY? → saves time → data would be a bigger barrier → enhances the communication	HOW? personally for me. I can see the value of this feature, but personally that's not motivation enough for me. (Only if I would have gone expert knowledge to share) WHY? → still important for the system	HOW? 1. For discovering a problem it helps a lot Many content creators, move fast. WHY? 2. For getting a solution for a problem → not very helpful "How can I trust this info"



mostly voting & reading but occasionally post

3. Tables of Feature Ratings

Users	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Average Feature
Subscription	9	9	9	9	10	8	7	10	8	9	10	9	8	8	9	6	7	8,50
Filters	8	5	6	7	7	7	8	10	9	4	8	6	9	7	7	7	8	7,25
Interactive Map	2	10	7	7	8	8	4	10	7	7	10	7	10	7	10	8	5	7,44
Notifications	10	0	9	10	9	9	10	9	9	10	10	9	10	8	7	7	8	8,44
Rating of Posts	4	10	8	2	6	8	8	7	5	2	5	6	10	6	6	5	4	5,88
Different Accounts	9	10	7	5	8	5	5	6	6	9	7	6	9	7	8	8	10	7,50
Posting	8	3	3	3	3	6	8	7	8	4	10	9	8	6	9	5	3	6,25
Social Community	9	5	5	5	9	8	7	8	10	7	10	10	9	8	8	3	7	7,69

4. Proto-Personas (1-3)

Anne Petersen

“Lack of information is the worst thing about public transport”
“I once experienced that the bus just drove away, even though on the display at the stop it said 2 minutes until departure”

DEMOGRAPHICS

- female
- 19 years old
- just started a Bachelor in Human Resources
- doesn’t work on the side
- single

BEHAVIOUR / BELIEFS

- uses the bus every day
- travelling as means to get from A to B as fast and efficient as possible

PERSONALITY

- naive
- extrovert
- confident
- popular

Mikael Jansen

“If I travel long distance I always plan everything, still sometimes I don’t get every connection.”
“Why can’t you get the same information on the screens, the speakers and on the itinerary? It's really frustrating”

DEMOGRAPHICS

- male
- 27 years old
- full time position as a Junior Consultant
- lives with his girlfriend

BEHAVIOUR / BELIEFS

- uses Metro every day to work
- uses long distance train every 2nd weekend to visit family
- travelling as means to get from A to B as fast and efficient as possible

PERSONALITY

- passionate
- entertaining
- caring

Birte Pedersen

“As long as I have a seat and I can read on the train, I’m fine”
“I just trust my experience, when I’m taking the train - These apps confuse me more than helping me”

DEMOGRAPHICS

- female
- 40 years old
- works part time as a secretary
- married
- 2 children

BEHAVIOUR / BELIEFS

- uses the train every day to go to work
- daily life is very structured

PERSONALITY

- caring
- stressed
- overworked
- loving
-