

Research Study of DeMo (Decarbonizing Transport And Mobility Through Data-Driven Modal Shift)

Methods in Human Computer Interaction

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1 Introduction

In the pursuit of global and national carbon emission reduction goals, the transportation sector emerges as a focal point for transformative change. Our project aims to explore strategies and tools to encourage individuals to transition from car usage to sustainable alternatives, such as public transport or active mobility. The project, named Decarbonizing Transport and Mobility through Data-driven Modal Shift (DeMo), is research-oriented and involves collaboration with partners Tampere University and VTT. This collaboration stands at the forefront of urban sustainability, focusing on cities like Tampere and Helsinki, where despite commendable efforts, the car remains the predominant mode of transport. The project started last autumn in practice and has identified key use cases and contexts for study, contemplating specific challenges, including the integration of tram services into diverse settings such as hospitals, cultural routes, and campus areas within the Tampere region.

So far, the focus has centered around comprehending the variables affecting mode choice, whether people choose public transport, active mobility, or private car, and defining use cases/contexts for further study. Our team's contributions to this project are seen as valuable in the next phase when developing service concepts for specific use cases. To achieve this, we aim to conduct interviews and surveys to determine why people prefer certain transportation modes and how we can encourage them to make more sustainable choices. Based on the results of a user study, we aim to create service concepts tailored to specific use cases.

1.1 Research and work plan

The topic of our project is important but also challenging. Many factors affect people's choices of transportation modes such as preferences, needs, habits, self-indulgence, the lack of choices, attitudes etc. To make sustainable transportation modes more attractive, it's crucial to identify the reasons behind users' choices as well as their preferences and motivations towards sustainable transportation.

So far, to gather insights, we have conducted one pilot interview. At this moment, our understanding of people's problems related to public transport comes from the pilot interview and our own experiences. To find out the real challenges, problems, and obstacles of the users, we plan to conduct semi-structured interviews and distribute a questionnaire to different discussion groups. An online form of questionnaire is planned to reach people through certain platforms including social media, Intranet or Tampere University's Yammer. Moreover, the involvement of industry partners, including Matkahuolto with their Trips and Tickets mobile app, adds a dynamic layer to our exploration of potential solutions.

Our target group includes individuals who primarily use a car but do not have a negative attitude towards public transport and see it as a possible mode of transportation. Although the target group could also be narrowed down to include, for example, tourists, parents with

small children travelling by car, etc., we will focus on this broader target group as it's easier to find interviewees.

Transcripts from interviews and results from questionnaires will be analyzed, including the creation of an affinity diagram to aid in persona development. Additionally, a sequence model and journey map will be employed to visualise events step by step, identifying potential pain points. The analysis aims to uncover the true underlying problem, as visible issues are often symptoms of deeper concerns. Following user research and result analysis, we will transition to designing a service concept. At this stage, the testing method for the service concept remains undetermined, given the broad challenge that may not have a one-size-fits-all solution.

Work will be distributed evenly within the team, with consideration for varying workloads during busy weeks. Tasks will also be assigned to allow each member the opportunity to learn and develop new skills, not solely based on existing expertise. Our primary means of communication is through Telegram and regular Teams meetings, although the latter has proven challenging due to team members' busy and divergent schedules. The goal is to secure a consistent time for weekly meetings, recognizing the importance of regular communication despite scheduling difficulties.

1.2 The goals of our group

The main goals of our group are to satisfy the client, help them to collect various insightful data and implement an efficient service. Sustainable development is one of the most essential megatrends many recent years. Hence, getting more insights about people's motivations, needs, behaviours and experience regarding sustainable modes of transportation, then changing people's minds and behaviours in using public transportation in Finland are what we expect to do in this project. We hope that the collaboration with Demo project and all the group members will be a great experience for our group.

1.2.1 Personal goals

Halsey: My personal goal when doing the project is to enhance the understanding and practical experience about essential methods in different stages of human-centered design processes. Through this project, I aim to apply studied knowledge from the course Methods in Human-centered design into exploring what users need regarding the public transportation as well as creating effective designs towards sustainable development. Conducting interviews and analysing user research data will definitely help me gain valuable insights. Additionally, collaborating with a multidisciplinary team and Demo project's representative is what I'm looking for.

Melina: My goals for this project include acquiring a comprehensive understanding of various methods and developing the ability to select the most suitable method for each specific purpose. I find the beginning phases of a project often daunting, and my goal is to gain additional insights, knowledge and confidence to simplify the planning and initiation

stages. I want to make these initial steps more manageable and less overwhelming. Furthermore, I am eager to learn more about the theoretical aspects of human-centred design and its practical applications.

Mikaela: I have simple and practical goals for this project. My first goal is to of course get the credits. My second goal is to learn how to be a good leader and manage group projects effectively. I also would like to learn from my past mistakes managing group projects, for example not stressing too much about deadlines and not doing more than what I could do. My third goal is to expand my knowledge in human centred design and research methods. My fourth goal is to effectively collaborate with my classmates and other stakeholders of this project.

Dat: In the beginning when I approached the project, I felt a little overwhelmed with a lot of information provided by Kirsikka. After reading most of the materials and having meeting with Kirsikka, I figured out what should I and our team need to do to follow the track. As my personal goals, I would like to get more insights and knowledges related to the real project. That helps me a lot to get more experience for other real future projects. Studying and applying the Human-Centered Design method on this project, that would help me sharpen my knowledge related to user experience, user research and data analysis.

Iffat: Sustainability itself is the topic very close to my heart and sustainable means of transportation is what I always wanted to do my goals for this project is to see how from abstract information leading to concrete goals, moreover, getting clear understanding of different human-centred design processes and practical implication of sustainability after results and its design.

2 Initial User Research

2.1 Methods

Our initial plan to conduct the first stages of user research includes:

- **Semi-Structured Interviews and Surveys:** To directly gain comprehensive understanding of our target users' needs and preferences regarding public transportation. In case we cannot conduct an interview, there is always the option of sending out an anonymous survey.
- **Contextual Inquiries:** By observing users naturally using public transport and/or driving a car, we could gain insights into their behaviors, challenges, and motivations.
- **Thematic Analysis:** Conducting a thematic analysis could help us identify recurring patterns and themes, extracting meaningful insights to guide our design decisions in this project.

2.2 Interview insights

Only one interview was conducted due to time constraints and difficulty in finding participants. The first interview was a pilot as it was important to test the questions and interview setup to figure out any deficiencies. Interview materials that were given to the participant includes an invitation letter, consent form and background questionnaire which were created on Microsoft Forms. These can be found in the appendix.

The participant, PI01 (Participant Interview 01), confirmed having access to a car and expressed a preference for utilizing services like Oma Go and Go more frequently for renting a car. The predominant mode of transportation varies between cities, with a preference for public transport in Tampere and a reliance on the car in Helsinki. She emphasized a clear understanding of sustainability but leaned towards prioritizing comfortability in her transportation choices. Factors influencing her decisions included the environmental friendliness of the mode of transport and the cost comparison between using a car and public transport. She highlighted a preference for public transport while consuming alcoholic beverages. In winter, the convenience and warmth of a car were preferred due to an aversion to cold weather. Conversely, during the summer, she favoured public transportation, enjoying activities like reading books and listening to music.

The interviewee commended the modernity of the public transport system in Finland, despite expressing frustrations with certain aspects. These included discomforts such as waiting outside in cold weather, delayed bus times, and overcrowded conditions at times.

To enhance the overall experience, suggestions were made for improvements, such as the provision of warm waiting stations or rooms, particularly beneficial for children. Additionally, concerns were raised about the bus and tram schedules, advocating for more concrete and straightforward road designs. The participant also recommended the availability of on-the-spot ticket purchase options and currently utilizes the Nysse app for transportation needs.

2.3 Transcript thematic analysis

Figure 1 shows the data collected from the interview, we delved into the transcript and analysed to get more participant's insights related to our project. We collected 21 codes including various ideas related to participant's awarenesses in the use of car, the use of public transport, environmental impact awareness, reasons for using and not using car, reasons for using and not using public transport, ideas to improve public transport and so on.

In the figure below, based on 21 codes collected from the interview's data, we simplify it to focus on five main groups of data with reasons and ideas including:

1. Reasons why PI01 prefer to use car
2. Reasons why PI01 do not like public transport
3. Reasons why PI01 use public transport
4. Reasons why PI01 like public transport
5. Ideas to improve public transport

From the reasons in the participant's awareness, we determine the roles of car and public transportation to the participant as well as the barriers that separate users to change the travel method from half using car and public transportation to fully using public transportation.

The coding data Excel file with coding detail and the interview's transcript can be seen more through the link in the Appendix part.

P001	Code	Time of mentioned		Code	Reason why P001 prefers to use car	Code	Reason why P001 do not like public transport
Code 1	Car owner & prefer use car	5		7	Time	10	Weather issue
Code 2	Experience in renting car	2		8	Convenience	9	Comfortability
Code 3	Opinion about public transport in Tampere	2		9	Comfortability	12	Bus delay
Code 4	Opinion about public transport in Helsinki	2		10	Weather issue	13	Too crowded
Code 5	Use of public transport	1		11	Route & road effectiveness		
Code 6	Environmental impact awareness	3					
Code 7	Reason preferring use car - Time	3		Code	Reason why P001 use public transport	Code	Reason why P001 like public transport
Code 8	Reason preferring use car - Convenience	3		15	Convenient (in Tampere)	16	Environment impact
Code 9	Reason preferring use car - Comfortability	2		15	Weather (in summer)	17	Sustainability
Code 10	Reason preferring use car - Weather issues	3		15	Other reason (drinking)	18	Scale & modern
Code 11	Reason preferring use car - Route & road effectiveness	1				15	Weather (in summer)
Code 12	Reason do not like public transport - Bus delay	1					
Code 13	Reason do not like public transport - Too crowded	1		Code	Ideas to improve public transport		
Code 14	Factor influences between using car and public transport - Cost	1		19	A warm station		
Code 15	Reasons for using public transport	4		20	Road more diverse		
Code 16	Like about public transport - Environment impact	1		21	Application improvement		
Code 17	Like about public transport - Sustainability	1					
Code 18	Like about public transport - Scale & modern	1					
Code 19	Ideas improve public transport - a warm station	1					
Code 20	Ideas improve public transport - road more diverse	1					
Code 21	Ideas improve public transport - application issue	1					

Figure 1 - Transcript thematic analysis P101

2.4 Changes to the work plan

Our group generated about 22 questions for the interview, which we minimized by choosing the 11 best questions. These open-ended questions are semi-structured in case we need to ask follow-up questions or get further clarification. We tested these questions in our pilot interview which brought a lot of valuable insights from the participant. However, although the quality of the questions is quite strong, our collaborator partner suggested that minor improvements could be beneficial. For example, some questions were a bit redundant which led to similar answers or follow-up questions. In the pilot interview, it was found that questions about specific situations or previous experiences were more useful in retrieving insights into what motivates or frustrates people to use public transport. Questions about people's attitudes, environmental awareness and intentions to use public transport also showed potential insights into how public transport could be made more pleasant.

Based on the insights gained from the pilot interview and the DeMo representative's suggestions, many questions will remain unchanged, but some questions will need to be reorganized and reformulated. Before the pilot interview, the consent form, background questionnaire and the main questionnaire were all sectioned separately in one form. We

concluded that this structure might confuse the participants, so the forms were separated. Two forms were created for two groups: interviewees, and questionnaire participants. Utilizing questionnaires as a research method is our backup plan in case, we find it challenging or fail to find an interviewee. This also has been reflected in the name coding of our participants e.g. PI01 stands for participant interview 01 and PQ01 stands for participant questionnaire 01.

In addition, we assume that filling out the questionnaire may take time and possibly demotivate the participant, especially if many of the questions are related to previous public transport use or experience. However, the questionnaire has not been tested yet, so it will be finalized before it is shared to larger discussion groups.

Before

1. Do you have access to a car?
2. Do you prefer using a car or public transport?
3. How often do you use public transport?
4. What kind of public transport do you use?
5. How important do you consider the environmental impact when choosing your means of transport? Why?
6. How do you define effective public transport in your opinion?
7. What would make you consider switching from using a car to public transport?
8. What other factors may influence your decision in choosing public transport or a car for travelling?
9. Do the different seasons (e.g winter, summer...) influence your decision in choosing public transport or a car for travelling? Why?
10. What do you like about public transport?
11. What are your frustrations with using public transport?
12. Do you have anything in mind regarding how public transport could be improved?

After

1. Do you have access to a car?
2. Do you prefer using a car or public transport?
3. How often do you use public transport?
4. What kind of public transport do you use?
5. When using public transport, are timetables available and readable if needed?
6. Describe a time when you enjoyed using public transport and why?
7. Describe a time when you got frustrated using public transport and why?
8. In your opinion, how would you like to improve the public transport you used in the past?
9. What kind of situations or factors that may influence you to choose public transport instead of a car? Why?
10. Do the different seasons (e.g winter, summer...) influence your decision in choosing public transport for travelling? Why?
11. How important do you consider the environmental impact when choosing your means of transport? Why?

12. Do you have anything else to share?

2.5 Contextual inquiry

It was very difficult for our team to conduct any kind of contextual research before submitting this report due to time constraints and lack of resources. Our team has considered various scenarios for implementing this research method, from recorded videos to accompanying the participant and to walk-me-through questions. We concluded that questionnaires and/or interviews would be better research methods for our situation. Since the target group is quite specific and requires certain criteria, it is understandable that it would be very challenging to find participants who are willing to give their time and effort. Perhaps a separate questionnaire and/or interview that focuses only on the participant's steps switching from a car to using public transport can be a possible way to conduct contextual research. However, this suggestion needs to be researched and finalised first.

3 User research

The user research was conducted through semi-structured face-to-face interviews and surveys in both Finnish and English. The study aimed to investigate the challenges experienced by individuals who primarily use cars regarding public transportation, what works well in public transportation, and how users could be encouraged to transition to more sustainable modes of transport.

3.1 Methods

To conduct the user research, semi-structured face-to-face interviews and surveys were utilized in both Finnish and English. The study aimed to delve into the challenges faced by individuals primarily using cars concerning public transportation, assess the strengths of public transportation, and explore possibilities for encouraging users to transition to more sustainable modes of transport.

Three interviews were conducted, one of which was a pilot interview. Questions were formulated based on the pilot interview, but we noticed that this change did not affect the usefulness and relevance of the results obtained from it.

Although the interview method proved effective in gathering user insights, we decided to also create a survey questionnaire in both English and Finnish. This decision was driven by the fact that team members and participants in the study reside in different locations. Furthermore, due to the complexity of the topic, we considered it important to gain a broader understanding of users' perspectives, needs, and behaviours across different age groups. Five individuals responded to the survey in Finnish, while two individuals responded in English.

Participants who agreed to be interviewed received an interview invitation, which included details about the time and location of the interview, as well as links to a background questionnaire and informed consent for data storage. Similarly, respondents to the survey were asked for permission to store their responses. The face-to-face interviews were conducted by a single team member due to scheduling constraints for both team members and participants. All interviews were recorded, and transcripts were generated for analysis. The research findings will be revisited later in the context of analyzing the results and discussing their implications.

During the user research process, we faced some challenges in finding suitable study participants who belong to our target group. People mainly use either private cars or public transportation. Hence, it was difficult to find participants who are switching between those options and having insights about that.

3.2 Analysis of mass data: affinity diagrams and thematic analysis

Initially, prior to the creation of affinity diagrams and the thematic analysis all survey and interview data were scanned and compiled into Excel, with separate sheets dedicated to each type of data. Subsequently, to manage the large volume of data, it was organized into different tables within a single Word document for clarity and organization. In addition, AI

tools like Notably AI Premium and ChatGPT-4 Premium have been utilized to assist us in efficiently finding corresponding participant responses to relevant themes. Due to the ethical considerations surrounding AI usage, these tools have been used carefully for rapid scanning and matching purposes only.

The affinity diagrams and thematic analysis were conducted concurrently. While these analysis methods share similar approaches, they served distinct purposes in our study. Affinity diagrams were used in aggregating participant responses into five overarching themes, facilitating the identification of recurring sub-themes. Whereas the thematic analysis delved deeper into individual participant responses, providing additional insights specific to each participant, and enriching the overall understanding of the data. This parallel use of methods allowed for a comprehensive exploration of the data from both macro and micro perspectives.

On the other hand, responses from both interviews and surveys have been aggregated into the affinity diagrams. This allowed the identification of recurring internal and external factors influencing car drivers' decisions to adopt public transportation. Regarding the thematic analysis, due to the nature of quantitative and qualitative analysis, the data collected from interview and survey participants were separated into two different groups. The data collected provided diverse insights, prompting our team to further investigate strategies and tools aimed at encouraging individuals to shift from car usage to sustainable alternatives. Based on the analyzed data, we applied thematic filtering and created tables on Excel to compare the data and insights with each participant.

These compiled data files can be found in the appendix.

3.2.1 Affinity diagrams

	Frequency of usage and popularity	Reasons for preferring to use car			Reasons for preferring to use public transport		
		Work-related necessity	Convenience and speed	Lack of good routes	When access to a car is unavailable or lacks space and/or if unable to drive	Saving on parking costs, fuel cost, and time	General bodily needs and safety
Theme 1: Transportation preferences and usage	Car preferences: 6 occurrences Public transport: 3 occurrences	PS01, PS03, PS05, PS07 - said "yes" to requiring a car for work	PI02: ... the speed (of a car) take precedence	PS01: More routes for public transport. Easier to use public transport applications elsewhere than in Helsinki, e.g. Oulu because it was too difficult to use public transport there, so I settled for an electric kick board.	PS02: I don't have a driver's license.	PS05: visiting the center of Helsinki (no free parking spaces and annoying traffic)...	PS07: Depending on my needs, places that require a long walk or are not near a metro station, I will take a car in the winter. But on the other hand, parking in winter is very uncomfortable
	Bus - 7 occurrences Train - 6 occurrences Taxi - 3 occurrences Subway - 2 occurrences Tram - 2 occurrences Metro - 2 occurrences		PI03: In general, I get frustrated with how long public transportation takes compared to driving ... I've missed the previous bus right in front of my nose ...	PI03: The most important thing for me is having the smoothest routes possible. Getting to the city centre as quickly as possible is crucial. It all boils down to that. If I can get to the city centre in 15-20 minutes, I'd take the bus every day.	PS04: I take the taxi when I'm drunk ... The taxi dropped me home cheaply from the center of Helsinki when I was almost collapsing due to being intoxicated	PI02: Well, at least for the reason that you don't have to find parking if you're going to the city centre ...	PI03: Only in the sense that there might be situations where I don't have a car available, and it's extremely cold or some such weather condition I can't use the bike, so in that case, I might choose public transportation. Depending on the weather, I'd opt for public transportation.
	Monthly - 5 occurrences A few times a week - 2 occurrences Occasionally - 1 occurrence Never - 1 occurrence		PS07: Depending on my needs, places that require a long walk or are not near a metro station, I will take a car in the winter. But on the other hand, parking in winter is very uncomfortable		PS05: Drinking alcohol... or having the car temporarily serviced.	PS06: Timing, i need time for work i will prefer using public transportation	
					PI03: ... So my preference is to go, well, I can't say I prefer it, but I go by car or bike rather than public transportation. If neither of those works, then I'll take public transportation.	PS07: distance, cost ...	
					PI02: ... And of course, if there are more people, for example, if a single car can't accommodate everyone, then it's easy to take public transportation.	PS06: Timing, i need time for work i will prefer using public transportation	

Figure 2 - Affinity diagram theme 1: transport preferences and usage

The affinity diagram for theme 1 above includes the underlying sub-themes of the following:

- Factors that influence car usage or public transport
- Frequency usage of car and public transport
- Popular modes of transport in order

In summary, among the 9 participants, 5 expressed a preference for using cars primarily because of work-related requirements, convenience, and speed, including having easy access to their vehicles and the freedom to travel without adhering to predetermined routes. However, several car users indicated that they may resort to public transportation under specific circumstances, driven by economic considerations and personal situations. These may include not having access to a car, being unable to drive, avoiding parking fees or fuel costs, and saving time spent searching for parking spaces.

Theme 2: Satisfaction with public transport	Internal factors		External factors		
	Saving on parking costs, fuel cost, and time	Pleasant ride and seamless transfers between bus and tram	General access, alternative option and great for emergency situations	Ease of access to status information	Frequency and punctuality
	PS03: If I move around in Helsinki, it's much better to get there by public transport or on foot than by car	PI03: Mmm, well, I've been satisfied when I couldn't use the car for some reason. It's relatively smooth even though I have to change once. The transfer from bus to tram is quite seamless. And traveling by tram is pleasant.	PI02: Well, you can easily get from one place to another by bus...	PS01: HSL's live bus routes can be seen online, it made it easier to get around when you know where the bus went and where to stay.	PS02: When there were buses more than once an hour.
	PS05: visiting the center of Helsinki (no free parking spaces and annoying traffic)...		PI03: Mmm, well, I've been satisfied when I couldn't use the car for some reason ...		PS03: Buses are usually on schedule according to my experience
	PI02: Well, at least for the reason that you don't have to find parking if you're going to the city centre ...		PS05: ... having the car temporarily serviced ...		
	PS06: It is fast and saves fuel cost				

Figure 3 - Affinity diagram theme 2: satisfaction with public transport

The affinity diagram for theme 2 above includes the underlying sub-themes of the following:

- Factors that influence positive associations with public transport usage
- Personal circumstances and emergencies situations
- General accessibility and service ease of use

In summary, car drivers' previous positive encounters with public transportation revolved around meeting their physical needs, such as comfort and a sense of security knowing that public transport serves as an alternative during essential or emergency situations, such as when their cars are temporarily under maintenance. This also includes benefits like avoiding traffic congestion, expensive parking fees, and fuel costs. Additionally, punctual, and frequent public transport services were perceived positively, along with the convenience of tracking and monitoring routes and stops online.

Theme 3: Frustrations with public transport	Internal factors	External factors			
	General bodily needs and safety and other personal circumstances	Discomfort in crowded situations or during rush hours	Unreliable service, inefficiency and unintuitive notification of delays	Inconsiderate or unaware bus drivers	Strikes and no other alternatives
	PS01: In winter, the means of public transport run worse and it's usually cold inside, while sometimes it's warm in the cars when the heating is on. In summer, especially in big cities, public transport will be used.	PS02: When the bus was full.	PS05: Not really. I can only see winter as a less reliable time for trains	PS03: When the driver drives no matter what happens ... that the drivers would care more	PS07: The only thing I think about is the strike, which is really stupid because the strike doesn't affect the company but directly affects us. We have to pay monthly to use public transportation. This means that whether you can go or not, the company still collects money every month.
	PS04: When the taxi couldn't find me when I was intoxicated	PI02: When public transport is crowded and there are no seats available, it can be frustrating and it's frustrating if it's significantly delayed.	PS01: I got frustrated with the bus service, because it's a big company, it's HSL's website when they crashed, so I had no idea which bus to take to get to the place I needed to go. And there were no routes for buses at the stops either, so I had to guess which bus to take. HSL could not fix its website quickly enough, even assuming such a large company.		
			PS05: Within a couple of months (2021), I was about four times late for appointments because the bus missed the train or the commuter train was cancelled altogether.		
			PS06: The routes showed on the map are longer than in reality PI03: ... especially when I've come home from the city centre, the transfer has taken time. I've missed the previous bus right in front of my nose, and then I've had to wait for the next bus at the TAYS Stop (Tampere University Hospital Stop) for 15-20 minutes, which is quite frustrating ...		

Figure 4 - Affinity diagram theme 3: frustrations with public transport

The affinity diagram for theme 3 above includes the underlying sub-themes of the following:

- Factors influencing negative associations towards public transport
- Physical needs
- Service reliability
- Customer relationships
- External factors

In summary, car drivers' past experiences largely centered on unmet physical needs, leading to their frustrations with public transportation. This encompassed discomfort caused by inadequate heating during the winter, a lack of personal space and mobility in crowded conditions during rush hours, and distant or indifferent interactions with bus drivers. Furthermore, certain external factors beyond the customers' control, such as strikes, often left them with no alternatives. Additionally, unexpected delays that were not communicated promptly added to their stress and contributed to mistrust towards the public transport system, especially given its substantial scale as a service provider.

Theme 4: Environmental considerations and impact	Reasons for not considering the environmental impact		Reasons for considering the environmental impact	
	Lack of awareness or concern	Pereception of individual impact to the environment is insignificant	Safe and helps the environment	Consideration towards animal wellbeing and safety
	PS01: oh its just because I don't really think about whether it pollutes the environment am not thinking when im going to drive like does this pollute the enviroment. It hasnt been on my mind even since i got my first car	PS04: Because I see it as a very small problem that I "pollute" the climate, I will die before it has a significant effect and the car is a much faster and easier alternative than public transport	PS06: It is safe and good for environment	PS07: Environmental protection does not directly impact car users too much. But for me it affects the animals living around me a lot
	PS02 and PS03: I use public ones (perhaps entails he doesn't think about it since he is already using public transport)	PS05: Because the impact of one person on a global scale is negligible. Unless you are rich and own private jets and yachts.		
	PI03: Price and the... the speed take precedence. I: So, you mean that a car is cheaper? P: Yes			
	PS07: Firstly, I will focus on the cost, because if I work or move to some place where is near transportation for long time I will choose transportation . It's cheaper than using car for moving ... I think whether a person uses public transportation or not is mainly due to cost and convenience ...			
	PI03: I don't really think about it when choosing a mode of transportation.			

Figure 5 - Affinity diagram theme 4: environmental considerations and impact

The affinity diagram for theme 4 above includes the underlying sub-themes of the following:

- Factors that influence the environmental considerations and impact towards public transport or car usage
- Indifference in perception and individual impact
- Convenience and distractions
- Road and public transport infrastructure

In summary, the data revealed a surprising trend, many individuals do not prioritize the environmental impact of car usage. This lack of concern stems from a combination of factors, such as convenience and costs, including a general unawareness of their individual contributions to environmental degradation and a perception that their actions have minimal impact on a larger scale. Moreover, immediate goals and intentions, such as reaching a destination, often overshadow considerations of environmental consequences. Additionally, possible distractions during travel, such as searching for tickets or seats, further divert attention away from environmental concerns. However, some participants expressed apprehension about the potential harm to animal welfare due to car usage and perhaps due to the expansion of public transport infrastructure. In contrast, only one participant viewed public transport as both safe and beneficial for the environment, recognizing its role in reducing carbon emissions and pollution, which are typically higher with cars.

Theme 5: Improvement suggestions for public transport	Internal factors		External factors		
	Renovation of furniture and services for better comfort or ease of use and intuitiveness	Building customer relationships	Service reliability and efficiency	Intuitive and early notifications of delays	Lessen transfer complexity
	PS01: 1. Renewal of bus benches with softer benches 2. More stops in less populated areas because public buses run so rarely More stops and connection routes in populated areas and transport services during rush hours to improve traffic	PS03: When the driver drives no matter what happens ... that the drivers would care more	PS05: Public transport should be more punctual ...	PS05: Also things like notifications of delays and guaranteeing the continuous functionality of the application ...	PI03: No, but let's say in a future scenario, probably even less with public transportation if I'm afraid that it will happen when the tram lines expand. Soon, we'll be in a situation where we can only get to the city center with two transfers. We'd have to first go to Koilliskeskus, then to Tays, and then another transfer, so that's not appealing at all.
	PS07: Changing the payment method from hourly to station-by-station payment like Singapore. It will reduce fare evasion because there are many people who only go to 1 or 2 metro stations but they have to buy a ticket for the 90 minute per only one time.		PS02: More buses at certain hours.	PI02: ... it can be frustrating and it's frustrating if it's significantly delayed ...	
			PS06: Optimizing the map and showing shorter routes for users are improvements		
			PI02: Probably due to adjusting the schedules or shortening the intervals. So that it would run more frequently.		
			PI03: The most important thing for me is having the smoothest routes possible. Getting to the city centre as quickly as possible is crucial. It all boils down to that. If I can get to the city centre in 15-20 minutes, I'd take the bus every day.		

Figure 6 - Affinity diagram theme 5: improvement suggestions for public transport

The affinity diagram for theme 5 above includes the underlying sub-themes of the following:

- Factors to improve public transport
- Service reliability, efficiency and effectiveness
- Transfer complexity
- Renovation of certain services
- Ease of access to information regarding delays

In summary, internal factors affecting the improvement of public transportation revolve around customers' physical, social, and psychological needs, including considerations of warmth, comfort, and a sense of respect and dignity. Some participants expressed frustration with bus drivers who are inconsiderate of **passengers' safety and well-being, contributing to overall mistrust and resentment towards public transportation**. Moreover, participants highlighted the importance of economic freedom in payment methods, advocating for more intuitive payment options similar to those seen in places like Singapore, where station-by-station payment options are available. The current practice of issuing 90-minute tickets may be viewed as restrictive and perhaps not well-suited for various scenarios, such as situations where travel time is extended due to traffic or emergencies. Additionally, external factors such as the reliability and frequency of public transportation services during specific hours, the **ease of transferring between different modes of public transport**, and the **overall reliability and effectiveness of transportation service applications and notifications of delays** were also identified as crucial areas for improvement.

3.2.2 Thematic analysis

Below is thematic analysis result of survey participants (comparison table):

	PS01	PS02	PS03	PS04	PS05	PS06	PS07
Car/ public transport	Car owner & prefer use car	Not own car & use public transport	Car owner & prefer use car	Car owner & prefer use car	Car owner & prefer use car	Car owner & use public transport	Car owner & use public transport
Frequency in using public transport	Monthly	Monthly	Occasionally	NEVER	Monthly	A few times a week	A few times a week
Type of public transport	Bus, Train	Bus, Train, Taxi	Bus, Subway, Train	Taxi, taxi when intoxicated	Bus, Subway, Train	Tram, Metro	Metro, Train, Tram
Ticket buying	Very easy	Easy	Very easy	Very difficult	Easy	Very easy	Easy
Timetables available and readable		Always	Sometimes	Never	Always	Always	Always
Satisfy with public transport	Easy to track the bus with HSL's live bus routes	High number of buses within an hour	On schedule	Low cost taxi service	Before HSL app become mandatory	Fast	Cheaper than using a car for moving
					Saving fuel cost	Hard for parking in the city center	
						Parking fee is high	
Frustration with using public transport	Crashed website	The bus is full	Driving recklessly	Lack of user location tracking	HSL app did not always work for participant	The difference of the routes between reality and on the map	Strike
	No routes for buses at the stops				Trains or buses are canceled without any warning		
Improvement ideas for public transport	Softer benches for the buses	More quantity of the buses	Driver would care more	Remove all public transport	Public transport should be more punctual	Optimizing the map	Payment methods changing from hourly to station-by-station
	More stops in less populated areas				Notification of delays should be improved	Shorter routes suggestion	
					Guaranteeing the continuous functionality of the application		
Participant awareness in different seasons affecting decision to choose public transport	Public transport run worse in winter	Does not affect	Does not affect	Does not affect	Less reliable time for trains in winter	Yes	Long walk and not near a metro station in winter
	It is usually cold inside						Hard parking in winter
Awareness in environmental protection	Not very important	Not important	Not very important	Not very important	Not important	Extremely important	Neutral
							Effects the animal living around

Figure 7 - Thematic analysis result (comparison between survey participants)

The thematic analysis table above shows 7 participants from PS01 to PS07. The thematics includes basic data of:

- Car owner or public transport traveller
- Frequency in using public transport
- Type of public transport
- Ticket buying
- Timetable available and readable

After that, we have thematics of

- **Satisfy with public transport:** This thematic is used to clarify the satisfaction of participants with public transport.
- **Frustration with using public transport:** This thematic is used to clarify the frustration of participants with using public transport.
- **Improvement ideas for public transportation:** This thematic is used to clarify the improvement ideas of participants for public transportation.
- **Participants awareness in different seasons affecting decision to choose public transportation:** This thematic is used to clarify the participants awareness in different seasons affecting their decision to choose public transportation.
- **Awareness in environmental protection:** This thematic is used to clarify the participants awareness in environmental protection.

Generally, each participant has different ideas related to different thematics. Both data collected and analysed provides us various insights from different aspects, helping us to strengthen our project idea. For example, PS01 has improvement ideas of having more bus stops in less populated areas, and PS02 has improvement ideas of having more number of the buses. Both of idea may sounds like not similar to each other, but both ideas aim to increase the bus frequency to serve people.

Besides, the analysed results also point out the issue related to people awareness in environmental protection. The result collected is 2/7 participants paid attention in environmental protection and the impact of private car or other private transportation on environment. This could be an important data for our team to care about if we really want to strengthen people awareness in environmental protection as well as encourage individuals to transition from car usage to sustainable alternative such as public transport or active mobility.

Thematic coding results of PS01, PS02, PS03, PS04, PS05, PS06, and PS07							
PS01	Code	PS02	Code	PS03	Code	PS04	Code
Code 1	Car owner & prefer use car	Code 1	Not own car & use public transport	Code 1	Car owner & prefer use car	Code 1	Car owner & prefer use car
Code 2	Frequency in using public transport - Monthly	Code 2	Frequency in using public transport - Monthly	Code 2	Frequency in using public transport - Occasionally	Code 2	Frequency in using public transport - NEVER
Code 3	Type of public transport - Bus, Train	Code 3	Type of public transport -Bus, Train, Taxi	Code 3	Type of public transport - Bus, Subway, Train	Code 3	Type of public transport - Taxi, taxi when intoxicated
Code 4	Ticket buying - Very easy	Code 4	Ticket buying - Easy	Code 4	Ticket buying - Very easy	Code 4	Ticket buying - Very difficult
	Timetables available and readable	Code 5	Timetables available and readable - Always	Code 5	Timetables available and readable - Sometimes	Code 5	Timetables available and readable - Never
Code 5	Satisfy with public transport - Easy to track the bus with HSL's live bus routes	Code 6	Satisfy with public transport - High number of buses within an hour	Code 6	Satisfy with public transport - On schedule	Code 6	Satisfy with public transport - Low cost taxi service
Code 6	Frustration with using public tranport - Crashed website	Code 7	Frustration with using public tranport - The bus is full	Code 7	Frustration with using public tranport - Driving recklessly	Code 7	Code 7: Frustration with using public tranport - Lack of user location tracking
Code 7	Frustration with using public tranport - No routes for buses at the stops						
Code 8	Improvement ideas for public transport - Softer bences for the buses	Code 8	Improvement ideas for public transport - More quantity of the buses	Code 8	Improvement ideas for public transport - Driver would care more	Code 8	Improvement ideas for public transport - Remove all public transport
Code 9	Improvement ideas for public transport - More stops in less populated areas						
Code 10	The factors influence decision in choosing public transport - More routes for public transport	Code 9	The factors influence decision in choosing public transport - No driving license	Code 9	The factors influence decision in choosing public transport - Moving around Helsinki	Code 9	The factors influence decision in choosing public transport - When participant is drunk
Code 11	The factors influence decision in choosing public transport - Easier to use public transport applications						
Code 12	Participant awareness in different seasons affecting decision to choose public transport - Public transport run worse in winter	Code 10	Participant awareness in different seasons affecting decision to choose public transport - Does not affect	Code 10	Participant awareness in different seasons affecting decision to choose public transport - Does not affect	Code 10	Participant awareness in different seasons affecting decision to choose public transport - Does not affect
Code 13	Participant awareness in different seasons affecting decision to choose public transport - It is usually cold inside						
Code 14	Awareness in environmental protection - Not very important	Code 11	Awareness in environmental protection - Not important	Code 11	Awareness in environmental protection - Not very important	Code 11	Awareness in environmental protection - Not very important

Figure 8 - Thematic analysis result table 1 (survey participants)

Above is the table of thematic coding results (survey participants). This table show the thematic coding with code number allowing researchers to track back to the recorded transcript data from the survey.

For example, in the comparison table above, the participant PS01 mentioned to the frustration of “crashed website” in the thematic of “frustration with using public transport”. In this table, we can track back to the recorded transcript in the excel analysis file with the code 6 of the participant PS01.

Participant PS01 – Code 6: Frustration with using public transport: Crashed website - *“I got frustrated with the bus service, because it's a big company, it's HSL's website when they crashed, so I had no idea which bus to take to get to the place I needed to go.”*

More detail of recorded transcript could be found in the excel analysis attached file in Appendix chapter of this report.

PS05	Code	PS06	Code	PS07	Code
Code 1	Car owner & prefer use car	Code 1	Car owner & use public transport	Code 1	Car owner & use public transport
Code 2	Frequency in using public transport - Monthly	Code 2	Frequency in using public transport - A few times a week	Code 2	Frequency in using public transport - A few times a week
Code 3	Type of public transport - Bus, Subway, Train	Code 3	Type of public transport - Tram, Metro	Code 3	Type of public transport - Metro, Train, Tram
Code 4	Ticket buying - Easy	Code 4	Ticket buying - Very easy	Code 4	Ticket buying - Easy
Code 5	Timetables available and readable - Always	Code 5	Timetables available and readable - Always	Code 5	Timetables available and readable - Always
Code 6	Satisfy with public transport - Before HSL app become mandatory	Code 6	Satisfy with public transport - Fast	Code 6	Factors in choosing public transport - cheaper than using a car for moving
		Code 7	Satisfy with public transport - Saving fuel cost	Code 7	Factors in choosing public transport - Hard for parking in the city center
				Code 8	Factors in choosing public transport - Parking fee is high
Code 7	Frustration with using public transport - HSL app did not always work for participant	Code 8	Frustration with using public transport - The difference of the routes between reality and on the map	Code 9	Frustration with using public transport - Strike
Code 8	Frustration with using public transport - Trains or buses are canceled without any warning				
Code 9	Improvement ideas for public transport - Public transport should be more punctual	Code 9	Improvement ideas for public transport - Optimizing the map	Code 10	Improvement ideas for public transport - Payment methods changing from hourly to station-by-station
Code 10	Improvement ideas for public transport - Notification of delays should be improved	Code 10	Improvement ideas for public transport - Shorter routes suggestion		
Code 11	Improvement ideas for public transport - Guaranteeing the continuous functionality of the application				
Code 12	The factors influence decision in choosing public transport - Party & drinking	Code 11	The factors influence decision in choosing public transport - Timing (extra time for other tasks)	Code 11	The factors influence decision in choosing public transport - Distance, cost, parking
Code 13	The factors influence decision in choosing public transport - Visiting the center of Helsinki				
Code 14	The factors influence decision in choosing public transport - Car temporarily serviced				
Code 15	Participant awareness in different seasons affecting decision to choose public transport - Less reliable time for trains in winter	Code 12	Participant awareness in different seasons affecting decision to choose public transport - Yes	Code 12	Participant awareness in different seasons affecting decision to choose public transport - Long walk and not near a metro station in winter
				Code 13	Participant awareness in different seasons affecting decision to choose public transport - hard parking in winter
Code 16	Awareness in environmental protection - Not important	Code 13	Awareness in environmental protection - Extremely important	Code 13	Awareness in environmental protection - Neutral
				Code 14	Awareness in environmental protection - Effects the animal living around

Figure 9 - Thematic analysis result table 2 (survey participants)

Result comparison table					
PI02	Factors in choosing transport	Code	PI03	Factors in choosing transport	Code
	Speed (time and speed relation)	6		Time management (time and speed relation)	7
	Price	7			
PI02	Factors in choosing car	Code	PI03	Factors in choosing car	Code
	Cheaper price	8		Faster	6
PI02	Satisfy with public transport	Code	PI03	Satisfy with public transport	Code
	Easy get to the destination by bus	9		Relatively smooth in changing between bus to tram	8
				Tram traveling is pleasant	9
PI02	Frustration with using public transport	Code	PI03	Frustration with using public transport	Code
	Crowded	10		Crowded	13
	Delay	11		Lack of alternatives	10
				Taking longer time than car	11
				Time waiting between changing public transport	12
PI02	Improvement ideas for public transport	Code	PI03	Improvement ideas for public transport	Code
	Schedule adjustment	12		Smoothest routes	14
	Shortening the intervals	13		Quick reaching to destination	15
PI02	The factors influence decision in choosing public transport	Code	PI03	The factors influence decision in choosing public transport	Code
	Do not have to find parking space	14		Evening events	16
	Large group of people	15			
PI02	Participant awareness in different seasons affecting decision to choose public transport	Code	PI03	Participant awareness in different seasons affecting decision to choose public transport	Code
	Does not affect	16		Extrremely cold temperature or bad weather condition	19
PI02	Encouragement for switching to public transport	Code	PI03	Encouragement for switching to public transport	Code
	Coverage and speed	17		Shorten the trips	19

Figure 10 - Thematic analysis result table PI02 & PI03 (comparison between interview participants PI02 & PI03)

Similar to the comparison table of survey participants above, this figure is thematic analysis results table of interview participant (PI02 & PI03). However, because we collected more qualitative data and detail from interview participants than survey participants, there are more thematics than the comparison table for survey participants above. The thematics in this table include:

- **Factors in choosing transport:** This thematic is used to figure out the main key points that participant consider when choosing a specific type of transportation.
- **Factors in choosing car:** This thematic is used to figure out the main key points that participant consider in choosing a car instead of public transportation.
- **Satisfy with public transport:** This thematic is used to clarify the satisfaction of participants with public transport.
- **Frustration with using public transport:** This thematic is used to clarify the frustration of participants with using public transport.
- **Improvement ideas for public transportation:** This thematic is used to clarify the improvement ideas of participants for public transportation.
- **The factors influence decision in choosing public transportation:** This thematic is used to clarify the factors influencing participant's decision in choosing public transportation.
- **Participant's awareness in different seasons affecting decision to choose public transportation:** This thematic is used to clarify the participants awareness in different seasons affecting their decision to choose public transportation.
- **Encouragement for switching to public transportation:** This thematic is used to clarify the encouragement for user in switching to use public transportation.

After analysing, both participants have the same opinion in why they decided to use car instead of public transportation. The same reason they mentioned is about time and speed relation or time management. According to participants, the consumed time or convenience for traveling is crucial. Combining with the thematic analysis result table below, we track back the recorded transcripts from the code we assigned for the analysed data.

For example:

Participant PI03 – Code 6: Speed (time and speed relation) - *"I don't really think about it when choosing a mode of transportation. That's why it's not important because other factors take precedence. Public transportation doesn't offer many alternatives. Also, I assume the follow-up question will be about it, but, well, the car is so much faster. In my priorities, it's more about time management than environmental factors."*

Participant PI02: – Code 7: Time management (time and speed relation) - *"Price and the... the speed take precedence."*

It is obvious that both of participants take convenience and speed (consumed time for moving) as main key points in decision of choosing the car. Those key points are also mentioned in the other recorded transcripts with the thematic of "encouragement for switching to public transport":

The question: What would make you switch to public transportation instead of your own car?

Participant PI02 – Code 17: Coverage and speed - *“If the coverage and speed were as good as having your own car.”*

Participant PI03 – Code 19: Shorten the trips - *“The goal is to shorten the trips. The journey should be as similar as possible to driving a car. That’s the key.”*

Coding results of PI02 and PI03						
PI02	Code	Time of mentioned		PI03	Code	Time of mentioned
Code 1	Car owner & prefer use car	2		Code 1	Car owner & prefer use car	2
Code 2	Frequency in using public transport - Monthly	1		Code 2	Frequency in using public transport - Once a month	1
Code 3	Type of public transport - Bus, tram, train and taxi	1		Code 3	Type of public transport - Bus and tram	1
Code 4	Ticket buying - Easy	1		Code 4	Ticket buying - Easy	1
Code 5	Timetables available and readable - Yes	1		Code 5	Timetables available and readable - Yes	1
Code 7	Factors in choosing transport - Price	1		Code 6	Factors in choosing car - Faster	2
Code 6	Factors in choosing transport - Speed (time and speed relation)	2		Code 7	Factors in choosing transport - Time management (time and speed relation)	2
Code 8	Factors in choosing car - Cheaper price	1				
Code 9	Satisfy with public transport - Easy get to the destination by bus	1		Code 8	Satisfy with public transport - Relatively smooth in changing between bus to tram	1
				Code 9	Satisfy with public transport - Tram traveling is pleasant	1
Code 10	Frustration with using public tranport - Crowded	1		Code 10	Frustration with using public tranport - Lack of alternatives	1
Code 11	Frustration with using public tranport - Delay	1		Code 11	Frustration with using public tranport - Taking longer time than car	1
				Code 12	Frustration with using public tranport - Time waiting between changing public transport	1
				Code 13	Frustration with using public tranport - Crowded	1
Code 12	Improvement ideas for public transport - Schedule adjustment	1		Code 14	Improvement ideas for public transport - Smoothest routes	1
Code 13	Improvement ideas for public transport - Shortening the intervals	1		Code 15	Improvement ideas for public transport - Quick reaching to destination	1
Code 14	The factors influence decision in choosing public transport - Do not have to find parking space	1		Code 16	The factors influence decision in choosing public transport - Evening events	1
Code 15	The factors influence decision in choosing public transport - Large group of people	1				
Code 16	Participant awareness in different seasons affecting decision to choose public transport - Does not affect	1		Code 17	Participant awareness in different seasons affecting decision to choose public transport - Extrimely cold temperature or bad weather condition	1
				Code 18	Participant worry with the fear of less available public transport in future	1
Code 17	Encouragement for switching to public transport - Coverage and speed	1		Code 19	Encouragement for switching to public transport - Shortern the trips	

Figure 11 - Thematic analysis result table PI02 & PI03

4 User Research Results

As the individuals who responded to the English-language survey already prefer public transportation, our focus in analyzing the results will be on interviews and the Finnish-language survey. This aligns with the client's preference, as the emphasis of the study is specifically on transitioning to public transportation rather than making it more appealing to those already using it.

Based on our user research findings, several key problems associated with transitioning from private cars to public transportation have been identified. The results from our interview and survey reveal that the study participants are facing some challenges and frustrations in using public transportation. The problems were clearly presented including the inconvenience of waiting for transportation, concerns about safety due to driver behavior, overcrowding leading to discomfort or lack of seating, delays in arrival times, ineffectiveness of mobile applications for route planning, and the impact of weather conditions on the overall commuting experience.

One of the primary concerns answered by participants is the time-consuming waiting for public transportation. This can hinder individuals from using these services, especially when they are familiar with the convenience of private vehicles. Safety is another crucial factor influencing people's willingness to transition to public transportation. Instances of unsafe driving practices can negatively affect the trust issues and decisions of passengers towards public transport. Besides that, overcrowding and the lack of available seating are common problems among public transportation users. Additionally, delays in arrival times are a big problem which can significantly disrupt passengers' schedules and weaken the reliability of public transportation systems. Wintertime in Finland could bring significant impacts on people's health conditions when waiting outside without notification of the delays.

To address those issues, increasing the frequency of drivers and vehicles could significantly reduce wait times and enhance the overall efficiency of public transportation systems. Moreover, optimizing routes and schedules as well as designing smoother routes and stops to match people's demand can help distribute passenger loads more evenly across vehicles and save their time. Additionally, incorporating innovative seating designs or adjustable seats within vehicles can maximize space utilization and improve passenger comfort. Enhancing infrastructure and operational efficiency, such as improving and updating frequently real-time tracking and communication systems, can provide passengers with accurate information about service status and anticipated arrival times, thereby minimizing inconvenience caused by delays. Furthermore, implementing measures to ensure driver training and following safety processes can help mitigate these concerns, enhance the quality of trips and security of commuters.

While the mobile application plays a vital role in the effectiveness of the public transport system and experience of passengers, bad designs in usability and functionality of it are common problems that users are encountering. Considering different user groups would have

a diversity in levels of using digital platforms, preferences, physical and psychological characteristics. Hence, finding difficulties in using the application is a common problem of various users. The function of searching for routes, tracking departure and arrival time, tracking stops and buying tickets are necessary for users and it should be designed to use easily, effectively, efficiently with users' satisfaction. Improving the design of the application to provide users intuitive navigation, easy to use features, real-time updates on service disruptions, and personalized notifications regarding delays can enhance user satisfaction and facilitate seamless journey planning. In addition, it is essential to iteratively conduct usability testing and improve towards a better version.

Lastly, adverse weather conditions bring additional challenges for public transportation users. Integrating weather forecasting features into mobile applications and providing shelters or covered waiting areas at outside stops combining heating systems can offer protection from the inconvenience of weather, ensuring a more comfortable and pleasant commuting experience for passengers.

Figure 1 presents a persona of our potential users based on research.



Figure 12 - Persona of a prospective car driver switching to public transport

4.1 User Stories

As a commuter, I want shorter wait times for public transportation, so I can reach my destination more efficiently and reliably.

As a passenger, I want to feel safe during my journey, so I can trust the public transportation system and feel secure while traveling.

As a public transportation user, I want to have access to available seating and avoid overcrowding, so I can travel comfortably and without feeling cramped.

As a commuter with a busy schedule, I want public transportation to arrive on time, so I can plan my day effectively and not be late for appointments or commitments.

As a user of mobile applications for route planning, I want the application to be easy to use and provide accurate real-time information, so I can plan my journey efficiently and effectively.

As a passenger with mobility concerns, I want public transportation to be accessible and user-friendly, so I can travel without facing barriers or difficulties.

As a commuter during winter, I want shelters or covered waiting areas at stops, along with heating systems, so I can wait comfortably and safely during adverse weather conditions.

As a public transportation user, I want the drivers to be well-trained and follow safety protocols, so I can trust in the competency and professionalism of the transportation staff.

As a passenger using public transportation, I want the routes and schedules to be optimized to match demand, so I can have a smoother and more efficient commuting experience.

As a user of the mobile application, I want intuitive navigation and personalized notifications about delays or disruptions, so I can plan my journey effectively and adapt to any changes.

5 Goals for the design

Our design goals for transportation aim to make public transit a preferred and sustainable option for residents and visitors alike. We want to ensure that using public transportation is not only efficient but also enjoyable, safe, and environmentally friendly. Our first goal is to promote sustainability. We aim to encourage more people to choose public transportation over private vehicles by addressing common challenges and frustrations faced by car users. This could involve improving the frequency and reliability of public transit services, as well as making them more accessible and convenient for all demographics.

Enhancing user satisfaction is another key objective. We recognize that passengers value factors such as reduced waiting times, safety, comfort, and minimal disruptions. Therefore, our design solutions will prioritize these aspects, seeking to provide a seamless and pleasant experience for everyone using public transportation in towns and cities in Finland. Empowering users and giving them a sense of autonomy in their transportation choices is crucial. We aim to achieve this by offering improved route planning tools, real-time updates on service status, and facilitating smooth transitions between different modes of transportation. This will enable passengers to feel more in control of their journeys and confident in their decision to use public transit. Ensuring smooth transitioning from private cars to public transportation is essential for increasing adoption rates. By optimizing routes, increasing service frequency during peak hours, and providing feeder services and park-and-ride facilities, we can make the transition more appealing and convenient for commuters. Gamification will play a role in engaging passengers and encouraging continued usage of public transportation. Bonus programs and loyalty incentives can reward users for their patronage, fostering a sense of community and commitment to sustainable travel habits. Cost-effectiveness and stakeholder priorities will guide our design decisions. We will work closely with stakeholders, including users, transportation authorities, and government agencies, to develop solutions that meet budgetary constraints while aligning with the needs and preferences of all involved parties. Improving the usability and functionality of mobile applications for public transportation is paramount. Our goal is to make these apps intuitive, efficient, and informative, providing users with real-time updates on service disruptions and delays, as well as convenient payment options such as integration with Google or Apple Pay. Enhancing the passenger experience is a priority. This includes renovating stops to provide shelter, seating, and intuitive air conditioning systems. Informative LED screens and sound notifications will keep passengers informed, while more convenient payment options will streamline the boarding process.

Building positive customer relationships is essential for fostering loyalty and trust. We will explore opportunities for effective communication, personalized services, and loyalty programs to ensure that passengers feel valued and supported throughout their journey. Finally, clear design goals and documentation will be crucial for ensuring a shared understanding among team members and stakeholders. We will define specific usability and user experience goals and provide comprehensive documentation, including user flows, interaction patterns, and visual design elements, to guide the design process and ensure successful implementation of our solutions.

6 Product vision and opportunities for design

The goal is to provide users with a flexible and fast travel experience on public transportation comparable to driving, but the challenge lies in doing so cost-effectively. Therefore, we aim to develop a service concept that encourages users to transition to more sustainable modes of transportation using positive incentives.

We believe that positive incentives influence people better than negative ones. An example of this is the differing approaches of two companies in engaging employees through training. In the first company, if training costs exceed the budget, employees can seek additional funding but are required to commit to the company for a certain period by signing a contract. This may serve as a negative incentive. In the second company, employees are positively encouraged to commit to the company: they cover the surplus training costs themselves but receive refund, including travel and accommodation expenses, two years later if they are still with the company. This incentive has proven to be more effective.

Just like in the example above, we can encourage people to switch to using public transportation through negative means, such as increasing parking fees significantly and making car travel more difficult. However, there is a risk that people who use cars will switch to services that are accessible by car. Therefore, we would prefer that people transition to more sustainable modes of transportation voluntarily, making the transition more likely to be permanent.

6.1 Nudging and bonus programs

We can achieve this by offering users financial benefits for using public transportation. Bonus programs can serve as effective tools to encourage reciprocity, loyalty, and minimize customer turnover. Bonus programs are frequently found in stores across Finland like Prisma, K-Market, Lidl and Power, but they are not yet widely available in public transport services. While it's understandable to advocate for lower prices, it's important to recognize that from a psychological standpoint, price and bonuses are not equivalent, particularly when it comes to how they are perceived in terms of profitability and nurturing a committed customer base. Bonus programs can potentially promote reciprocity and cultivate positive associations between customers and brands by conveying the notion that customers are receiving valuable rewards in return. Bonus programs can incentivize new customers including ongoing engagement and repeated usage of public transportation. In addition, there is the potential for bonus programs to be gamified which can add more value and fun beyond the fundamental value of public transport services. Bonuses can be for example returned to customers as digital coupons within the app or transferred to the user's account as cash, which they can use, for example, to purchase bus tickets or at the store. In addition, travellers for example can receive bonuses for their travels. The more they travel, the higher their bonus level and greater financial benefit. However, the bonus coupons might be more enticing for the company due to the reduced necessity for customer data, such as bank credentials which can simplify the management process. In addition, integrating bonus coupons within the app can mitigate the exclusion of numerous tourists, internationals, and some residents in Finland without access to a Finnish bank account. Customers can also be

given the option to activate the bonuses within the app making boarding public transportation seamless as only scanning to the reader is necessary.

6.2 Feeder services

In addition, the efficiency of public transportation can be improved by increasing feeder services to the tram and adding park-and-ride facilities. During peak hours, buses and trams are often overcrowded, which frustrates passengers. Increasing the frequency of services during rush hours enhances the user experience. At other times, buses may run nearly empty. To make public transportation a more attractive option, buses should operate more frequently. With the current fleet, this is not cost-effective, but during off-peak hours, self-driving smaller electric buses could operate without significantly increasing costs, especially if passenger numbers increase as a result. This allows for faster and more flexible mobility for our users.

6.3 Park-and-ride facilities

Park-and-ride facilities, if strategically located, are an effective means of encouraging users to switch to public transportation mid-journey. However, they should be positioned in areas where the denser route network of self-driving buses is not feasible. This ensures that transitioning from a car to public transportation mid-journey does not significantly extend travel time, and users can avoid multiple transfers during their trip. Additionally, free, and conveniently located park-and-ride facilities are an attractive option for users.

6.4 Other possible product visions listed to consider

- Ability to add tickets into Google or Apple Pay
- More intuitive payment methods e.g. station-by-station payment methods
- Intuitive and smart notifications regarding delays and/or passenger capacity
- More LED screens at stops and/or inside public transport
- Sound and speech informing stops within public transport for better accessibility
- Renovation of furniture at stops e.g. seats and enclosed with roofs for better comfort during bad weather
- Intuitive smart air conditioning that adjusts depending on the temperature e.g. a substantial warm temperature during winter to mitigate bodily odour

7 Changes to work plan & plan for the next steps

According to valuable insights gained from our user research and analysis, several adjustments to our work plan and next steps are considered to ensure the effectiveness of our project. Firstly, it is essential to verify the feasibility, practicality, and efficiency of our proposed service concept. This requires assessing whether our ideas can be implemented effectively within the constraints of available resources and technological capabilities. Conducting further feasibility studies and consulting with relevant stakeholders will help validate the viability of our concept and identify any potential challenges or limitations.

To gather additional insights and refine our design concept ideas, we may consider conducting another survey to collect feedback from our target user group. This survey would focus specifically on gathering opinions and preferences regarding the proposed design concepts, allowing us to understand users' interest and identify areas for improvement. Additionally, employing A/B Testing methodology, particularly if we have multiple concept ideas, can help us compare and evaluate the effectiveness of different design approaches, then guiding our decision-making process. Incorporating a storyboard or journey map into our project documentation will provide a visual representation of the user experience and highlight key activities and needs throughout the service interaction. This tool will support communicating our design concepts and illustrating the intended user journey as well as providing a concrete picture for team members and stakeholders.

Furthermore, it is beneficial for the project to define clear usability and user experience (UX) goals for our design implementation. This involves determining specific goals related to ease of use, efficiency, satisfaction, and accessibility, which can be considered as a standard for evaluating the success of our design solutions. In addition, providing a detailed description of the design rationale, user flows, and interaction patterns will ensure a comprehensive understanding of the proposed user experience for the development process. Considering the importance of visual aesthetics and interface design in promoting user motivation and engagement, we will explore the possibility of including an overview of the user interface (UI) within our project documentation. This overview will present the visual elements, layout, and other UI factors of our design, providing stakeholders a picture of an intended look and feel of the final product.

In summary, by reassessing our service concept, gathering user feedback, conducting concept testing, incorporating visual illustrations, defining clear UX goals, and illustrating the UI design, we aim to refine and enhance our project quality to meet the needs and expectations of our target audience.

8 Competitor analysis & inspiration

Competitor analysis plays an important role in any industry, and particularly in the public transportation sector, it serves as a strategic tool for understanding the dynamics of the market and enhancing service delivery. By going through the strengths and weaknesses of competitors, valuable insights are obtained regarding areas that are primed for enhancement.

For instance, in examining **Matkahuolto Trips & Tickets**, it becomes evident that while the platform offers functionality, there are notable shortcomings in real-time updates, leading to inconvenience for users reliant on accurate timing information, buying separate tickets for travel within the city and for journeys to other cities. This analysis prompts considerations for inspired solutions such as intuitive unified travel pass, location-enabled tracking, bonuses and discounts to bolster user experience. While this app offers various ticketing options, there's a lack of clarity regarding unused seasonal tickets. For instance, seasonal tickets purchased for a specific time period may have restrictions on their usage based on distance, which limits their flexibility. This restriction was not clarified well in the app and website.

Matkahuolto app's **value card** allows payment for one or multiple passengers' travel expenses, deducted from the card balance based on single ticket prices. It's usable for most bus routes but not for specific services like OnniBus MEGA or local traffic in areas such as Helsinki, Tampere, and Turku. Users can check ticket eligibility through timetable searches. Considering user research and competitor analysis, we're exploring a **Unified Travel Pass** for a seamless travel experience. School children tickets have restrictive validity periods. Improved transparency and user-friendly guidelines are needed for tickets and value cards. Users want flexible purchasing options like card, NFC, and MobilePay, along with multi-use tickets. Real-time updates in the app, particularly for bus delays, need enhancement. Our solution includes intuitive disruption alerts and location features for accurate tracking. While Matkahuolto app offers discounts for various passenger groups, the lack of bonuses for regular users stands out as a significant gap.

Despite bonuses being available for specific groups such as students, military personnel, groups of three people, pensioners, and children, feedback from our usability test suggests dissatisfaction. Users feel that receiving a discount every time they use the app is redundant, as they consistently pay the same price. They propose lowering the base price to better reflect the app's benefits or introducing gamified bonuses as a potential solution.

The other apps that inspired us to consider a multi-transport application and provide mobility as a service include TFI Live (Transport For Ireland) and the Whim app by MaaS Global. TFI Live is an application and service owned by the government of Ireland which is dedicated to enhancing the accessibility and sustainability of public transport nationwide (National Transport Authority Ireland, 2023). It integrates various transportation modes,

such as buses, trams, trains, taxis and ferry services into a single platform, simplifying journey planning and ticket purchasing processes. Similarly, Helsinki's Whim app extends this concept by incorporating additional mobility services like electric scooters, car sharing, bicycle rentals (m2050 NGOMA, 2022). Unlike in Ireland, different cities in Finland maintain their own separate applications for public transportation management, such as Föli in Turku, HSL in Helsinki, and Nysse in Tampere. This fragmented approach not only inconveniences travelers but also results in inefficiencies in resource allocation and development, thereby reducing sustainability (O'Sullivan, P. J., & Patel, T., 2004). MaaS tried to unify the public transportation into a single application and offer mobility as a service (MaaS) for a subscription fee. However, this B2C business model wasn't unsustainable for the company, ultimately leading MaaS into bankruptcy in March 2024. In contrast, TFI Live doesn't charge its users a subscription fee, likely because it's government-owned and intended for public use. Since many public transport services are owned by Finnish municipalities, there is potential for the Finnish government to oversee the unification of public transportation across Finland. This could help maintain consistent ticket prices, prevent privatization and monopolization, and make public transportation more accessible to the public. The integration of public transportation services not only streamline the process of journey planning and ticket purchasing but also contributes to sustainability by reducing resource consumption and maintenance expenses.

Apps that inspired us to consider bonus programs and gamification elements include VR, Lidl, K-Market and S-Market. Lidl, in particular, stood out due to its various gamification elements, such as the Spin of Surprises and badge achievements. The Spin of Surprises rewards users with random coupons that discount certain products or, if lucky, offer something more valuable, such as free groceries. The badge achievements feature encourages users to complete certain requirements to earn a badge, which may also come with a random coupon. These features could foster engagement, anticipation, and curiosity.

The apps that inspired us to consider eco-friendly solutions include, VR's CO2 offset tracking feature and HSL's simple icons indicating which transport modes are eco-friendly. VR gamified this feature by presenting engaging visual statistics summarizing the customer's usage. The information includes the distance traveled in kilometers within a year, usage frequency, preferred routes, instances of shared rides, instances of bringing bicycles or other equipment onboard, and CO2 emissions performance.

The apps that inspired us to consider the inclusion of anthropomorphic features, comes from HSL and VR, where anthropomorphic features, such as mascot images, are incorporated to help represent the brand. Additionally, VR displays different pictures for customers as well as nicknames, indicating their frequency of use and experience.

9 Concept validation: strengths and weaknesses

Concept validation is crucial as it helps ensure that our ideas align with the needs and preferences of our target audience, allowing us to make informed decisions and prioritize resources effectively. Recognizing the importance of validating our concepts, our team has chosen to prioritize bonus programs out of all the other concepts.

This decision is based on our assumption that designing it into an application may be more feasible and that it may encourage users to utilize public transport while addressing cost-related factors associated with it. It also enables us to refrain from delving into the business model mindset or infrastructure city design, as they are beyond our expertise.

Due to time constraints, the results of the concept validation were analyzed manually, and the findings were summarized instead of undergoing the tedious process of using thematic diagrams.

9.1 Concept 1: Bonus Program – A seed for further innovation

The first concept centers on implementing bonus programs within public transport services through an integrated application we've named as **EcoTransitRewards**. This initiative aims to entice occasional users to choose public transport while enhancing its appeal to existing users. This is similar to the frequent flyer program seen on flight operators.

- **Centralized Bonus Accumulation:** Users can accumulate bonuses from all their public transportation trips within a centralized application.
- **Flexible Bonus Utilization:** Users can choose whether to use their accumulated bonuses in full or in part during payment, providing them with flexibility to optimize the use of their bonuses.
- **Direct Transfer of Bonuses to Bank Account:** Users can also transfer their bonuses directly to their bank account as cash, expanding their options for utilizing the bonuses.
- **Real-Time Travel Information:** The app can provide users with real-time information on public transportation schedules, routes, and any disruptions, helping users plan their trips efficiently.
- **Personalized Planning and Tracking:** The app can offer users personalized recommendations and tips for using sustainable transportation modes, as well as track their travel behaviour and bonus accumulation.
- **Community Engagement and Incentives:** The app may include a social element, such as the ability to share travel experiences and tips with other users, as well as provide incentives like special offers and rewards for active users.
- **Data Privacy and Security:** The app ensures the security of users' personal information and offers transparency about how data is processed and stored.

9.1.1 Oversight due to lack of participant requirements and market research

Our oversight in participant requirements and market research led to unreliable data collection during this survey, potentially failing to accurately represent the ideal target user group; car drivers. A majority of respondents expressed strong emotions and skepticism,

indicating a lack of enthusiasm for this concept. Concerns regarding privacy, potential corruption, complexity, and resource wastage were among the prominent issues raised. Additionally, factors highlighted in previous studies, such as convenience, travel time, routes, and cost, resurfaced again. Despite these challenges, potential insights were gathered from this survey that showed promising leads. For example, among the most valued features includes **Real-Time Travel Information and Centralized Bonus Accumulation**. While it suggests limited effectiveness in attracting car drivers, it enhances our understanding of the preferences and needs of both car drivers and existing users regarding public transport services. Moreover, some users have suggested **centralizing public transport services, including the implementation of a multi-pass system across different cities**. This suggestion is one that we have decided to pursue further.

9.2 Concept 2: Centralized Multi-Transport-Pass System - Possible MVP

The second concept introduces a **centralized multi-transport-pass system**, which was created based on the results of the second survey, with prior research taken into consideration. We also have identified an opportunity to enhance this concept by integrating the bonus programs proposed initially. The features include the following:

- **Unified Public Transport Pass & Various Payment Methods:** This feature aims to implement a single application that provides access to a centralized multi-transport pass in Finland. By integrating various transport operators across cities like HSL, VR, Nysse, Föli, as well as other mobility services such as bicycles, car sharing, and scooters, users can seamlessly manage their journey and access a multi-transport pass/card through a centralized application. This consolidation simplifies the ticketing process for users, eliminating the need to manage multiple apps or carry different transport cards, thus reducing resources and maintenance expenses. Additionally, the app offers various payment method features such as the ability to top up physical transport cards via NFC of smartphones, Mobilepay, card and more.
- **Efficient, Easy-To-Use, and Comprehensive Journey Planning:** This feature aims to balance simplicity and functionality, offering a streamlined user interface for seamless transportation planning. Users can navigate a straightforward interface that balances information and white space, ensuring clarity and ease of use. Within the app, users can have access to comprehensive information and tools to help them with their journey. This includes a route planner tool that offers various transportation options, including specialized mobility services, along with real-time schedule updates and an interactive map, as well as a fare calculator. Additionally, intuitive alerts for disruptions and schedule changes can be seamlessly integrated, providing users with clear guidance and compensation, facilitating smooth transfers and minimizing customer dissatisfaction and confusion. By providing comprehensive tools within an intuitive interface, the app may encourage greater adoption of public transportation, making journey planning effortless and accessible for all users.

- **Nudge-able Gamified EcoTransitRewards Program:** This feature integrates gamified bonus programs with environmental considerations, incentivizing users to utilize public transportation while promoting sustainability. Users can earn rewards, discounts, and incentives for eco-friendly commuting practices, fostering loyalty and engagement. Drawing inspiration from successful gamified bonus programs found in Föli and Lidl, interactive gamified elements that provide users with rewards could be included. A gamified CO2 tracker similar to the feature found in the VR or Föli app could be included to provide users with insights into their environmental impact as well as transportation usage. In addition, features similar to Lidl's rewards progress bar tracker could be included. Challenges and leaderboards could possibly be implemented also, alongside gamified educational content to nudge eco-friendly behaviors and encourage community engagement. By combining these features, not only does it enhance environmental consciousness, but it also encourages sustainable commuting practices and rewards users for their efforts.

9.2.1 Survey results and the adjustment of the target user and priority of objectives

To address the prior oversight, a more focused survey with specific participant criteria was crafted for this other concept. However, this adjustment inevitably shifted the target user focus from car drivers to regular public transport users. This was a deliberate decision to gain more nuanced insights into the strengths and weaknesses of this concept. Moreover, due to time constraints and lack of resources, we acknowledged the impracticality of achieving the primary client's goals, which aimed to convince car drivers to use public transport more frequently. We eventually opted to pursue the secondary objectives which is to enhance the usability, accessibility, and sustainability of public transport services.

In the second survey, many respondents, including those who don't prefer public transport for their daily routine, reacted positively towards the multi-transport-pass concept. There was notable interest in the bonus programs feature, and especially the consolidation of all transport information into one platform. Users see this concept as a potential means to ease access to information, alleviate economic burdens, and provide added value to their travel experience. Even respondents who prefer other modes of transport expressed interest in using such an application if it were available today, especially if it provides a user-friendly and intuitive interface. Therefore, this indicates that the multi-transport-pass system could be considered as a potential minimum viable product (MVP). This is due to its potential of catering to both the needs of the target users and the client's objectives of enhancing the sustainability of public transportation.

10 Prototyping the Multi-Transport-Pass System

At this point of this chapter, our chosen MVP concept, the Multi-Transport-Pass system, will be materialized. Sketches were first created on paper which were converted into medium-fidelity prototypes on Figma. With these prototypes, they helped us refine the features in more detail, enabling us to better bring and communicate the ideas to the users.

While our initial goal was to implement many of the features we mentioned, time constraints, misunderstandings, and stress limited our ability to do so, resulting in the implementation of only certain features. Additionally, there are some limitations in the prototypes; for example, the app may not fully display certain features or contain mismatching information or images.

Pictures of our prototypes and links to the Figma prototypes can be found in the appendix.

Features in the app we couldn't implement:

- Allowing users to filter and choose their preferred mode of transport
- Detailed gamification of bonuses and CO2 emissions; only a simplified version was introduced
- Top-up payment screen
- Showing earlier or later departures
- A name for our application
- Anthropomorphic features

Full description of the features we implemented:

Our app aims to make travelling easier, sustainable, and environmentally friendly throughout Finland. Users can use it to pay for short or long distance trips on various modes of transport, such as buses, trams, trains, scooters, bicycles, and more. The users can get a digital card and or a physical card with NFC functionality if they wish. Loading both travel cards is easy and can be done using various payment methods such as via card, MobilePay, bank, NFC and more.

In the app, users can plan routes from their chosen starting point to their desired destination, selecting either departure or arrival time. By default, the app automatically sets today's date and the current time as the departure time options. Once a day and time are chosen, the app displays available transportation options with schedules closest to the selected departure time. In addition to public transportation, the app always prioritizes the most environmentally friendly options at the top, such as bicycles or electric scooters. Car-sharing or renting options are also available but are presented last, as they are not the most environmentally friendly.

Users are also presented with comprehensive information about their journey, including when to begin walking to the stop/station, departure times of vehicles, transfer schedules (such as switching from bus to tram), total travel time from start to finish, the cost of the journey based on the user's passenger status type (child, student, conscript, adult, pensioner, unemployed and disabled) and the CO2 emissions associated with the journey.

Despite prioritizing speed and convenience over sustainability, users are equipped with data on the carbon footprint of each choice, promoting environmentally conscious decisions.

After users select their preferred option, they are shown the chosen route on a map, where they can also track the real-time movement of vehicles. The map also displays the walking route and time to the stop, as well as the estimated arrival time of the vehicle.

If the Unified Travel Pass does not have sufficient balance, users can either top up the card within the app or alternatively purchase a single ticket. Users always need to buy a seat ticket for the train, which they can do directly from the app. The app also notifies users if the Unified Travel Pass has enough balance to cover the bus, tram, or metro fare and encourages them to continue with the train ticket purchase.

Users can add passengers and automatically switch between offered seat options. Unused and used tickets purchased within the app can be found conveniently on the Tickets page, where users can present them to the conductor for inspection and later reference.

Users can earn bonuses for each use of public transportation. The user's bonus level increases based on their usage of public transportation. The more they use, the more they benefit. Users can convert bonuses into money for the Unified Travel Pass and use them to pay for journeys made on public transportation. Therefore, the payment is always determined based on the user's passenger status type.

11 Prototype Usability Testing: Centralized Multi-Transport-Pass System

11.1 Planning

In order to collect more data from users for the purpose of designing and developing the application, our team decided to find three volunteers to conduct the usability test. That helps us test our ideas through the application and gain insights from users for future development.

Before conducting the usability test sessions, our team planned carefully to avoid problems happening during and after the tests. Our team has one week for sketching, creating low fidelity prototypes, preparing surveys, usability test tasks, interview questionnaires and so on. Thus, we divided the week into two periods including:

1. The first half of the week was used for sketching, creating low fidelity and preparing for surveys, test tasks, interview questionnaires, informed consent.
2. The left half of the week was used for conducting the usability test sessions, collecting data, analyzing and then making the report.

These sketches and brainstorming of ideas can be found in the Appendix at the end of our report.

11.2 Usability test

11.2.1 Test procedure

As we mentioned above, the usability test will be conducted three times with three different participants. Due to the different schedule of the team members, our team decided to conduct usability test sessions both on-site and remotely. The data collected includes screen records, voice (think out loud) records and transcripts from the tests. Three usability test sessions include:

1. The first pilot usability test session was conducted on-site by the moderator – **Melina Aalto-Halme** and the participant 001 (pilot)
 - The test session took around **12 minutes** (11:53 minutes).
 - The test was conducted on a computer with Figma prototype opened.
 - The data collected:
 1. The screen interaction **without** voice recording.
 2. The notes from the moderator.

Note: Due to the technical issue, although the pilot test was recorded by the moderator with screen interacting record and voice record, the voice record was error, and the moderator cannot collect the voice record. Only screen interacting record was collected by moderator.

2. The second usability test session was conducted on-site by the moderator – **Tram Nguyen (Halsey)** and the participant 002
 - The test session took around **19 minutes** (18:37 minutes).
 - The test was conducted on a computer with Figma prototype opened.
 - The test tasks were given to users by using Mural website application (<https://app.mural.co/>).
 - The test task was split into 3 parts:

1. **Introduction and important information to the participant**; including the purpose of the test, the consent form – permission to record the test, and think aloud method (00:00 - 05:35).
 2. **Starting the test with the test tasks**; including 7 test tasks (05:35 – 15:15).
 3. **Ending the test with the after-test questionnaire**, including 9 questions related to the usability test session, the participant's experience, thoughts and feedback about the prototype the participant interacted with during the usability test session (15:15 – 18:37).
- The data collected:
 1. The screen interaction **with** voice recording.
 2. The text transcript from the record.
3. The third usability test session was conducted remotely by the moderator – **Mikaela Marie Punzalan** and the participant 003.
- The test session took around **38 minutes** (38:14 minutes).
 - The test was conducted remotely using Teams Microsoft application. The moderator shared the moderator computer screen with the participant and gave the participant the accessing right for controlling the moderator computer remotely. Both the participant and moderator interacted with prototype and test tasks by remotely control with the moderator computer.
 - The test tasks were given to users by using the Microsoft Word application. The moderator sent the test tasks one by one to the participant by copy paste directly to the Microsoft Word application.
 - The test task was split into 3 parts:
 1. **Introduction and important information to the participant**; including the purpose of the test, the consent form – permission to record the test, and think aloud method (00:00 - 06:25).
 2. **Starting the test with the test tasks**; including 8 test tasks (an extra test task was given to the participant beside the official test tasks list) (06:25 – 35:50).
 3. **Ending the test with the after-test questionnaire**, including 9 questions related to the usability test session, the participant's experience, thoughts and feedback about the prototype the participant interacted with during the usability test session (36:00 – 38:14).
 - The data collected:
 1. The screen interaction **with** voice recording.
 2. The moderator notes with comments during the usability test session.

11.2.2 Participants

The participants were selected based on diverse criteria to ensure a broad representation of user groups likely to engage with the service. The selection criteria including private car owner and not own private car people

Private car owner:

- These participants, who have driving licenses, own cars and usually use cars (maybe also use public transportation) for travelling.

Not own private car people:

- These participants, who have or do not have driving licenses, do not own cars and usually use public transportation for travelling.

Table 1 below describes the background information of the participants obtained with a questionnaire.

Table 1 - Background information of the participants

	Participant 001 (pilot)	Participant 002	Participant 003
Age group	35 - 44	25 - 34	25 - 34
Gender	Man	Man	Woman
Occupation	Full time working	Full time working	Full time student
Public transport applications have used	Nysse, Matkahuolto app, HSL	Matkahuolto app, HSL, Onnibus	Nysse, Matkahuolto app, HSL, Onnibus
How often use public transport	Monthly	Weekly	Weekly
How often use private car	Daily	Weekly	Do not have a car or license

Besides the background questionnaire, our team asked the participants a specific question in the same survey to collect the participant experience in seeing or using features of the public transport applications in Finland. By collecting data on these features, we can assess their effectiveness and popularity among our participants. This information could help us identify areas for improvement in our application to enhance its competitiveness. The answers for this question includes:

- Live tracking
- NFC cards top up payment
- Accumulating travel bonuses
- CO2 emissions tracker

Table 2 - Participant answers in seeing or using special features related to public transportation

	Participant 001 (pilot)	Participant 002	Participant 003
Live tracking	Yes	Yes	Yes
NFC cards top up payment	No	No	Yes
Accumulating travel bonuses	No	No	No
CO2 emissions tracker	No	No	No

11.2.3 Test tasks

The test tasks used in the usability test are reported in table 3. The purpose of each task is also defined.

During the test, the test tasks were given to participants from moderators, and the moderators take responsibility for recording, leading the usability test, asking questions and guiding participants (only in the case if necessary).

The time for the task was determined as beginning right after the participant finished reading the test task, and as ending right after the participant says, “The task is finished”, “The task is done” or “I complete the task”. The time calculation depends on how different participants interact, follow the test task, and interact with the prototype. The exact time for each task of different participants will be reported in the next chapter.

Table 3 - Test tasks used in the usability test

Task 1 (flow 1): Find out how much money your travel card has. The purpose of this task was to find out how the participant navigates to the spot showing travel card money amount <it's done if the user says 42.20>
Task 2 (flow 1): You're walking in Tampere, and you want to borrow a book from your favourite library. Plan a trip from your current location and select the first option from the list of public transportation options. The date is the 19th of April 2024 and you want to leave now. The purpose of this task was to find out how the participant interacts with the function of planning a trip in the prototype. <it's done if the user sees the selected bus route on the map>
Task 3 (flow 1): Tell us how many minutes you must wait for the bus at the bus stop. The purpose of this task was to find out how the participant navigates to the spot showing time (minutes) participant must wait for the bus at the bus stop. <The answer is 3 mins>
Task 4 (flow 1): You want to check what ticket you used in Helsinki last month. Find this ticket. The purpose of this task was to find out how the participant interacts with buttons and navigates to the screen showing the achieved tickets in the prototype. <it's done if the user shows the right ticket: March 2024 Helsinki AB>
Task 5 (flow 1): You're curious to know your bonus accumulation progress. Find the bonus program. The purpose of this task was to find out how the participant interacts with buttons and navigates to the screen showing the bonus accumulation progress. <it's done if the user checks their Account and points out the bonus program bar>
Task 6 (flow 1): You have thought about going to Helsinki City centre. Plan a trip from your current location and select the first option from the list of public transportation options. Also, buy a train ticket. The date is the 19th of April 2024 and you want to leave now.

The purpose of this task was to find out how the participant interacts with the function of planning a trip (planning train trip and buying ticket in advance) in the prototype.

<it's done if the user sees the notification "Payment successful">

Task 7 (flow 1): You want to know how much money is left on your travel card after buying a train ticket. Find out the card balance.

The purpose of this task was to find out how the participant navigates to the spot showing the amount of left money (card balance) on travel card after buying a train ticket.

<it's done if the user says 20.30>

Extra task

Besides the list of test tasks above, the participant 003 interacted with the prototype with one extra task:

- **Extra test task:** After visiting the Metso library, you decided to hop on a bus to return home. The bus driver asks you for a ticket, but you forgot to buy one, and you notice there is a queue behind you. The bus driver wants you to scan your travel card at the terminal. Find your travel card and show the QR code (Starting at 21:20).

11.3 Results

11.3.1 Task times and completion rates

Task times, number of problems per task and task completion are described in Table 3. The following codes are used to describe task outcomes:

- A – Task was performed successfully
- B – Moderator helped in task performance
- C – Task failed
- D – Task was suspended
- E – Task was not tested (e.g. there was no more time)

Table 4 - Task times, number of problems per task and task outcomes

Test task	Participant 001 (Pilot)			Participant 002			Participant 003		
	Task Time	Number of Problems	Task Outcome	Task Time	Number of Problems	Task Outcome	Task Time	Number of Problems	Task Outcome
Task 1 (flow 1)	0:06	0	A	0:20	0	A	0:05	0	A
Task 2 (flow 1)	1:33	0	A	1:15	1	A	2:45	2	B
Task 3 (flow 1)	1:47	1	B	2:35	2	C	5:30	2	C
Task 4 (flow 1)	0:28	0	A	0:30	0	A	0:35	0	A

Task 5 (flow 1)	0:15	0	A	0:20	0	A	0:30	0	A
Task 6 (flow 2)	2:25	1	A	1:40	0	A	3:05	1	A
Task 7 (flow 2)	0:14	0	A	0:10	0	A	0:15	0	A
Extra tasks							(21:20 - 23:00) 1:40	0	A

Participant 001 (Pilot)

As we mentioned above, due to the technical issue, the data collected are only screen interaction record and notes from the moderator. Although that data is still possible for analyzing, the screen interaction record is not enough for understanding the participant's thoughts with think aloud method (participant thinking, considering, and giving decision) and the way how the participant interacted with the prototype. Consequently, the task time, number of problems and task outcome are filled in table 3 based on the notes provided by the moderator of the pilot usability test session.

Through the report, the moderator of the pilot test discovered that the usability test tasks should be improved before the next usability test sessions. The moderator updated the test tasks based on the pilot test result she monitored.

Besides, based on the notes provided by the moderator, the pilot usability test can provide the insights to the report including:

- **Task number 3**

The moderator said in the note that *"Everything else went smoothly but there was a bit of difficulty in telling how long time the user must wait the bus at the bus stop. He said 8 min at first. Then I said it was not correct and finally he offered the right answer."*, it could be considered that the participant 001 got confused with the information shown in the prototype and answered wrongly. After the moderator said it was the wrong answer, the participant 001 gave the correct answer.

- **Task number 6**

The moderator mentioned that the participant 001 tried to change the seat when buying the train ticket and then commented that nothing happened. The moderator answered that the feature of changing the seat is not implemented and that is why our team did not ask the participants to change the seat through the usability test tasks.

The participant commented that in that case, the button should not exist. However, the button is important from the point of view of the application and the moderator provided two solutions:

1. Either inform the participant in the task that he accepts the offered seat.
2. Our team implements an error page that says, "work in the process".

Participant 002

The usability test session was conducted well without any technical issue or specific problems from the moderator's side.

Success rate: 86% with 6 completed test tasks in total of 7 test tasks.

During the usability test session, the participant 002 interacted well with the prototype. However, there are still some problems with task number 2 and 3.

- **Task number 2 (06:20 – 08:00)**

(07:30) - Right after reading the test task, the participant 002 followed the test task to choose departure location with **“Hevoshaankatu 2, Tampere”** and destination location with **“Main library Metso”**. Instead of continuing to click to choose **“Date”** and **“Time”**, the participant 002 got confused with the list of public transport options.

Participant 002 said: *“I don’t see the list of the public transportation here”*.

However, the confusion did not last too long, the participant 002 realized that he needed to click to the **“Date”** to choose the information of date first. Then the participant 002 finished the task smoothly.

Generally, this problem happened due to the usability test task, belonging to the mistake in creating usability test task of our team. According to usability test task 2: “You're walking in Tampere, and you want to borrow a book from your favorite library. Plan a trip from your current location and select the first option from the list of public transportation options. The date is the 19th of April 2024, and you want to leave now”, the participant 002 got confused due to the sentence “plan a trip from your current location and select the first option from the list of public transportation options”. Participant 002 followed the sentence closely, then the participant 002 expected to see the options from the list of public transportation right after choosing the locations.

Finally, based on the deficiency in creating and checking usability test tasks to avoid wrong meaning in using sentence, the participant’s confusion pointed out the problem from the test tasks and allow us to monitor and modify the test tasks more careful before the next usability test task sessions.

- **Task number 3 (08:10 – 10:35)**

(09:00) - After calculating for a while in the screen “your route”, the participant 002 got confused with the number of 34 (minutes).

Participant 002 said: *“So... 34 minutes is the duration of the whole trip, not just the walking. I saw 34 minutes here, so I thought it belongs to the walking”*.

Based on the sentence the participant 002 said, the participant 002 thought that the number of 34 minutes belongs to the walking time. The number of 34 minutes confused the participant 002 due to its position designed right below the walking icon. However, although the participant 002 realized his misunderstanding with the number of 34 minutes, the participant 002 still could not finish the task number 3 by giving the wrong answer.

(9:57) - Moreover, the participant 002 got confused because the time (number) showing in "your route" screen does not match with the time showing right after the participant 002 clicked to "leave now" button in the beginning screen. The participant 002 said: *"Yeah, but I think it's not clear because I said I will leave now, and I'm not sure if this one is the time that I set before 36?"*.

It is obvious that the design positions and design elements in the "route screen" confused the participant 002 leading the participant's misunderstanding in determined the information. This data pointed out the potential problems allowing our team to pay attention to and change the design layout and the designed element positions in the next step of development.

Participant 003

The usability test session was conducted well without any technical issue or specific problems from the moderator's side.

Success rate: 87,5% with 7 completed test tasks in total of 8 test tasks.

During the usability test session, the participant 003 interacted well with the prototype. However, there are still some problems with task number 2, 3 and task number 6 (flow 2)

- **Task number 2** (08:30 – 11:15)

(10:25) - (User preference found | Incomplete feature) The participant 003 prefers to click on "Leave Now" button instead of pressing the calendar icon and then pressing "Leave Now" button. Participant 003 thinks if she presses "Leave Now" button, it should show both the current date and time and not just the time, then the participant does not need to choose the date (*"it makes sense in real life"* – the participant 003 said). Participant 003 got confused with the button "Leave Now".

(10:45) - (Task description issue + user perspective found) Participant 003 found the test task description for Task 2 confusing. It should have been specified that the participants must select the "second option" because the first option in the routes list shows a bicycle, which has no function at all. The second option displays Bus 28, which does have a function in the prototype. Despite the task stating to select from the list of public transportation, it is important to note that the participant 003 also considered the bicycle as a mode of public transport as she mentioned; what if she could rent it and the tasks didn't tell her if she must choose the bus.

In this situation, it could be considered that there is nothing wrong exactly with the prototype because the prototype could not provide all the functions or the flows the application has. The way participant 003 mentioned bicycle as public transport is correct but due to the time limitation in sketching and designing phases, that function has not been designed to give the exact flows or screens to the participants for interacting.

Although, that bicycle information caused confusion to the participant, it is still valid to show that information in the prototype because it provides participants with the overall idea and design of the application which aims to whole system of public transportation (including bus, train, tram, bicycle and so on.)

- **Task number 3** (13:40 – 19:00)

(14:18 – 18:00) - (User preference found) Participant 003 was informed that the top bar showing the time is static. Participant 003 seems to prefer to look at the clock to help her calculate how much time she must wait for the bus to arrive.

Besides, participant 003 found the waiting time shown on the interactive map confusing. This is also due to the incorrect schedule presented for Bus 28. For example, participant 003 wants to leave at 8:36, but the walking time to the bus stop starts at 8:54. That information showing in the prototype caused confusion to participant 003 as the participant 003 asked what is the number 8:54 in the prototype. Participant 003 also said she was confused with the information of 8:54 and 34 minutes. She thought that information represents the time going to the bus stop.

Moreover, participant 003 also tried to click on earlier departures, indicating she would prefer to find a route that will depart closest to the current time.

- **Task number 6 (23:50 – 27:00)**

(24:50) - Participant 003 got some misunderstanding regarding the “Leave Now” time, but the participant quickly understood afterwards that the task for Flow 1 and 2 are similar, but the goals are different. Besides, the participant 003 also got confused with the time in the “searching results” screen.

In this situation, we can consider this problem in 2 different scenarios including:

1. Participant is trying to buy train ticket at the moment she wants to travel (buying ticket then using them for travel immediately): This makes sense to add the button “Leave Now” because it provides the shortcut to the participant, she does not need to choose what exact time at the moment she is trying to buy ticket.

However, in this situation, the application requests participant to input the information of “Date” could be considered as being redundant. Because when the participant provides the information of time as leaving now, it does mean that she wants to leave now and the request of inputting the date information is not necessary.

2. Participant is trying to buy train ticket departing on the date of 19.04.2024 (buying in advance and then using them later): This does not make sense to add the button “Leave Now” because the time should be requested to input manually or choosing time options from drop-down menus.

In this situation, the button “Leave Now” could be considered as being redundant and not necessary button if the participant wants to buy ticket for future use. Even worse if the button “Leave Now” appearing in this situation caused confusion to the participant and has ability to cause system conflict in the ticket buying system (for example, choosing to buy ticket for next Monday but accidentally clicking to the “Leave Now” button).

Sum up:

Through the usability test sessions, our team collected various valuable feedback, participant’s insight, and the error spots pointed out by the participants. Based on table 3 and analysis above, the problems mainly happened during the usability test task number 2, 3 and 6 (flow 2). It does mean that the button “Leave Now”, time suggestion system, designed

element positions in the prototype still need to be optimized for users to use comfortably in the real situation.

Those collected data is valuable for our team to analyze and understand. Then based on the analyzed data, we can optimize, modify the prototype and continue to develop the application following the criteria we mentioned in the application concept chapter.

11.3.2 After-test questionnaire results

After the test, our moderators asked the participants to fill in the after-test questionnaire (survey) to collect participant's experience, thoughts, insights and feedback related to the interaction between the participant and prototype during the usability test session.

Our survey shows that the prototype is easy to use as well as it is easy for the participant to find the way around the application. However, one of the participants mentioned that there is too much information on a small screen, and some numbers the participant did not understand. That matches exactly with the confusion during the usability test when the participants got confused with the time and numbers shown in the prototype.

On the other hand, the results collected provide us with good insight showing that the participants' thoughts are positive in getting discounts each time using the application and being able to track the CO2 emissions.

Participant 002: *"it encourages me to use more"*.

Participant 001: *"It would be also good to know how much money has been spent on an early basis and how much money and emissions has been saved"*.

Table 5 below shows the data we collected through 9 questions related to the usability test sessions, prototype and the participants' feedback & insight.

Table 5 - After-test questionnaire result

Question	Participant 001 (Pilot)	Participant 002	Participant 003
1. On a scale from 1-5, how easy was it for you to find your way around the application?	4	4	5
2. Is it easy to find your way around the menus and navigate through them?	Yes	Yes	Yes
3. What do you think about the design of the user interface?	Easy and simple to use	It has too much information in a small screen, some numbers I didn't understand the meaning	I think it is easy to use, and it has all the basic functions of a transportation APP.

4. How do you perceive the clarity of visual cues in guiding you to various features, such as arrival and departure information?	Neutral	Easy	Easy
5. On a scale of 1-5, how would you rate the responsiveness of the application overall?	4	4	4
6. Do you like the easy pay option in the application (NFC payments, MobilePay) ?	Yes	Maybe	Yes
7. How do you feel about the idea of getting discounts each time you use the application, while also being able to track your CO2 emissions?	It is a good idea. It would be also good to know how much money has been spent on an early basis and how much money and emissions has been saved	I like it, it encourages me to use more	If I'm receiving discounts every time, it almost feels like discounts are just the norm and not really special anymore. As for tracking CO2 emissions, I struggle to see its immediate impact or relevance in my daily life.
8. What are your thoughts on earning bonuses through the application while using public transportation?	See the previous answer	same as the discount features	It is a good way to encourage people to use public transportation more often, and I'm intrigued about the potential rewards I could earn through accruing bonuses.
9. If any, what additional features, feedback or suggestions would you like to see in the application?	Ideas given in the answer nro 7	not atm	Incomplete prototype implementations confuse me sometimes.

11.3.3 Iteration of the prototype

Here are some of the screens that were iterated based on the user feedback after the usability test:

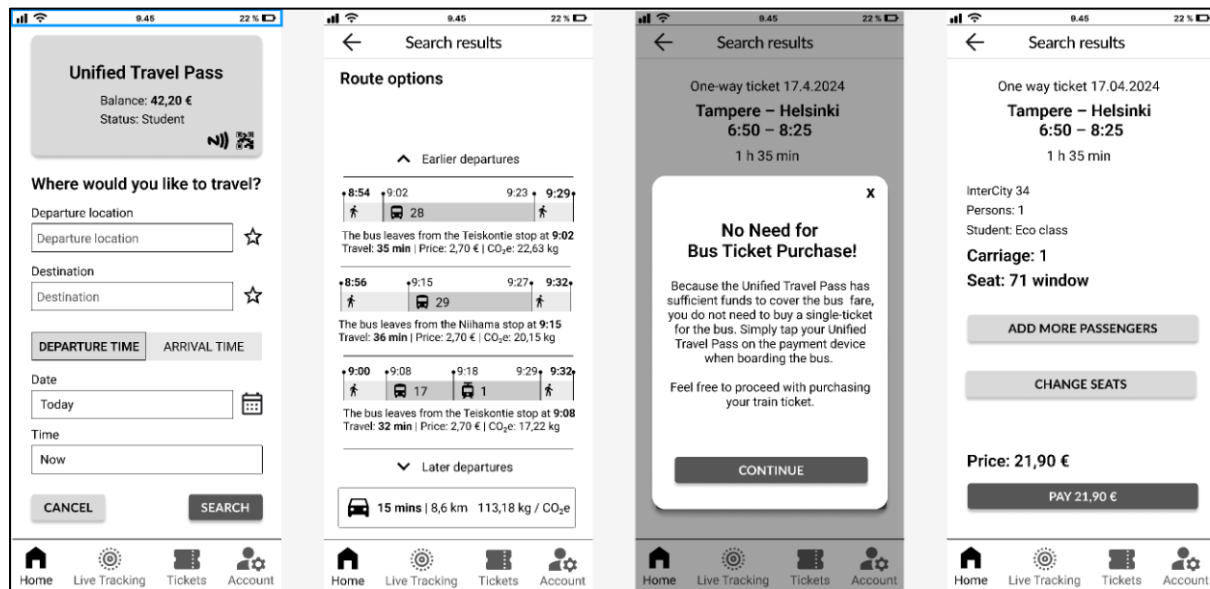


Figure 13 - Iteration of trip planning and payment details

12 Challenges and ideas for the future

Issues we faced:

During our project, we have faced several constraints that affected the progress and outcomes of our project. The complex nature of our topic, combining with tight time constraints, creates challenges beyond our expertise zone in Human-Technology Interaction (HTI) while the topic needs long-term research and implementation. This led to oversights and confusion, especially in our process of creating effective prototypes within the given timeframe. Our prototypes, though valuable in concept, revealed limitations during usability testing, often causing distraction and requiring extra guidance for users. Moreover, identifying suitable participants proved challenging due to the complexity of our target groups. In addition, aligning service concepts with user needs and client goals was a delicate task, requiring us to stay within our expertise while addressing all relevant concerns. These challenges highlighted the complexity of HCD and provided valuable insights for future projects. Lastly, due to the nature of the project, different phases we have gone through following the human-centered design methods and our target of giving details of process and outcomes to our client, we cannot avoid this over required pages report.

Ideas for the future:

From the future perspective in our app development journey, there were several features that we couldn't implement due to time constraints, but we envision incorporating them in the future to enhance user experience and engagement. One of these features is the ability for users to filter and select their preferred mode of transportation within the app. By allowing users to choose from various transportation options, such as public transit, biking, or ridesharing, we empower them to make informed decisions based on their preferences and needs. Additionally, we plan to implement detailed gamification elements to incentivize and reward users for choosing public transportation. By integrating gamified bonuses, such as points, badges, or rewards, users can be encouraged to opt for eco-friendly modes of transportation, thus contributing to the reduction of carbon emissions. This gamification approach not only promotes sustainable travel habits but also makes the user experience more enjoyable and interactive.

We aimed to incorporate gamification features into the tracking of CO2 emissions. By visualizing users' carbon footprint and providing insights into their environmental impact, we can motivate them to make greener choices and track their progress over time. Through gamified challenges, achievements, and leaderboards, users can compete with friends or community members to reduce their carbon footprint and contribute to a more sustainable future. Another planned feature is the inclusion of a top-up payment screen within the app for added convenience during public transportation use. This feature allows users to easily manage their fares and access information about earlier or later departures, enhancing the

overall usability and efficiency of the app. We recognize the importance of branding and naming our app to create a memorable and distinctive identity. A catchy and meaningful app name can resonate with users and make our app more recognizable in the market.

Finally, one of the most significant aspects we aim to explore is the integration of anthropomorphic features into our app design. Anthropomorphism, the attribution of human characteristics to non-human entities, can significantly enhance user engagement and satisfaction. By incorporating friendly and relatable elements, such as chatbots with human-like qualities or app icons with emotional appeal, we create a more immersive and enjoyable user experience. Drawing inspiration from successful implementations like Föli, we plan to delve deeper into gamified bonus programs and CO2 emissions tracking to design innovative and impactful features for our app. By leveraging gamification and anthropomorphic design, we aim to create a user-centric platform that not only promotes sustainable transportation but also fosters a sense of connection and enjoyment for our users.

13 Appendix

13.1 Initial user research gathering

PS01 = Participant Survey 01, **PI01** = Participant Interview 01

Pilot interview: [PI01 \(results view\)](#)

Main interview: [PS06 - PS07 \(results view\)](#)

(Finnish) public transport experience survey 1: [PS01 - PS05 \(results view\)](#)

(English) public transport experience survey 2: [PI02 - PI03 \(results view\)](#)

[Excel - Thematic analysis - interview responses](#)

[Excel - Thematic analysis - survey responses](#)

[Excel - Affinity diagrams - survey and interviews responses](#)

[PDF Version - surveys and interviews responses](#)

13.2 Concept validation research

Bonus Programs: [Concept Survey Validation 1 \(results view\)](#)

Multi-Transport-Pass System: [Concept Survey Validation 2 \(results view\)](#)

13.3 Prototype usability test

[Consent form and background questionnaire for the usability test \(results view\)](#)

[After the usability test tasks survey \(results view\)](#)

13.4 Sketches and Figma Prototypes

[Link to Figma Prototypes \(user view\)](#)

[Link to Figma Prototypes \(edit view\)](#)

Sketches: Trip Planning, Live Tracking and Bonuses

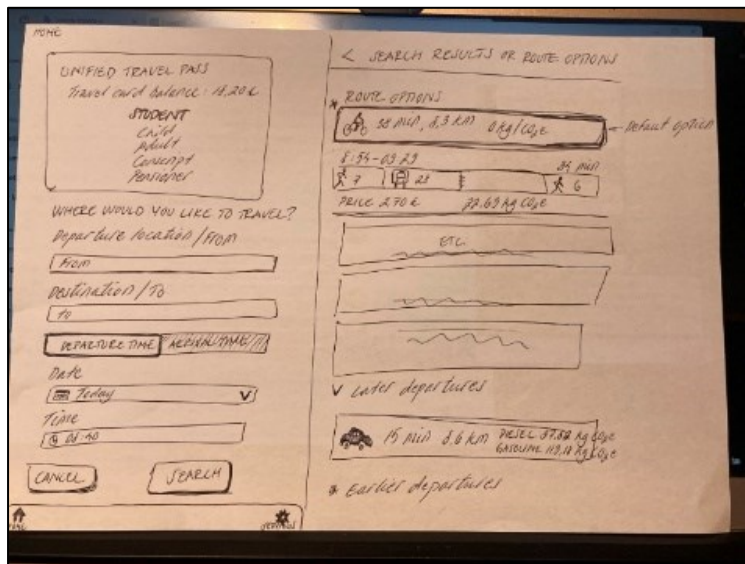


Figure 14 - Sketch 1: Trip Planning



Figure 15 - Sketch 2: Live Tracking

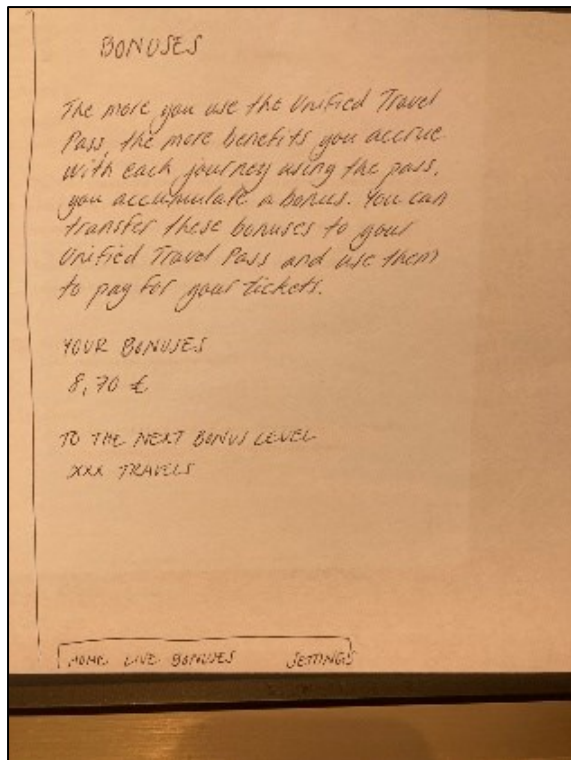


Figure 16 - Sketch 3: Bonus Program

Trip Planning and Routes Selection for short and long distance trips

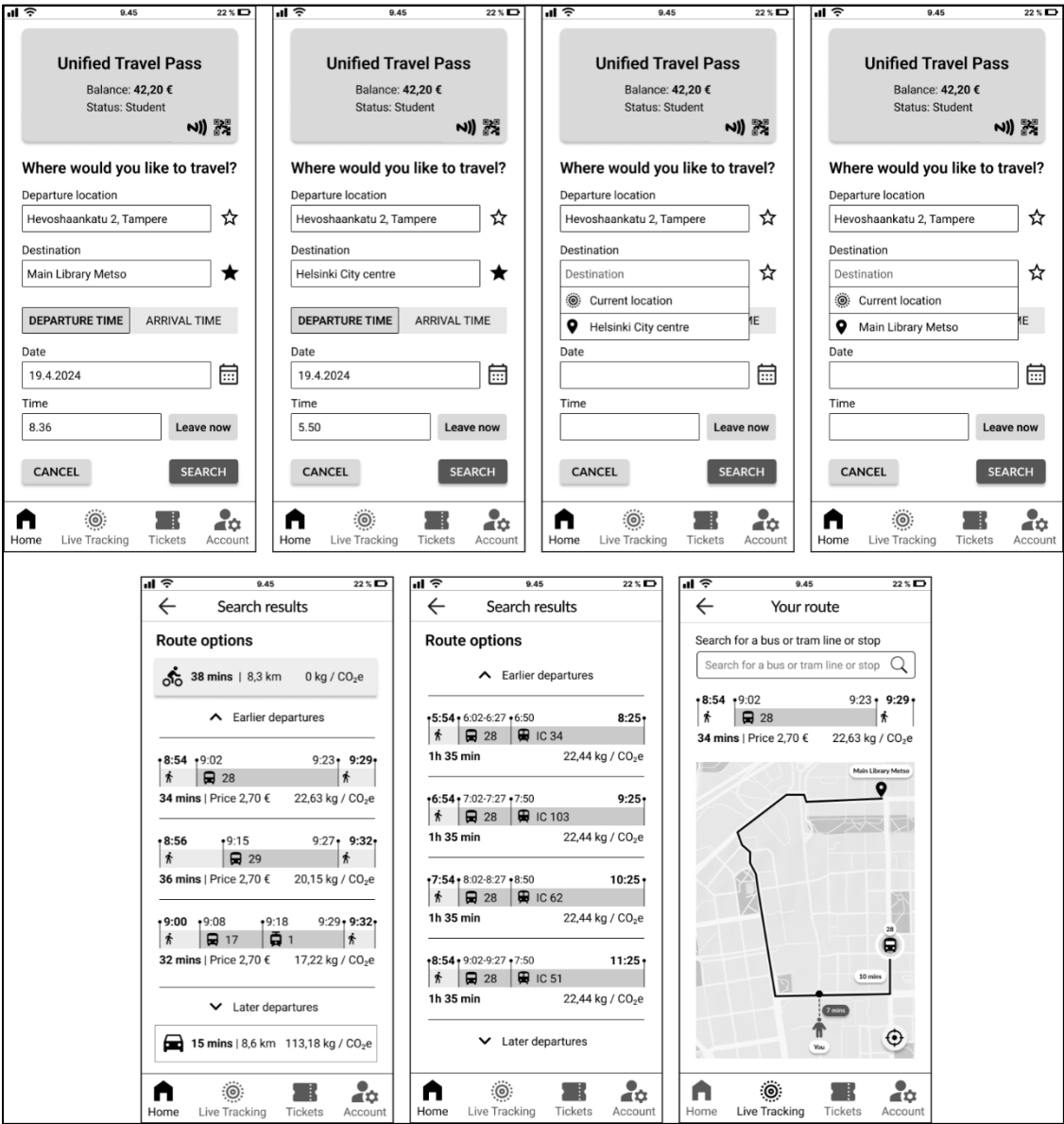


Figure 17 - Figma prototypes for trip planning and live tracking

Paying for single-tickets for short and long distance trips, travel card QR code, viewing the tickets and the bonus programs screens

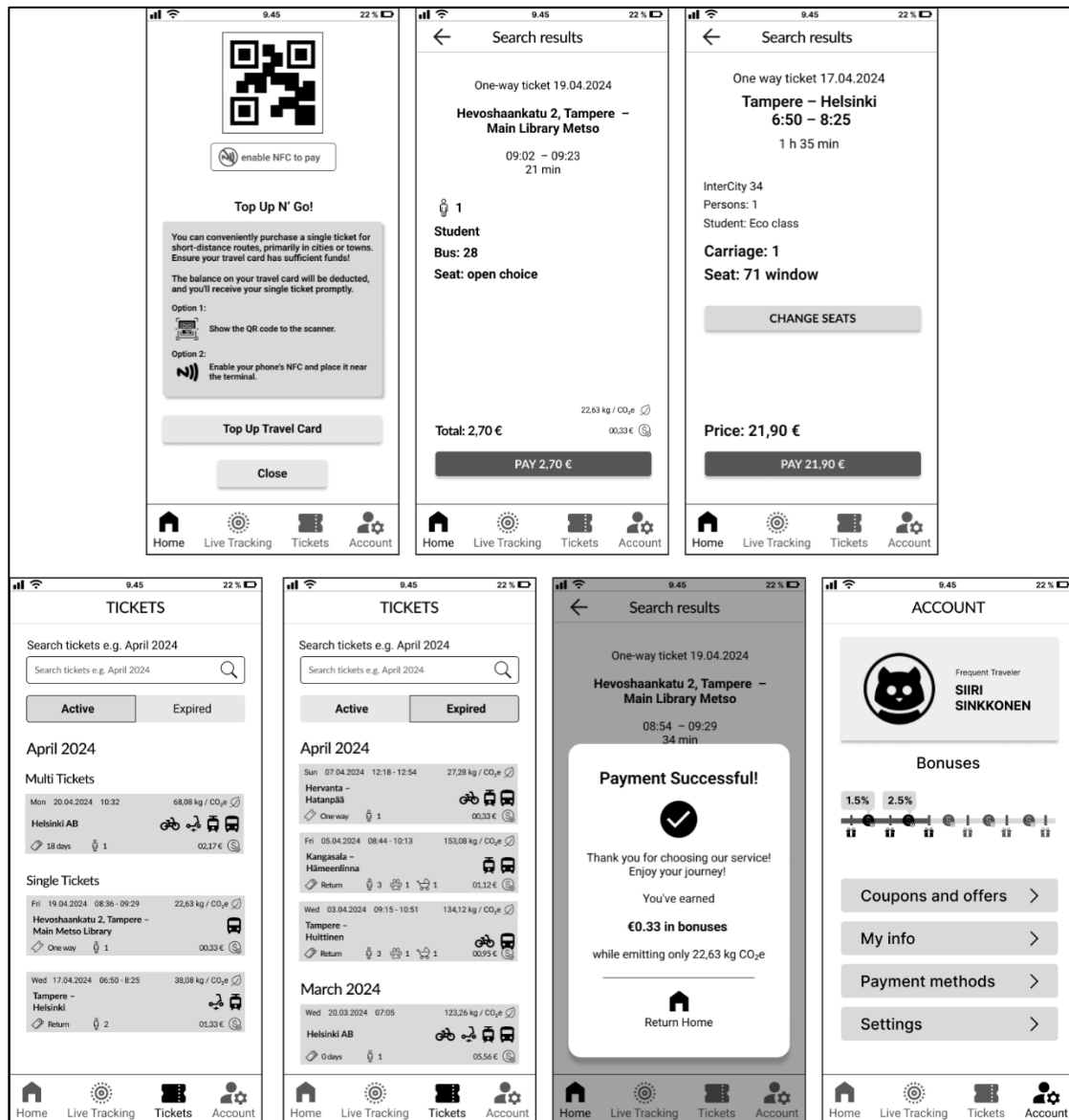


Figure 18 - Figma prototypes for paying single tickets, viewing the tickets and the bonus programs

14 References

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