The preferences of end-users and service providers towards the functionalities of a mobility as a service platform

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Master Thesis

The Preferences of End-Users and Service Providers towards the Functionalities of a Mobility as a Service Platform

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Acknowledgements

For this master thesis is set out to investigate the preference of end-users and service providers towards the functionalities of mobility as a service platform. In researching the existing literature, the researcher found out that there was little research done in this area even though this information would be useful when developing a mobility as a service platform.

During the duration of my master thesis, I have been fortunate enough to have the help of my two supervisors from the Eindhoven University of Technology, Alexia Athanasopoulou and Oktay Türetken. They helped me by given advice on how to best proceed and by given feedback on the work that I had produced. I would like to express my gratitude towards them for their guidance.

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Tom Deijkers

Abstract

Mobility has changed in the last couple of years. Mobility is changing from private vehicles and public transportation to ride, bike and car sharing. Mobility as a service (MaaS) is a new concept. MaaS has the goal of giving travellers have access to all transportation modes in one website or app.

However, there is little research done into the preference of the end-users and the service providers of MaaS towards the functionalities of MaaS. The service providers consist of both the mobility service providers and the enhancing service providers, like parking lots, insurance providers, et cetera.: The research objective of this research is to identify which functional requirements and non-functional requirements are preferred by the end-users and the service providers for a mobility as a service platform.

By examining literature and existing MaaS application a list of functionalities is created for both the end-users and the service providers. The functionalities on these lists are divided into different categories. For the end-user these categories are: “Planning, Personalization, Payment, Booking, Ticketing, Social Media, Assistance, Ratings, Enhancing Services and Non-Functional”. For the service providers the categories are: “Transportation, Analysis, Other Services, Other Features and Non-Functional”.

Two surveys are then conducted, one for the end-users and one for the service providers, to evaluate the lists. The conclusion is that the more standard functionalities of a MaaS platform are deemed the most important by the end-users, such as the functionalities in the category Planning. While the functionalities that have to do with social media are deemed unnecessary for a MaaS application. For the service providers, only the functionalities related to the environmental impact are deemed not important to have in a MaaS platform. The other functionalities suggested in the list are almost never deemed extremely important, but are almost always considered important. A comparison between the frequent and infrequent travellers revealed that functionalities that would make day trips more comfortable would be a better addition to a MaaS platform for the infrequent travellers than the frequent travellers.

Keywords:

Mobility as a Service, MaaS, Preferences, End-Users, Travellers, Service Providers

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1. Introduction

1.1 Background

In recent years mobility has started to change. From mostly consisting of the use of private vehicles or public transportation towards a future with ride, bike and car sharing. The introduction of these new mobility options led to a situation in which different applications needed to be used to have access to all transportation modes. So, you would have one application for ride sharing and another application for public transportation. Switching between these different applications and their different layouts can be confusing for users. A new concept of mobility as a service (MaaS) is introduced to have access to all transportation modes in one application. Meaning that one website or app would give you access to several transportation modes.

In order to better understand MaaS a definition has to be introduced. Mobility as a service is defined as: "*Mobility as a Service (MaaS) is the integration of, and access to, different transport services (such as public transport, ride-sharing, car-sharing, bike-sharing, scooter-sharing, taxi, car rental, ride-hailing and so on) in one single digital mobility offer, with active mobility and an efficient public transport system as its basis.*" (Cerfontaine, 2019). Figure 1 (Cerfontaine, 2019) provides a visual picture of the way MaaS works compared to the system it will replace. In Figure 1, the current situation shows that the users have to pay for each transportation mode separately, while in the MaaS model situation the user can access all transportation modes through one application.

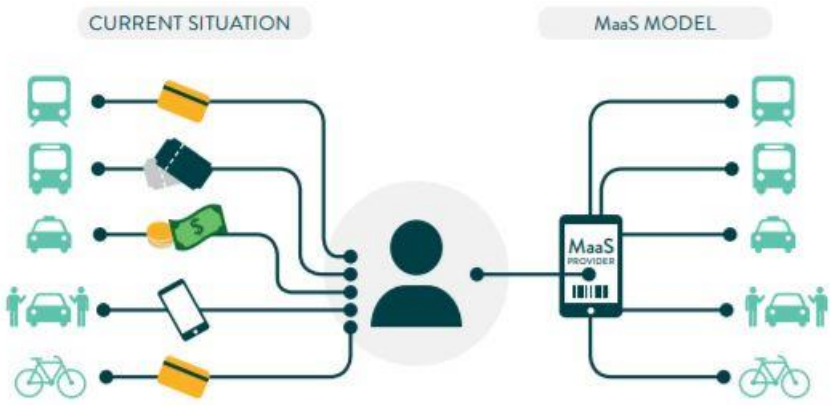


Figure 1: Mobility as a Service

Since MaaS already exists in the real-world examples can be found, like UbiGo and the Whim App. The Whim App is a MaaS application from a Finnish company. There transportation modes include public transportation, bikes, scooters, taxis, and cars ("WhimApp Service and Support," 2020). UbiGo on the other hand started as a scientific MaaS research (Holmberg, Collado, Sarasini, & Williander, 2016). However, UbiGo continued as a commercial project after the trail period was over.

1.2 Research Gap

The Economic Commission for Europe (2020) discussed the different parties that are involved with the MaaS platform. The European travellers (end-users), the public authorities (city, state government or public transport authorities), the mobility service providers and the enhancing service providers are the parties involved with the MaaS platform. However, MaaS is a relatively new concept. Therefore, there are not a lot of real-life examples of MaaS platforms to use as a reference when building a MaaS platform and deciding which functions to give the MaaS platform. There is also, to the best of my knowledge, little research done into the preferences that consumers or service providers have towards the functionalities that are required for the MaaS platform, as will be discussed later in the thesis. Therefore, the focus of this study is to find the functional requirements and non-functional requirements that are preferred by both end-users and service providers. However, during the course of this research another thesis was found that did look into the basic functionalities of MaaS for end-users. The study of Den Boer (2020) looked into the preferences regarding functionalities in the categories: "planning, ticketing, booking and payment". A MaaS platform can have functionalities that do not fall into the four categories that are mentioned above. Therefore, it would still be useful to look into the preferences of end-users regarding functionalities of a MaaS platform if the categories, "planning, ticketing, booking and payment", are examined as well as more enhancing functionalities. The study of Den Boer (2020) does not cover the preferences of service providers, so that part of the research would, to the best of my knowledge, still be completely new.

The research should result in two lists of preferred functionalities, one for the end-users and one for the service providers. The service providers referred to in the previous sentence are both the mobility service providers and the enhancing service providers, like parking lots, insurance providers, et cetera. The information that can be found will be discussed in the next

paragraph. The preferences might make it easier to convince consumers to use your application if the MaaS platform meets their preferences. The same goes for the service providers. If their demands for a MaaS platform are not met and they are not able to find the information they need, they might be hesitant to join the MaaS platform. If the service providers do not join the central MaaS platform, they would probably still have a MaaS platform for only their own transportation mode. In this scenario, they would still be different applications for the different transportation modes. As a result, the end-user would still need different applications to meet their mobility demands. Which means that the goal of the introduction of a MaaS platform, getting all transportation modes and other services into one application to make the mobility process easier for the end-user, is not reached.

As seen in the definition of MaaS, all services are offered in one single digital mobility application. This means that there is one platform that provides the consumer with everything that they might need. Research from Jittrapirom et al, (2017) did look into the functionalities that exist with real-life MaaS initiatives. The functionalities of twelve real-life MaaS initiatives, from both public and private sector, were listed. The functionalities of the MaaS platform, range from real time information to customization options. However, Jittrapirom et al, (2017) do not look at which functionalities are preferred. Jittrapirom et al, (2017) do recommend future research and say that the addition of other attribution, like features that can influence travel decisions, inclusion of other services and mobility currency can possibly enhance the proposed framework. However, that would require extra research not done by Jittrapirom et al, (2017). Caiati, Rasouli and Timmermans (2019) investigated the intention to subscribe to MaaS and preferences for bundle configurations, and the willingness to pay for extra features of the service. However, these features are more focussed on the different transportation modes and how much you can use these transportation modes in a subscription than on the functionalities of the MaaS platform. Furthermore, Caiati, Feneri, Jittrapirom, Rasouli and Timmermans (2020) focusses on the differences between people in various age groups and life stages, and the different choices they make regarding the potential use of MaaS. This paper was more focussed on the transportation services that where provided and less on the functional requirements. Díaz, Pozo, González, Wilby, and Sánchez Ávila (2020) focus on clustering of bikes when redistributing them amongst the bike sharing locations. This would be an interesting functionality for the bike sharing company that participates with the MaaS platform. However, they only discuss one possible functionality and not several functionalities and the preferences of the service providers. Based on the research that is

currently available, see references above, a research gap exists. Since there is, to the best of my knowledge, little information about which functional and non-functional requirements are preferred by both end-users and service providers. The information that is available is just on the basic functionalities of a MaaS platform, like the four categories mentioned by Den Boer (2020). These basic functionalities do not include all functionalities a MaaS platform can have as will be shown in Chapter 2. And without this information it is difficult to make a MaaS platform that consumers and service providers want to use.

1.3 Research Objective

The research gap was discussed in the previous paragraphs. The preference regarding the functionalities of a MaaS platform are, to the best of my knowledge, not known, besides some basic functionalities of a MaaS platform. Hence, aim is to identify the preferred functionalities of a MaaS platform and to fill the research gap discussed in the previous section. This results in the research objective of this research that is presented below.

To identify which functional requirements and non-functional requirements are preferred by the end-users and the service providers for a mobility as a service platform

The decision was made to look at end-users and service providers, because end-users and service providers play a big role in making the MaaS platform successful. The end-users by using the MaaS platform and giving the providers enough customers to be profitable. The service providers by making their services available through the MaaS platform and giving the end-users access to all services. The service providers referred to in the previous sentence are both the mobility service providers and the enhancing service providers, like parking lots, insurance providers, et cetera. Kujala (2003) explains why user involvement is a good thing for the system. First, the user requirements for the system are more accurate. Secondly, there are costs that can be avoided by not adding functionalities that users do not want. Thirdly, users are more likely to accept the system. Lastly, the user will have a greater understanding of the system. Therefore, the decision is made to involve the users of the MaaS platform, both end-users and service providers, in the process of developing the MaaS platform. However, the functionalities that are required to use the MaaS platform, are not all the same for end-users and service providers as will be shown later in this research. Some of these functionalities might not be able to be present in the same platform. Therefore, it is needed to

look at both end-users and service providers. The next section will describe the steps that are necessary to reach the research objective.

1.4 Approach of the Project and Scope

Following the design science research (DSR) method (Peffers et al., 2006), an artifact will be developed. According to Hevner et al. (2004) IT-artifact can be one of four possible definitions. The IT artifact is a construct, model, method or instantiation. Based on the objective of this research the best description of the artifact that will be develop in this research is a model. This artifact is a list of preferred functionalities of a MaaS platform for both the end-users and the service providers. Previously, this researcher preformed a literature review on MaaS in general. This literature review is the starting point of this research. Based on this literature review and conversations with supervisors, a problem with MaaS was identified. This problem being that there is little research done into the preferred functionalities of the different stakeholders involved with MaaS, at least regarding the functionalities of the MaaS platform, see section 1.2. After this problem was understood a research gap is identified. More details on the research gap can be found in the previous section. After the research gap is identified and before the list of functionalities is created the properties of the artifact have to be determined. A detailed description of these properties can be found in Chapter 3. The initial list of functionalities that can be used for a MaaS platform will be created by reviewing the literature that is available regarding functionalities of a MaaS platform and examining real-life MaaS initiatives. This list can be used as a starting point in determining the preferred functionalities of the different parties and with this completing the research objective. In order to determine which functionalities are preferred by the end-users and the service providers a survey will be conducted. This survey will be in the form of a Likert-scale and will be held amongst potential end-users and service providers. However, the survey will be different for the parties, since there are different functionalities needed to make the platform work for the end-users and the service providers. The results of this survey will be used to evaluate the list of the preferred functionalities of a MaaS platform for both the end-users and the service providers, called the design artifact. The results of the survey will tell whether a functionality is actually preferred by the stakeholders by showing how important each functionality is according to the stakeholders. The list will be used as the basis for a survey amongst end-users and service providers.

The scope of this master thesis includes both the end-users and the service providers, as can be seen in the research question. The service providers being the mobility service providers and the enhanced service providers, like parking lots, insurance providers, et cetera. Both parties are included since both parties will use the MaaS platform. Since both parties will benefit from the MaaS platform it would be interesting to research both preferences. Having the preferences of both parties will make sure that the MaaS platform is not tailormade for one party, while the other party cannot use the MaaS platform in a way that fits them. The scope includes both the functional requirements and the non-functional requirements. The difference lies in the functional requirements indicating what the MaaS platform should do, while the non-functional requirements indicate how the MaaS platform should operate (Milani, 2019). While the functional requirements are unique to the MaaS platform, the non-functional requirements are more general for all platforms. This can be seen in more detail in Chapter 2.

1.5 Thesis Outline

This master thesis will show which functional requirements are preferred by both the end-users and the service providers for a MaaS platform by answering the research question and the sub questions. Chapter 2 will describe the literature review that was carried out on functionalities of MaaS platform as well as the functionalities of real-life MaaS initiatives. Subsequently in Chapter 3, the research design of the thesis will be explained following the DSR method. Afterwards, Chapter 4 will provide an overview off the functionalities that were found using the method discussed in Chapter 3 and the information collected in Chapter 2. Chapter 5 will show the evaluation of the functionalities described in the previous chapter using data collected through a survey. Finally, Chapter 6 will describe the conclusions and future recommendations of the functional requirements of a MaaS platform.

2. Background and Related Work

In this chapter, the literature is reviewed to determine the functionalities of a MaaS platform. These functionalities were collected from academic publications (for example Jittrapirom et al., 2017), white papers (for example European Union, Scotland Technology and the International Association of Public Transport) and real life MaaS cases (for example UbiGo and the Whim App). In order to find the functionalities in the academic papers a systematic literature review is conducted. The databases are generic databases like ProQuest, Science Direct and Google Scholar. The keywords for this review were 'mobility as a service', 'MaaS', 'functionalities', 'requirements', 'platform', 'features' and 'functional'. To narrow down the search even further several other aspects are added. The language of the paper has to be English; the full text needs to be available online and the paper has to be written in the last decade. The first two points are added to make sure everything is understandable and that there is no conclusion drawn based on incomplete information. The last point was added because the development of MaaS is a new process and older papers would not contain the latest technological developments. This literature review led to 40 different research papers. When determining which research papers would have the information that was needed for this research a number of papers was deemed not useful. The criteria for excluding a paper were mainly about the content not being detailed enough about the functionalities of MaaS platforms. This resulted in 12 academic papers being used in the rest of the chapter.

The reason why it is important to look at the requirements of a platform is already mentioned by Deming (1986). He says that meeting and exceeding customer requirements is the task that everyone within an organization needs to accomplish. This is also the case for a MaaS platform. So, in the context of this research, the goal of the MaaS operator should be to meet and exceed the requirements set by their customers, in this case the end-users and service providers. Therefore, it is important to know which functional and non-functional requirements are preferred by these stakeholders.

2.1 Functional Requirements

The definition of mobility as service from Cerfontaine (2019) as already mentioned earlier takes about the integration of different services into one single digital mobility offer. Sochor, Arby, Karlsson and Sarasini (2018) talk about different level of integration. These levels go from level 0 till level 4. These levels will be discussed individually below. An overview of the

different levels can be found in Appendix A. The reason that these levels are discussed is because at each different level one or more new functionalities is added to the mobility platform.

Level 0 talks about single, separate services (Durand, Harms, Hoogendoorn-Lanser, & Zijlstra, 2018; Sochor et al., 2018). Which means that there is no integration in this situation.

Level 1 is named the integration of information (Durand et al., 2018; Sochor et al., 2018). Sochor et al. (2018) classify it further based on functionality. The information is only centralized, there is a multimodal travel planner, and the goal is to facilitate the choice regarding the time of day, the route, or the mode of transport for the user (Durand et al., 2018). The functionalities can be seen at this level are the travel planner and customization regarding time, route and transportation mode.

When the booking and payment is integrated into the planner that was described for level 1 you come to level 2 (Durand et al., 2018; Sochor et al., 2018). Sochor et al. (2018) say that a level 2 service provider still focuses on single trips and is an extension on a travel planner by adding ticketing. Meaning that customers can book/pay through a single point (Durand et al., 2018). At level 2 it is possible to have both registered customers and ad hoc customers. The functionalities that are added at this level are registration, ticketing, booking and payment.

Level 3 builds upon level 2 and adds the integration of the service offer (Durand et al., 2018; Sochor et al., 2018). At level 3 a proper alternative is provided to car ownership since there are multiple mobility services combined. These mobility services can be combined, e.g., take my private car to X, then the train to Y and then rental bike to destination. This means that there are customers interested in the services of level 3 mobility provider that are not interested in the single transportation services that are provided at the earlier levels (Sochor et al., 2018). Extra functionalities at this level can vary, because of the different services that can be added.

The last level, level 4, is the integration of societal goals into MaaS (Durand et al., 2018; Sochor et al., 2018). The added value level 4 is that private cars will be used less, and the city will be more liveable (Sochor et al., 2018). In this scenario a collaboration with the public authorities on different levels will help reach these goals. Customization is an extra

functionality that is added at this level, especially regarding having the routes/modes with the least amount of environmental impact. Jittrapirom et al. (2017) mentions customization as well as personalisation. This paper mentions that the system provides specific recommendations and tailor-made solutions based on several aspects. One of these aspects is the past behaviour of the users. Meaning that the system should learn from the choices of the users and adapt the travel options accordingly. Resulting in a system that should constantly learn from and adapt to the users.

However, Durand, Harms, Hoogendoorn-Lanser and Zijlstra (2018) mention that level 2 is the minimum integration level that is needed for a mobility platform to be considered mobility platform a MaaS application. Therefore, the functionalities from appearing on integration levels 0, 1 and 2 should be considered functionalities are mandatory for a MaaS application. However, it is still interesting to test whether these mandatory functionalities are actually something that end-users want in their MaaS application.

Jittrapirom et al. (2017) looked at twelve real-life examples of MaaS initiatives. They compared them on different factors, like tariff options, use of technologies and functionalities. The functionalities described by Jittrapirom et al. (2017) are useful in two ways. First, they provide an overview of functionalities that can exist for MaaS platforms. Secondly, they compare the different MaaS initiatives. This makes it possible to compare the functionalities as well. Based on this comparison it is possible to see which functionalities are common amongst MaaS initiatives and which functionalities are unique to some MaaS initiatives. The functionalities are for the end-users of the MaaS initiatives, even though some functionalities might be useful for the service providers as well. Table 1 is created by the researcher to provide an overview of the MaaS initiatives and the functionalities that are present at each of them. The ✓ means that the functionality is present in the MaaS initiative according to the information that is presented in the paper of Jittrapirom et al. (2017) and the information that is found when looking at the real-life version of these MaaS applications. These real-life MaaS initiatives, in Table 1, were chosen because these initiatives were mentioned in Jittrapirom et al. (2017). Also, when investigating these initiatives, it showed that these initiatives met the MaaS definition and had some aspect of customization amongst its functions. Therefore, when created Table 1, a theoretical basis, from Jittrapirom et al. (2017), is combined with the information found when looking at the real-life MaaS initiatives.

Table 1: Functionalities MaaS Initiatives

	TransitApp	Optymod	Mobility 2.0	SHIFT - Project 100	UbiGo	Mobility Shop	Smile	Tuup	My Cicero	Moovel	Whim	WienMobil Lab
Real Time Information	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Trip Planning	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Booking	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Payment	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Service Alerts	✓	✓	✓			✓	✓					
Departure Alarms	✓											
Stop Notifications	✓											
Congestion Prediction		✓										
Plane's Arrival Time Information		✓										
Plane's Departure Time Information		✓										
Real Time Congestion Monitor			✓									
Invoicing				✓	✓	✓	✓		✓	✓	✓	✓
Ticketing					✓	✓	✓	✓	✓	✓	✓	
Twenty-Four Hour Customer Service					✓							
User Registration	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Store Routes	✓		✓	✓		✓				✓		
Save Location	✓											
Preferable Modes	✓	✓				✓	✓	✓				✓
Link with Calendar	✓							✓			✓	
Personal Contact	✓											
Service Subscription		✓					✓		✓		✓	✓
Accessibility for People with Special Needs			✓									
Mobility Budget with Top-Up and Roll-over				✓	✓				✓		✓	
Cancelation Options						✓				✓	✓	
Filtering Based on Costs							✓	✓				✓
Filtering Based on Time							✓					✓
Filtering Based on CO2 footprint							✓	✓				✓
Link with Social Media										✓	✓	
Record Journey									✓			
Share Journey									✓			

Rodriguez-Sanchez & Martinez-Romo (2017) discuss one of the functionalities that can also be found in Table 1, accessibility for people with special needs. They mention that it is important to provide access to people with special needs and that the application should be

able to be used by people with special needs without major problems. This way no person is excluded from the use of MaaS.

The Japanese MaaS application EMot ("EMot," 2021) has several new features that are not yet present in most of their competitors. Like the creation of a Tour Plan for tourists. The tourist would tell the application which places it would like to go and then the application would create a travel schedule that would make it possible to see all these places. Through the application it is also possible to get tickets for a Japanese amusement park. This can be made into a more general feature of having the possibility to get tickets for entertainment events through the MaaS application. The application would then both be providing the entertainment and the journey to the entertainment. EMot also has the option for users to select a location on a map and then EMot will provide directions to this location ("EMot," 2021).

An important feature that can be present in the MaaS platform for both types of stakeholders is the consideration of environmental impact when making decisions (Banister, 2008; Signorile, Larosa, & Spiru, 2018). This is something that is considered important in today's society and therefore it is useful to have a functionality in the platform which takes the environmental impact into consideration.

Ashkrof, Correia, Cats and Van Arem (2020) talk about a feature that is present at for example Uber, namely ratings. Ratings give both the users as well as the drivers insight into the quality or behaviour that can be expected from the other party involved. Where the paper mentions that drivers are not fans of the rating system given the consequences that it can have for them, for example getting temporarily banned or even permanently. However, this is not the case for the users. They do see the benefits from the use of a ratings system. One other functionality that can be taken from Ashkrof et al. (2020) is that the drivers are just regular people. These people should be able to become a driver to the MaaS application that provides these services.

The Dutch MaaS application, the NS reisplanner ("Reisplanner | Reisinformatie | NS," 2021), is a source for another functionality that a MaaS application can have. The functionality to get your money back in case of delays, malfunctions or bad service (e.g. if my train is delayed due to snow). In the NS reisplanner there is also the function to have a business card ("NS-

Business Card | NS Zakelijk | NS," 2021). This function allows the users to travel with the application while the bills are automatically sent to their bosses. This would make the MaaS application more interesting for businesses to use.

Den Boer (2020) discussed several functionalities in the categories: "planning, ticketing, booking and payment". In this publication there are a few functionalities mentioned that did not appear directly in the descriptions of functionalities above. However, the functionalities that are not mentioned directly are more detailed descriptions of the functionalities mentioned above. A functionality like trip planning, see Table 1, includes a lot of specific functionalities that are mention in Den Boer (2020), like "includes additional transfer time". Den Boer (2020) also mentions "limit to accessible journeys" and "limit walking distance" which can be covered by trip planning. While most of the filtering options are already mentioned in the descriptions above there is one additional filter option that Den Boer (2020) also mentions "View current weather situation for consideration in modality selection". The global terms "ticketing, booking and payment" can also be seen in Table 1. The more detailed functionalities that Den Boer (2020) used for these functionalities can be found in Table 6. Den Boer (2020) describes several navigation functionalities that a MaaS application can have. These functionalities are "Step-by-step guidance", "Text-to-speech (TTS) directions" and "Offline navigation". The specific functionalities mentioned in Den Boer (2020) would make a good addition to the functionalities mentioned in Table 1.

Both Jittrapirom et al. (2017) and Díaz et al. (2020) discuss an advantage the service providers can have based on the functionalities of a MaaS platform, vehicle fleet optimization and relocation. This would mean that the MaaS platform would give the service providers of shared transportation modes can optimize the distribution of the transportation mode based on the demand that is registered on the MaaS platform. Also, the information that is provided to the service providers regarding the prices and the quality of the service from a user perspective (Jittrapirom et al., 2017). According to Hernandez et al. (2020) data can be collected from the users and used for KPI calculations, which can be used by service providers to base their policy on.

The reporting functionality can help analyse the information gotten from the MaaS platform and help the service providers adjust their mobility related products and services (Economic Commission for Europe, 2020). Service providers can even use the MaaS platform to help

with traffic management and improve the traffic flow (Economic Commission for Europe, 2020).

In the research done by Technology Scotland and Scotland IS (2018), functionalities of the MaaS system that are beneficial to service providers are mentioned. The insight gotten from MaaS can help with the improvement of the utilization of the transport assets. The service providers with parking possibilities, both regular and e-vehicle, can improve the management of the existing parking places in the city and determine whether extra (charging) places are necessary. Another functionality mentioned by Technology Scotland and Scotland IS (2018) is the ability to see how transportation assets are being sued around the city to help insurance providers with determining their rates based on the expected trip.

This section shows that there are a lot of functional requirements that can be present in a MaaS platform, from both the end-users and service providers perspective. It can be seen that the functional requirements for the end-users consist mainly of features that the MaaS platform could have and that the functional requirements for the service providers consist mainly of benefits/information they can get from the usage of the MaaS platform. Which functional requirements will be tested in this research will be chosen in section 2.3 of this report. The next section will first discuss the literature that exists regarding non-functional requirements.

2.2 Non-Functional Requirements

The functionalities that are mentioned above are in the category of functional requirements. However, there are also non-functional requirements that need to be discussed. These non-functionalities are not unique to MaaS. The five most common categories of non-functional requirements: Availability, Maintainability, Reliability, Performance and Security (Milani, 2019).

Wiegers and Beatty (2013) described the non-functional requirements, named quality attribute, for software systems, like a MaaS platform. They divided the quality attributes into two main categories, external quality and internal quality. Where the external quality is mainly important to the users and the internal quality is mainly important to designers and developers. This is the reason that the internal quality is not used when looking at the non-

functional requirements of the end-users, as can be seen in Table 4. However, the internal quality can be important for the service providers. However, the descriptions of the internal qualities do not match with the way the service providers are expected to interact with the MaaS platform. The service providers are expected to have the same kind of relationship with the MaaS platform as the end-users. Meaning that they use the MaaS platform, but do not run the platform itself. Running the platform itself is done by an outside party and this outside party will have to look after the internal quality. Hence, it is decided to leave the internal quality out for the service providers as well. Table 2 and Table 3 show the different quality attributes and a short description of the individual quality attributes (Wiegers & Beatty, 2013). A more detailed explanation on which non-functional requirements are used in the list of functionalities and why, will be shown in section 2.3. The Tables below will be used as the basis for choosing the non-functional requirements in the next section (Wiegers and Beatty (2013). However, as can be seen the five main non-functional requirements according to Milani (2019) are also present in these Tables. Only maintainability is split between interoperability and modifiability, so an external and internal quality, in the Tables below. Berander et al. (2005) compare different models for non-functional requirements, for example Boehm's model and McCall's model. When looking at these different models and their comparison it is shown that the non-functional requirements found by Wiegers and Beatty (2013) are also present in the different models in Berander et al. (2005). Therefore, the decision is made to use Wiegers and Beatty (2013) as the basis for this research.

Table 2: External Quality

External Quality	**Description**
Availability	The extent to which the system's services are available when and where they are needed
Installability	How easy it is to correctly install, uninstall, and reinstall the application
Integrity	The extent to which the system protects against data inaccuracy and loss
Interoperability	How easily the system can interconnect and exchange data with other systems or components
Performance	How quickly and predictably the system responds to user inputs or other events
Reliability	How long the system runs before experiencing a failure
Robustness	How well the system responds to unexpected operating conditions
Safety	How well the system protects against injury or damage
Security	How well the system protects against unauthorized access to the application and its data
Usability	How easy it is for people to learn, remember, and use the system

Note: Reprinted from Software Requirements, by Wiegers and Beatty. Retrieved from https://www.academia.edu/ Copyright 2013 by Karl Wiegers and Seilevel

Table 3: Internal Quality

Internal Quality	**Description**
Efficiency	How efficiently the system uses computer resources
Modifiability	How easy it is to maintain, change, enhance, and restructure the system
Portability	How easily the system can be made to work in other operating environments
Reusability	To what extent components can be used in other systems
Scalability	How easily the system can grow to handle more users, transactions, servers, or other extensions
Verifiability	How readily developers and testers can confirm that the software was implemented correctly

Note: Reprinted from Software Requirements, by Wiegers and Beatty. Retrieved from https://www.academia.edu/ Copyright 2013 by Karl Wiegers and Seilevel

2.3 Functionalities

The functional and non-functional requirements that are discussed above come from different research papers and real-life MaaS initiatives. These studies were conducted previously and discuss possible functional and non-functional requirements for a MaaS platform. However, as already mentioned in Chapter 1, these research papers do not discuss the preferences of the end-users and service providers regarding these functionalities. With the exception of the paper by Den Boer (2020). However, this paper does cover the basic functionalities. Being functionalities that fall in the basic categories: "planning, ticketing, booking and payment". However, there are more (enhancing) functionalities than are covered by these four categories. These enhancing functionalities, falling into other categories that the four categories mentioned above, will be covered in this research. Therefore, this study will add the stakeholder's preferences on MaaS functionalities that are not yet covered by other studies. This will make sure that the MaaS developers do not use functionalities that are redundant for the MaaS platform. This report will study the preferred functionalities from the end-users and service providers to help illuminate the needed functionalities of a MaaS platform. Table 4 and Table 5 show the description of the functionalities that will be used as a starting point when determining the solution that can be found in Chapter 4. To get to these two Tables several mentioned functionalities are excluded. Functionalities can be excluded because of several reason:

- Different functionalities can talk about the same thing

- Number of times a user will have to deal with the (non-functional) requirement
- Non-functional requirement is needed for MaaS to operate
- Without (non-functional) requirement MaaS is not interesting to the consumers

Some of the functionalities talk about the same thing. This can be concluded from the description of the functionality. Sometimes the different applications call a functionality different, but the functions are the same. Like that in Table 1 “Real Time Information” includes “Real Time Congestion Monitor”, “the Plane’s Arrival and Departure Times”. Therefore, these functionalities, “Real Time Information”, “Real Time Congestion Monitor” and “Plane’s Arrival and Departure Times” can be covered under one single functionality, “Real Time Information”. The non-functional requirements are chosen based on whether the stakeholders will have to deal with it one time or multiple times. For example, “Installability” is in principle only needed once to install the application, while “Performance” is important every time the MaaS platform is used. If for instance they would just have to deal with something inconvenient once it might be less troublesome to them then when they would have to deal with it every time they use the MaaS platform. This is why “Installability” is not included in the data collection process. The reason that “Interoperability” is excluded from the data collection process, is that if a MaaS platform does not support the exchange of data between the different databases then the whole purpose of the MaaS platform, combining different services into one application, is not possible. This makes “Interoperability” mandatory for a MaaS platform to operate. Therefore, “Interoperability” is excluded from the data collection process. The two non-functional requirements, “Reliability” and “Availability”, cover the same aspects for the users of the MaaS platform. This can be given based on the description of the two non-functional requirements in Wiegers and Beatty (2013). Also, if the system is not reliable it will fail frequently. If the system fails it will not be available for use. Therefore, it expected to score low on “Availability” as well (Ebeling, 2004). This makes including both “Reliability” and “Availability” into the data collection process redundant (Ebeling, 2004). However, nowadays most systems need to be close to 100% available/reliable in order to get any interest from potential customers (Wiegers & Beatty, 2013). Therefore, it is not needed to include this requirement in the survey at all. The same goes for “Integrity” and “Safety” (Wiegers & Beatty, 2013). “Robustness” is another aspect that does not have to be included in the survey. This is the case since “Robustness” talks about bugs in the system. Bugs are unacceptable to have in a system nowadays (Wiegers & Beatty, 2013). Therefore, it should be a bugs free system and this makes it not necessary to

test in the survey. As already mentioned earlier when discussing the non-functional requirements, all internal quality requirements are not included in the data collection process. This is because they are relevant to designers and developers. Since the end-users and service providers are both considered users of the MaaS platform in this scenario the internal quality does not apply to them. All of this leads to the two Tables below.

Table 4: Functionalities End-User

Functional Requirements	**Definition**
Real Time Information	The system provides real time information about the arrival and departure times of the transportation modes
Notifications	The system notifies the user about the arrival of, delay of and changes to the transportation mode
Congestion Prediction	The system predicts the congestion in traffic and changes the route to best fit the users' needs
Twenty-Four Hour Customer Service	Twenty-Four Hour a day customer service is available to help the user with problems
Store Information regarding Travels Made	The system stores and display information about the previous travels made by the user
Link With Calendar	The system is linked with the calendar of the user to adapt the travels to the calendar of the user
Personal Contact	The system links you with your personal contact (name, e-mail, phone number, etc.) to personalize the responses to you
Service Subscription	It is possible to subscribe to enhancing service through the application, e.g. insurance for car rental
Accessibility For People With Special Needs	The system is adaptable to users who are blind, deaf, etc.
Cancelation Options	It is possible for the user to cancel booking made using the application
Preferred Way of Travel	The system takes into consideration the user's profile and preferences (cost, time, user ratings, modality, etc.) when listing the travel options for the users
Share Journey on Social Media	The system makes it possible to share your travels on social media
Pay for Travel	The system makes it possible to book and pay for your travels through the application
Store Tickets for Travel	The system makes it possible to store a single electronic ticket in the application, that is applicable for all travel modes in a journey
Travel Ratings	The user is able to rate the travels and see the ratings that other users have given to different travel options.

Intelligent Customization	The system learns from the user's choices and adapts the travel options accordingly.
Multimodal Transport Option	The system combines different transportation modes on one journey, e.g. first take your private car to X, then the train to Y and then rental bike to destination
Non-Functional Requirements	**Definition**
Performance	How quickly and predictably the system responds to user inputs or other events
Security	How well the system protects against unauthorized access to the application and its data
Usability	How easy it is for people to learn, remember, and use the system

Table 5: Functionalities Service Providers

Functional Requirements	**Definition**
Vehicle Fleet Optimization	The system determines the optimal number of vehicles for the given transportation mode
Vehicle Fleet Relocation	The system helps relocate the vehicles to the best location for optimal usage
Demand Analysis	The system analyses the demand of the users and presents it to the service providers
Price Analysis User	The system analyses the response of the users to the price of the services and presents it to the service providers
Quality Analysis User	The system analyses the response of the users to the quality of the services and presents it to the service providers
KPI Calculation	The system calculates the KPI's of the service providers
Adjustment Services	The services provided can be changed within the system, e.g. making less vehicles available for use
Traffic Management	Service providers can use the MaaS platform to help with traffic management and improve the traffic flow
Utilization Optimization	The insight gotten from MaaS can help with the improvement of the utilization of the transport assets
Parking Space Analysis	The system helps the management of the existing parking places in the city and helps determine whether extra (charging) places are necessary
Accident Analysis	The ability to see where transportation assets get into accidents round the city to help insurance providers with determining their rates based on the expected trip
Filtering	The system can filter the analysis based on your needs
Support Communication other Providers	The system supports the communication with other providers to help base your decision on all needed information

Environmental Impact	The system shows the environmental impact that the transportation modes have
Non-Functional Requirements	**Definition**
Performance	How quickly and predictably the system responds to user inputs or other events
Security	How well the system protects against unauthorized access to the application and its data
Usability	How easy it is for people to learn, remember, and use the system

2.4 Remarks

Chapter 2 talks about the literature and real-life examples that are available to review. In this research there was little information found about the preferences of certain functionalities over other functionalities. The only exception was the preferences regarding some basic functionalities was found in the paper of Den Boer (2020). This is in accordance with the research gap that was found in Chapter 1. The review led to a list of functionalities for both the end-users and the service providers. These lists can be found in Table 4 and Table 5. The next chapter will discuss the research design of this study, including the data collection process that will be used.

3. Research Design

In this chapter of the thesis, the research design, following the DSR method (Peffers et al., 2006), will be explained. The DSR method that is used will be briefly explained and the reason why this method is used out of the different options. Afterwards, the DSR method will be applied to this specific research. This will result in a method that will be used in this research Following this method will lead to the design artifact. Which in this research is a ranking of the preferred functionalities of a MaaS platform for both the end-users and the service providers.

3.1 Design Science Research

The research design is based upon a DSR method. The papers of Gregor and Hevner (2013), Hevner et al. (2004) and Peffers et al. (2006) were examined to base the method of this research on. Gregor and Hevner (2013) do not have a real method for working on DSR. They do however have a publication schema made on which the lay-out of a research paper or thesis should be based if the research is of the DSR kind. This lay-out of a DSR paper is also used as a lay-out for this master thesis. An overview of the publication schema for a DSR study (Gregor & Hevner, 2013) can be found in the Table in Appendix B. However, this publication schema is not a method that can be followed. Because this publication schema describes the structure a DSR paper could have. It does not provide a step-per-step description of what should be done in DSR. This is where the other two papers come in. Each provides a method which can be followed when conducting DSR. Hevner et al. (2004) use the Information Systems Research Framework, while Peffers et al. (2006) use the Design Science Research Process (DSRP) model. The latter is used in this research, because the DSRP model provides a better step-per-step instruction on how to conduct a DSR than the Information Systems Research Framework. Since the DSRP model shows which step should happen after one step is completed. The Information Systems Research Framework is a process that goes in a circle, meaning that it constantly comes back to the same points. Therefore, it does not have a clear start and end point. This made the DSRP model easier to understand and easier to follow. Therefore, this method is used for this research. Figure 2 shows the DSRP model.

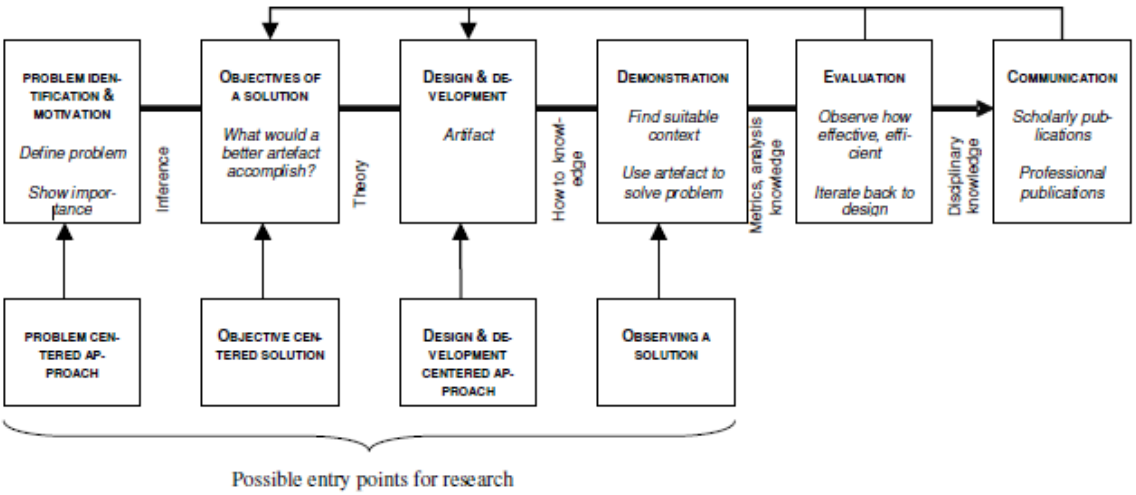


Figure 2: DSRP Model

The DSRP model follows six steps before being completed. The problem identification and motivation step defines the specific problem on which the research focuses on. It also needs to make sure that the solution to the problem has value, since this value motivates the researcher to pursue the solution and helps to understand the reasoning of the researcher (Peffers et al., 2006). The second step is the objectives of a solution and should follow from the problem identification. The goal here is to say what the study or artifact will add to the previous studies (Peffers et al., 2006). The next step is the design and development of the artifactual solution. The fourth step is to demonstrate the artifact that is developed in the previous step of the DSRP model. The artifact should show that the efficacy solves the problem defined in problem identification (Peffers et al., 2006). The fifth step, evaluation, is the first time that according to the DSRP model, there is an opportunity to provide feedback and possible changes to previous steps in the DSRP model. In this step it is determined whether the results of the artifact match the objectives set in step 2 (Peffers et al., 2006). If the artifact does not meet the objective set in step 2 the researcher might be forced to go back in the DSRP model to redesign the artifact. The last step of the DSRP model is communication. The goal of this step is to communicate the research, artifact and results to the relevant parties. This can be done through a research paper or a master thesis that follows the structure descript by Gregor and Hevner (2013). The last thing to see in the DSRP model is the point of entry into the research. Since the master thesis follows a specific structure on its own, with first looking for a research gap. The starting point is set already to the problem centric approach. This can be seen in better detail in Figure 3. The next part of Chapter 3 describes how the DSRP model is used in this thesis.

3.2 Method

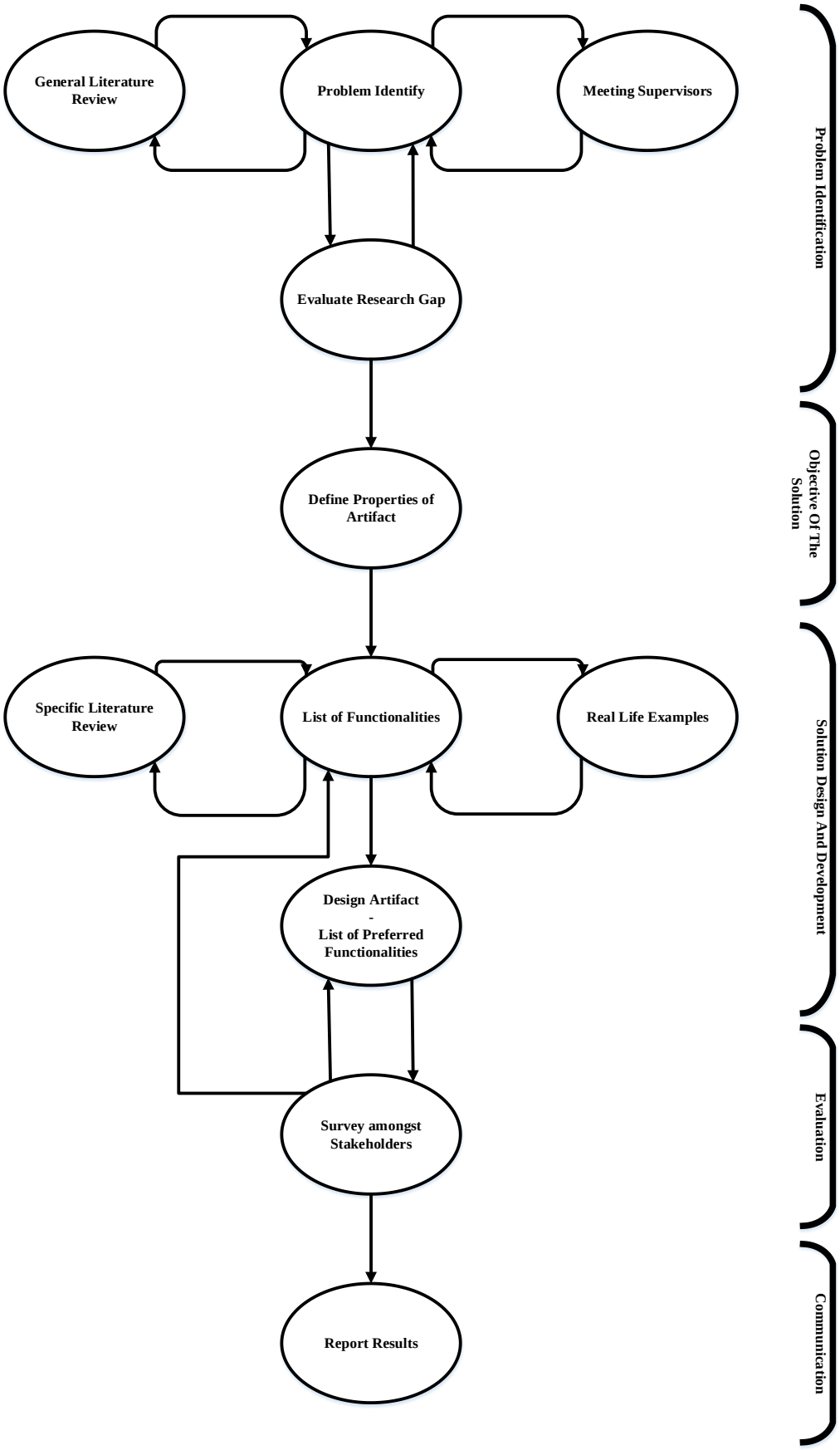


Figure 3: Research Design

Figure 3 above shows the research design for this research. A more detailed description of the research design will follow below. Figure 3 used the DSRP model that is shown in Figure 2 as a basis. This can be seen by Figure 3 following the same steps that the DSRP model in Figure 2 introduces. At the right side of Figure 3 the different actions taken in this research design are placed with the different steps of the DSRP model.

3.2.1 Problem Identification

The first step is the problem identification and motivation. The problem identification and motivation are already found earlier in this report. Chapter 1 describes the problem and the motivation in detail. However, the short description is that MaaS is a relatively new concept. Therefore, there is, to the best of my knowledge, no information about the preferences of end-users and service providers for the MaaS platform. Without this information it is difficult to make a MaaS platform that consumers and service providers want to use.

3.2.2 Objectives of the Solution

The second step is to set the objectives of the solution. What the artifact adds to the knowledge that is currently available about the preferred functionalities of end-users and service providers is described in Chapter 2 of this report. In short, there is, to the best of my knowledge, no information available regarding the preference of certain functionalities over other functionalities. This research and artifact will determine the preferred functionalities of end-users and service providers.

Another part of the objectives of the solution is to set the properties of the artifact that is to be developed in this report. The properties of the artifact of this research are:

- The artifact should show which functionalities are more preferred compared to other functionalities
- The artifact should make a distinction between end-users and service providers
- The artifact should only exist of functionalities that can be implemented in a MaaS platform in practice
- The artifact should show which functionalities cannot be present in the same platform

3.2.3 Solution Design and Development

The design and development of the artifact is partly already presented in the previous chapter, with the descriptions of the functionalities, and partly done in the next chapter, with the more detailed functionalities divided into different groups. The functionalities that a MaaS platform can have, need to be collected first. In Chapter 2 of this report a detailed explanation is given on how the list of functionalities are collected. The list of functionalities can also be found in Chapter 2 of this report. This leads to Table 4 and Table 5 with the functional and non-functional requirements for the end-users and the service providers based on the literature review and the real-life examples of MaaS. These two Tables will be used as the basis for the solution.

3.2.4 Demonstration

The next phase of the DSRP model is the demonstration. In this particular instance the demonstration is not the biggest part of the research. Since the goal is to develop a ranking of functionalities, there is no real way to demonstrate this in practice. However, what can be demonstrated is how the ranking can be used in a real-life situation to develop a MaaS platform. So, in the context of giving advice on which functionalities are preferred by the stakeholders and which functionalities the stakeholders deem unnecessary for a MaaS platform. This way the question of how the ranking can be used in real-life situation to develop a MaaS platform, can be answered.

3.2.5 Evaluation

First, the decision has to be made which data collection method, which will be used as the evaluation of the solution in Chapter 4, is going to be used for this research. There are two different stakeholders involved in the research, the end-users and the service providers. This means that you can use one data collection method for both stakeholders or you can use different data collection methods for both stakeholders. Therefore, the decision needs to be made whether both stakeholders require a different data collection method or if both stakeholders can be examined using the same data collection method with only a few small differences to specify it for the specific stakeholder. The decision is made to use the same data collection methods for both stakeholders. There are several reasons for this decision. First, the time that goes into making two completely different research methods would be better spent on other research activities. Especially since it is not one hundred percent certain that the

service providers can be reached. Secondly, if there is a need to compare the different outcomes for both stakeholders it would be easier if both numerical values have the same meaning. It is also possible to compare the two outcomes when the values are different, but it would be clearer when numerical values have the same meaning. Another reason to use the same research method is that the service providers are also potential end-users meaning that they can give data for both groups of stakeholders. Using the same research method would make it easier on the service providers. The service providers would not get confused by having to switch methods to provide the necessary data for this research. Lastly, with the same data collection method the data can also be processed in the same way. This prevents mistakes from being made when switching between the different ways of processing the data and using the wrong processing steps on the different data collection methods.

Next, the researcher needs to decide which data collection method is going to be used for both stakeholders. It is also worth considering that because of the Covid-19 pandemic it is preferable to have the data collection method conducted in a way that minimizes face-to-face meetings. The data collection methods that are executed in an online environment are therefore preferable. Hence these only online methods are considered as options. Research methods that are considered options are interviews and surveys (Blumberg, Cooper, & Schindler, 2011; Fahy & Jobber, 2015; Landy & Conte, 2013). The goal of this research is to find the preferred functionalities of both end-users and service providers. Therefore, it is important to speak to as many people as possible to make sure the preferred functionalities are based on as many opinions as possible. Since interviewing all these people on an individual or even a team basis would require a lot of scheduling and time (Blumberg et al., 2011; Fahy & Jobber, 2015), the decision is made to use surveys to have people fill in the surveys in the time that suits them best.

However, a survey can vary, because there are different ways in which a survey can be used. The online use of the q-methodology can just as easily be considered a survey as the more traditional Likert scale. However, a Drag-and-Drop ranking method instead of the q-methodology or Likert scale is also considered as an option. Since the goal is to create a ranking of the functionalities starting with the most preferred functionality and ending with the least preferred functionality, it is best to let the participants of the survey create the ranking themselves. Blasius (2012) found in his study that the Drag-and-Drop ranking method is shown to be the best method for collecting ranking data when the survey is taken in an

online environment. However, when looking at the functionalities that need to be asked of the participants of the survey, the Drag-and-Drop ranking method might not be the best option. Since the number of functionalities that need to be ranked would be too high for the participants to still have a clear overview of the functionalities by the end of the ranking process. Therefore, the decision is made not to use the Drag-and-Drop ranking method. This leads to the Likert scale being used for the survey, because it is more commonly used and less time consuming for the participants than the other survey options. Therefore, it would be easier to understand, and it would require less effort for the participants.

After the definitions of the items that need to be tested in the survey are set, see Chapter 4. The next step of the research can take place. This step is the development of the survey. The final surveys can be found in Appendix C and Appendix D. The first part of the survey is the same for both parties that take part in the survey, the end-users and the service providers. First, an introduction is given into why this researcher is conducting this research. This part is included in the survey to give the participants a better understanding of why their help is required for this research. Secondly, the concept of MaaS is explained to the participants to make sure that they understand the concept on which the questions are going to be asked. This part ends with the question whether the participants have any experience with the use of MaaS. This can be useful later on to see if people with experience find different things important than people without experience. After this question the survey is different for the end-users and the service providers. The end-users are asked some demographic questions to determine their age, place of residence and travelling behaviour. While for the service providers the questions are asked to know whether they are transportation providers or enhancing service providers and to see if they know that MaaS can be a business opportunity for them. After these questions both types of participants end up at the main goal of the survey, determining the preference for the different functionalities. The end-users will have to scale 88 items on a Likert scale with the values: “Unimportant”, “Slightly Unimportant”, “Neutral”, “Slightly Important” and “Important”. The service providers will have to scale 29 items on a Likert scale with the same values as the end-users. The last question will ask both the end-users and the service providers what functionality they might have missed in the survey. Afterwards the participants can press send and the survey is concluded.

However, before the survey was distributed amongst the participants a pilot test was taken to test the survey. The goal of this pilot test was to see if the test subjects, similar people to the

potential participants, understood the survey. This can be from the introduction and the explanation of MaaS to the items that need to be ranked or scaled. The conclusion of the pilot test was that there were some small parts that were not 100% clear to the test subjects. This mostly included small corrections of grammar to make things clearer and some tips of functionalities that might be useful to ask. To make sure that the parts that were not 100% clear would be clear to the participants of the survey some changes were made. These changes were made in consultation with the test subjects of the pilot.

The survey is distributed to the experts who participate in the UMOS project, and to people that are known to the researcher. UMOS is a universal service platform that offers an one-stop platform for optimized and customized travel experience ("UMOS-Alliance," 2020). However, UMOS is beyond MaaS. It envisions an ultimate experience for the traveller. It incorporates services, such as parking, insurance, and even accommodation and entertainment ("UMOS-Alliance," 2020). The UMOS group works on this platform. The work on the UMOS platform gives the UMOS group experience with MaaS platforms and how these MaaS platforms look in practice. It would be interesting to get their perspective on the functionalities. Participants from the UMOS alliance and from the network of the researcher filled in the survey and in some cases distributed the survey further to other people that would be willing to fill in the survey. Since the majority of these participants would be from the Netherlands the survey has the option to switch between Dutch and English to make it easier for the Dutch people to fill in the survey, especially in case that their English skills are not of great quality.

Once the surveys are filled in by the relevant parties, a data analysis has to be performed to determine which functionalities are preferred by the end-users and which functionalities are preferred by the service providers. The first step is to make sure that all questions are converted to values that can be used in the analysis. The step to determine the preferred functionalities is to see either which functionalities have the highest-ranking position on average or to see which functionality is ranked in first position by the most participants. For the Likert scale, the average score of the items on the five-point Likert scale will determine the preferred functionalities for the end-users and the service providers. The results will be shown in Chapter 5.

There are a few other things that need to be looked at during the evaluation. First, it needs to be possible to implement the list of preferred functionalities on a MaaS platform. Another point that has to be considered is whether the list of preferred functionalities of the end-users conflicts with the list of preferred functionalities of the service providers. If the functionalities cannot co-exist the list will not change, but if used in real life the MaaS developer will have to decide on which stakeholder will get their preferred functionality.

3.2.6 Communication

The last step of the DSRP model is the communication of the five previous steps to the relevant stakeholders. This is done through this master thesis that follows the structure descript by Gregor and Hevner (2013). While the research follows the steps of Peffers et al. (2006).

3.3 Remarks

This chapter first discussed the general DSR method and then explains how it is applied in this situation. Problem Identification, Objectives of the Solution, Solution Design and Development, Demonstration, Evaluation and Communication are all discussed in this Chapter. The decision has also been made to use surveys to collect the data from the end-users and the service providers.

4. Solution

In this chapter the two detailed lists of functionalities for the end-users and service providers are shown. These lists are made using the literature studies that were conducted earlier. These two lists are functionalities of a MaaS platform for both stakeholders and these lists will be the solution for this research.

4.1 Solution End-Users

The functionalities for the end-users (Table 4), is used as the basis for the more detailed list of functionalities for the end-users. The more detailed functionalities will all fall into one of the requirements that is mentioned in Table 4. However, the definitions will be used for the Likert scale in the survey instead of the terms, because the terms used might not be known to participants without experience with MaaS applications (Fahy & Jobber, 2015). Table 6 covers the functionalities of a MaaS application that will be used by the end-users. Table 6 is colour coded since some of these functionalities came from Den Boer (2020) in order to cover both his functionalities and the new enhancing functionalities. This is not needed for the functionalities for the service providers since these functionalities are not covered by Den Boer (2020). The red coloured definitions are adapted from Den Boer (2020). The orange/yellow coloured definitions are implied in the thesis from Den Boer (2020). However, they are never asked directly to the participants. The inclusion of these functionalities in the survey will result in new information regarding the preferences of these functionalities. The green coloured definitions are new and the preferences for these functionalities are unknown. The last column in Table 6 is the source column. This column gives the source that is used as a basis for this definition. Sometimes the source directly mentions the functionalities are used and sometimes the functionalities are deducted from the information that is given. For example, if an app gives the option to provide feedback to the provider then the provider should also have an option that lets them see the feedback of the consumers. To keep this column easy to read only the most important source for getting this definition is used. When looking at this last column it is shown that the functionalities mentioned in Table 6 are either based on literature or based on real life MaaS applications. These sources give the idea that these functionalities are wanted by the end-users of MaaS platforms.

The functionalities that are shown in Table 6 are designated to different groups that can be seen in the first column of Table 6. These groups are formed following a few steps. Firstly,

Den Boer (2020) had used four groups in his thesis. These groups were “planning, payment, booking and ticketing". The decision was made to use these four groups in my thesis as well. However, some of the functionalities taken from Den Boer (2020) are placed in different groups, since the researcher thought that they would fit better in another group. For example, “Text-to-speech (TTS) directions” fits better with assistance than with planning. The other groups are named according to a common trade amongst the functionalities that the researcher placed together. Some functionalities might be covered by two or more different groups. In this scenario the researcher placed the functionality in the group that the researcher thought would have the best fit with the functionality.

Table 6: Functionalities Survey End-Users

Group	Definition	Source
Planning	The app provides real time information about my departure times	(Den Boer, 2020)
	The app provides real time information about my arrival times	(Jittrapirom et al., 2017)
	I can change my departure time and date	(Den Boer, 2020)
	The app combines different modes in one journey (e.g. take my private car to X, then the train to Y and then rental bike to destination)	(Sochor et al., 2018)
	I can select my departure and destination location	(Den Boer, 2020)
	I can select a location on a map and the app will provide directions to this location	(“EMot,” 2021)
	I can choose my favourite locations and/or routes	(Den Boer, 2020)
	The app includes additional transfer time	(Den Boer, 2020)
	The app limits my options to easily accessible transportation modes	(Den Boer, 2020)
	The app limits my walking distance	(Den Boer, 2020)
	The app provides information on the traffic changes during my journey and recommends updates accordingly	(Den Boer, 2020)
Personalization	The app takes costs into consideration when displaying my travel options	(Den Boer, 2020)
	The app takes time into consideration when displaying my travel options	(Den Boer, 2020)
	The app takes the user ratings into consideration when displaying my travel options	(Ashkrof et al., 2020)

	The app takes the transport mode into consideration when displaying my travel options	(Den Boer, 2020)
	The app takes the environmental impact into consideration when displaying my travel options	(Den Boer, 2020)
	The app takes the current weather situation into consideration when displaying my travel options	(Den Boer, 2020)
	The app limits the transport modes based on subscription allowance and other payment requirements	(Den Boer, 2020)
	The app stores and displays information about my previous travels	(Jittrapirom et al., 2017)
	The app is linked with my calendar to adapt my travels to my schedule	(Den Boer, 2020)
	The app personalizes their responses to me (e.g. using my name instead of general terms)	(Jittrapirom et al., 2017)
Payment	I can pay for single tickets through payment providers	(Den Boer, 2020)
	I can pay through prepaid or pay-as-you-go smart card schemes	(Den Boer, 2020)
	I can pay through pre-defined mobility subscriptions	(Den Boer, 2020)
	I can pay using payment terminals in or around individual modalities	(Den Boer, 2020)
	I can pay using direct debit/credit schemes	(Den Boer, 2020)
Booking	I need to confirm my ticket details before checkout	(Den Boer, 2020)
	The app applies discount coupons before checkout	(Den Boer, 2020)
	I can export and print out tickets on paper (e.g. QR-/ barcodes)	(Den Boer, 2020)
	I can digitally store tickets (offline) on mobile devices (e.g. QR-/ barcodes)	(Den Boer, 2020)
	I can choose a tip (percentage) for ride hailing/ taxi drivers	(Den Boer, 2020)
	I can change between anonymous tickets or person-bound tickets	(Den Boer, 2020)
	I can change the tickets I bought through the app	(Jittrapirom et al., 2017)
	I can cancel the tickets I bought through the app	(Jittrapirom et al., 2017)
	I can get a refund in case of delays/malfunctions/bad service (e.g. if my train is delayed due to snow)	("Geld terug bij vertraging | Klantenservice | NS," 2021)
Ticketing	I can select tickets/time slots for each journey and/or transport mode	(Den Boer, 2020)
	I can choose a single ticket, day return or other similar time- or use-restricted schemes	(Den Boer, 2020)

	The app applies joint journey discount (i.e. fare reduction based on travel group size)	(Den Boer, 2020)
	I can compare ticket offers by price between mobility providers/booking offices	(Den Boer, 2020)
	I can compare ticket offers by price based on applicable mobility subscriptions	(Den Boer, 2020)
	I can choose different travel class for public transit tickets	(Den Boer, 2020)
	I can choose from specific seating options (e.g. window seating or more legroom)	(Den Boer, 2020)
	I can select tickets based on age group	(Den Boer, 2020)
	I can select from (third-party) discount offers	(Den Boer, 2020)
	There is a single ticket that gives access to all transportation modes	("UMOS-Alliance," 2020)
	The app enables business-to-business payment by invoicing my employer (e.g. NS Business Card)	("NS-Business Card | NS Zakelijk | NS," 2021)
Social Media	I can share my real-time location with selected other people during transit	(Den Boer, 2020)
	The journey I made can be shared on twitter	("Reisplanner | Reisinformatie | NS," 2021)
	The journey I made can be shared on Facebook	("Reisplanner | Reisinformatie | NS," 2021)
	The journey I made can be shared on Instagram	("Reisplanner | Reisinformatie | NS," 2021)
	The journey I made can be shared on LinkedIn	("Reisplanner | Reisinformatie | NS," 2021)
Assistance	A notification is sent to notify me of changes to my journey	(Jittrapirom et al., 2017)
	A notification is sent to remind me of my departure time	(Jittrapirom et al., 2017)
	A notification is sent to remind me to rate my journeys	(Ashkrof et al., 2020)
	The app provides step-by-step guidance	(Den Boer, 2020)
	The app provides text-to-speech (TTS) directions	(Den Boer, 2020)
	The app provides offline navigation	(Den Boer, 2020)

	I can report an issue with the app	(“Reisplanner | Reisinformatie | NS,” 2021)
	Twenty-Four Hour Customer Service is available through phone	(Jittrapirom et al., 2017)
	Twenty-Four Hour Customer Service is available through live chat	(“Reisplanner | Reisinformatie | NS,” 2021)
	Twenty-Four Hour Customer Service is available through social media	(“Reisplanner | Reisinformatie | NS,” 2021)
	The app has an audio function for visually impaired people	(Jittrapirom et al., 2017)
	The app color pattern is distinguishable for the color blind	(Jittrapirom et al., 2017)
	The app has different text sizes for people with far-sightedness	(Jittrapirom et al., 2017)
	The app has button size usable for people with mobility difficulties	(Jittrapirom et al., 2017)
Ratings	I can rate my overall journey through the app	(Ashkrof et al., 2020)
	I can see rating given by other people	(Ashkrof et al., 2020)
	I can rate individual parts of my journey	(Ashkrof et al., 2020)
Enhancing Services	The app learns from my ratings and adapts my travel options accordingly	(Jittrapirom et al., 2017)
	The app learns from my past travels and adapts my travel options accordingly	(Jittrapirom et al., 2017)
	I can subscribe to car insurance through the app	(“UMOS-Alliance,” 2020)
	I can subscribe to parking subscription through the app	(Jittrapirom et al., 2017)
	I can book entertainment through the app (e.g. movie or theatre)	(“UMOS-Alliance,” 2020)
	I can book accommodation through the app	(“UMOS-Alliance,” 2020)
	The app suggests options for the return trip when booking a one-way trip	(“UMOS-Alliance,” 2020)
	If I travel for an event then the app will have an option to buy tickets for this event	(“UMOS-Alliance,” 2020)

	When I book entertainment/accommodations the app can suggests my journey to the venue as well	("UMOS-Alliance," 2020)
	The app can present a Tour Plan for a city to help me with sightseeing	("EMot," 2021)
	The app can show me points of interest within the city I am visiting	("EMot," 2021)
	The app lets me explore facilities along the route	(Den Boer, 2020)
	I can subscribe to travel insurance through the app	("UMOS-Alliance," 2020)
	I can sign up to become a 'mobility service provider' through the app (e.g. sign up as an Uber driver)	(Ashkrof et al., 2020)
Non-Functional	The app responds quickly to my inputs	(Wiegers & Beatty, 2013)
	The app responds predictably to my inputs	(Wiegers & Beatty, 2013)
	It is easy for me to learn how to use the app	(Wiegers & Beatty, 2013)
	It is easy for me to use the app	(Wiegers & Beatty, 2013)
	The app autocorrects the errors that I make	(Wiegers & Beatty, 2013)
	The app protects against unauthorized access to the app and its data	(Wiegers & Beatty, 2013)

4.2 Solution Service Providers

The functionalities for the service providers (Table 5), is used as the basis for the more detailed list of functionalities for the service providers. The more detailed functionalities will all fall into one of the requirements that is mentioned in Table 5. However, the definitions will be used for the Likert scale in the survey instead of the terms, because the terms used might not be known to participants without experience with MaaS applications (Fahy & Jobber, 2015). The point made for the end-users, the terminology, will be less of a problem for the service providers. Since they will be more familiar with the terminology that is being used in their field. Table 7 covers the functionalities for the service providers that a MaaS application can have. The last column in Table 7 is the source column. This column gives the source that is used as a basis for this definition. Sometimes the source directly mentions the functionalities that are used and sometimes the functionalities are deducted from the information that is given. For example, if an app gives the option to provide feedback to the provider then the provider should also have an option that lets them see the feedback of the

consumers. When looking at this last column it is shown that the functionalities mentioned in Table 7 are either based on literature or based on real life MaaS applications. These sources give the idea that these functionalities are wanted by the service providers of MaaS platforms.

The functionalities that are shown in Table 7 of are designated to different groups that can be seen in the first column of Table 7. These functionalities are grouped together based on a common trade amongst the functionalities. However, there are functionalities left that did not really fit with any of the other groups. These functionalities are therefore grouped together in the group "Other Features". Some functionalities might be covered by two or more different groups. In this scenario the researcher placed the functionality in the group that the researcher thought would have the best fit with the functionality.

The functionalities that are shown in Table 7 might not be able to coexist in the same MaaS platform as the functionalities of the end-users described in Table 6. This might be a problem if both functionalities are important to the relevant stakeholder and a choice has to be made which functionality to include in a MaaS platform. One of the stakeholders will be disappointed in this case. When looking at the functionalities of the service providers many require data from the end-users. However, as long as the non-functional requirement ("The app protects against unauthorized access to the app and its data") of the end-user is met and the data is well protected the functionalities of the service providers and end-users should be able to coexist.

Table 7: Functionalities Survey Service Providers

Group	Definition	Source
Transportation	The application helps determine the optimal number of vehicles for a given transportation mode	(Jittrapirom et al., 2017)
	The application helps relocate the vehicles to the best location for optimal usage	(Jittrapirom et al., 2017)
	The services provided can be changed within the application (e.g. make less vehicles available)	(Economic Commission for Europe, 2020)
	The application helps determine how to improve the utilization of the transport assets	(Technology Scotland &

		Scotland IS, 2018)
	The application takes into account events that take place so the number of vehicles can be adapted accordingly	("EMot," 2021)
Analysis	The application analyses the demand of the users and presents it	(Jittrapirom et al., 2017)
	The application analyses the response of the users to the price of the services and presents it	(Jittrapirom et al., 2017)
	The application analyses the response of the users to the quality of the services and presents it	(Jittrapirom et al., 2017)
	The application calculates the key performance indicators of the service providers	(Hernandez et al., 2020)
	The application analyses the customer complaints to determine problem areas in the service	("Reisplanner | Reisinformatie | NS," 2021)
	The application can filter the previous analysis based on your needs	(Jittrapirom et al., 2017)
Other Services	Service providers can use the application to help to improve the traffic flow	(Economic Commission for Europe, 2020)
	Service providers can use the application to help with traffic management (e.g. indicate road work, accidents, etc.)	(Economic Commission for Europe, 2020)
	The application helps optimize the performance of existing infrastructure	(Technology Scotland & Scotland IS, 2018)
	The application helps the management of the existing parking places in the city	(Technology Scotland & Scotland IS, 2018)
	The application helps determine whether extra parking places are necessary	(Technology Scotland & Scotland IS, 2018)
	The application helps the management of the existing charging places in the city	(Technology Scotland & Scotland IS, 2018)
	The application helps determine whether extra charging places are necessary	(Technology Scotland &

		Scotland IS, 2018)
	The application helps to see how transportation assets are being sued around the city to help insurance providers determine their insurance rates	(Technology Scotland & Scotland IS, 2018)
Other Features	The application helps to improve safety by getting insights into places with a lot of accidents	(Technology Scotland & Scotland IS, 2018)
	The application supports the communication with other providers to help base your decision on all needed information	("UMOS-Alliance," 2020)
	The application shows the air pollution that the transportation modes cause	(Banister, 2008)
	The application shows the carbon emissions that the transportation modes produce	(Banister, 2008)
Non-Functional	The application responds quickly to my inputs	(Wiegers & Beatty, 2013)
	The application responds predictably to my inputs	(Wiegers & Beatty, 2013)
	It is easy for me to learn how to use the application	(Wiegers & Beatty, 2013)
	It is easy for me to use the application	(Wiegers & Beatty, 2013)
	The application autocorrects the errors that I make	(Wiegers & Beatty, 2013)
	The application protects against unauthorized access to the application and its data	(Wiegers & Beatty, 2013)

4.3 Remarks

In this Chapter the potential functionalities of a MaaS platform are displayed. The descriptions of the functionalities in this Chapter goes into further detail than the descriptions of the functionalities in Chapter 2. The functionalities are also grouped together in this Chapter. None of the functionalities that are described in the Tables above cannot be present in the same platform as another functionality, meaning that they should be able to coexist in one MaaS platform.

5. Evaluation

This chapter presents the results of the surveys that was conducted and the evaluation of the lists made in Chapter 4. The participants of the survey were recruited in several ways. As already described in Chapter 3, the survey is distributed to the UMOS group and to people that are known to the researcher. The survey was distributed in the network of the researcher via social media and other means of communication. The participants were also asked by the researcher to pass the survey along to anybody that might be willing to fill in the survey. The survey was opened on 17-02-2021 and was closed on 26-02-2021. In the end, the survey for the end-users was filled in by 71 participants. MaaS applications can be used all over the world. This leads to a big population of which the survey participants should be representable. The sample size should be 370 to be perfectly representable of the target population. This is not the case resulting in a margin of error of 11.6% instead of the normal 5% for the 71 participants that responded. In this scenario the confidence interval is kept at 95% for calculating the sample populations and margin of errors. For the service providers this is not the case with only 5 responses. This means that there will be no strong evidence that the list made in Chapter 4 holds for the service providers. The margin of error would be 45% for the sample size of the service providers compared to the population.

5.1 Demographics Questions

First, the demographic results are presented. These questions can be found in the surveys shown in appendix C and D. First, the results for the end-users will be shown followed by the results for the service providers.

5.1.1 End-Users

As can be seen in Table 8, most of the participants of the study are to some degree familiar with the concept of MaaS platforms. The largest group is clearly the participants that are moderately familiar with a MaaS platform. The other four groups are more evenly distributed. The age distribution of the participants is divided more even with the expectation of the lowest age category and the highest age category, see Figure 4. The lowest age category did not have any participants in the survey. However, this might not be such a bad thing, there are ethical reasons not to use minors in a research program and just to stick with adults. The highest age category did not get a lot of participants. However, this category did get some participants, so there is some data to be used to determine what they prefer to have in an

MaaS application. Figure 5 shows the type of area that the participants live in. As seen in the Figure most of the responders live in an urban environment. The rest of the participants live either in the suburbs or a village. None of the participants live in a rural environment. This properly means that they have decent access to at least one transportation service close to their residents.

Table 8: Familiarity End-Users

How familiar are you with mobility as a service platforms?	**%**
Not at all familiar	19,72%
Slightly familiar	12,68%
Somewhat familiar	15,49%
Moderately familiar	40,85%
Extremely familiar	11,27%

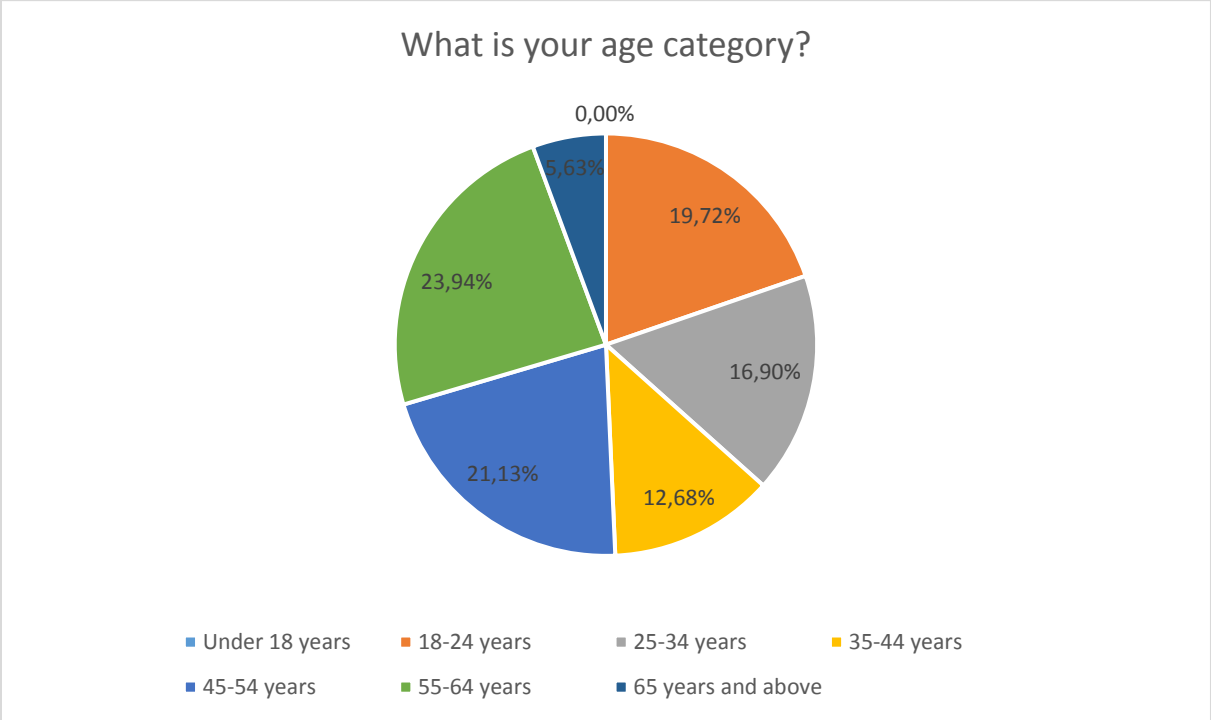


Figure 4: Age Category End-Users

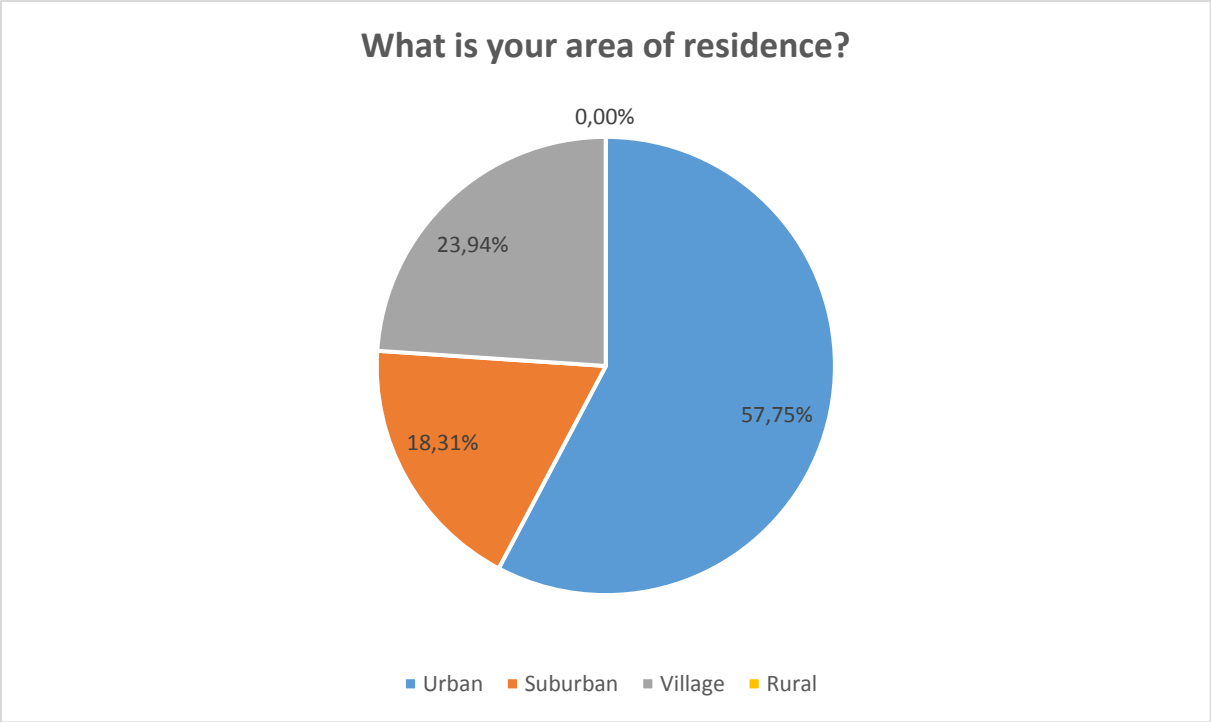


Figure 5: Area of Residence End-Users

The next part of the demographics questions for the end-users goes about their travel behaviour. Figure 6 shows the amount of times that the participants use public transportation. The question did ask the participants to answer for their pre-Covid situation. This way the temporary changes in their behaviour related to the Covid-19 pandemic are not included in the results. The first point to make is that the answer of the people that answer "Other" on the question responded that they rarely use public transportation or only use public transportation on vacation. This means that they do not often use the public transportation system. The second point is that there is a clear split between two types of travellers. None of the participants answered that they use public transportation on a monthly basis. They either use it more than once a month or less than once a month. This leads to two types of travellers whose answers need to be compared. Because one group consists of more frequent travellers with public transportation, while the other group consists of travellers do not use public transportation frequently. It would be interesting to see whether these groups have different preferences towards functionalities of a MaaS platform.

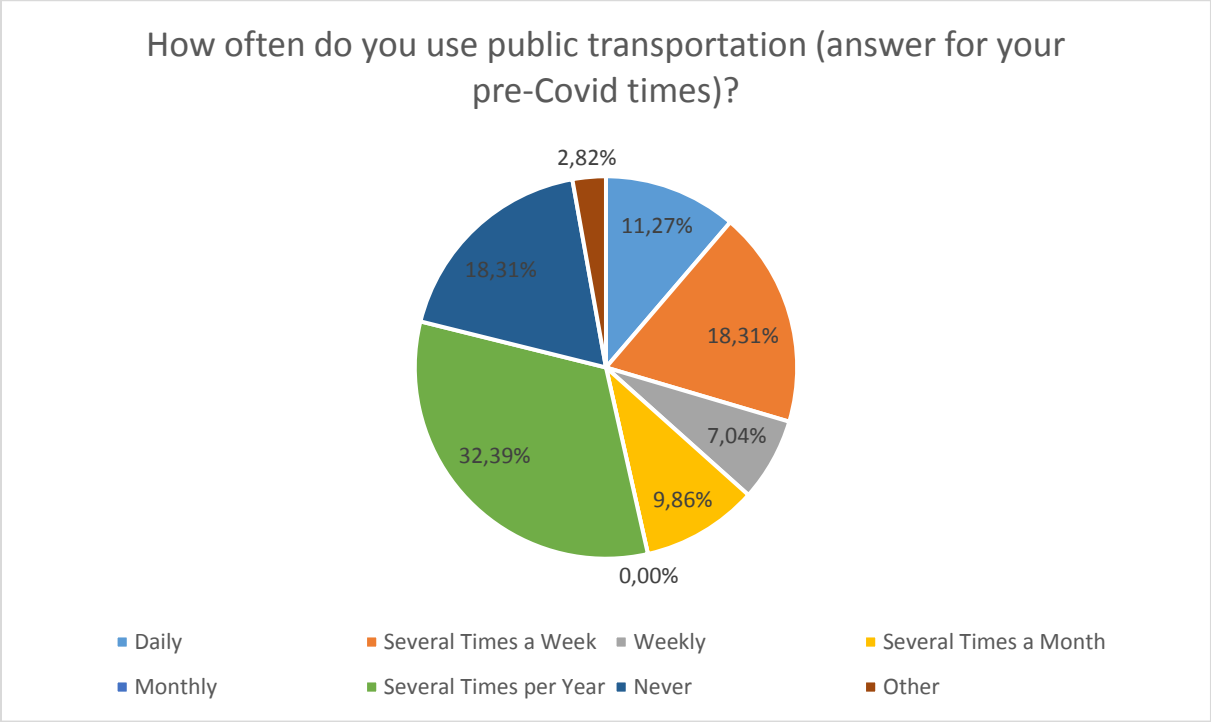


Figure 6: Use of Public Transportation

The last demographic was about the transportation modes that they often used before the Covid-19 pandemic. Figure 7 presents the results regarding the different transportation modes and the percentage of participants that uses them often. As can be seen in Figure 7, the most used transportation mode is the car, followed by the bicycle, walking and public transportation. This corresponds with the data on the amount of trips per transportation mode that can be found on the website of Centraal Bureau voor de Statistiek (CBS) (Centraal Bureau voor de Statistiek, 2021).

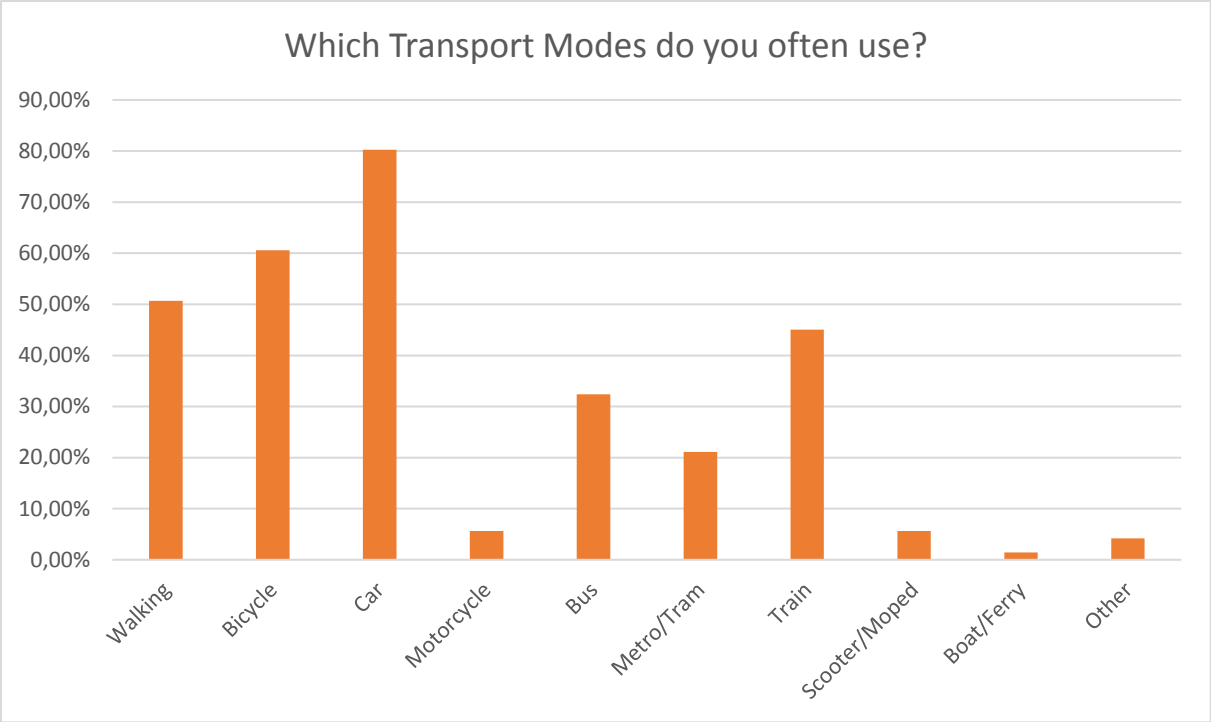


Figure 7: Transportation Modes

5.1.2 Service Providers

All service providers are at least to some degree familiar with MaaS platforms. One of the service providers is extremely familiar with MaaS platforms while the other participants are either slightly familiar (2 participants) or moderately familiar (2 participants) with MaaS platforms.

The response to whether service providers consider MaaS as a business opportunity. 4 of the service providers see MaaS as a business opportunity, with 1 of the service providers being not sure whether it is a business opportunity or not. This leads to none of the responders being sure that MaaS would not be a business opportunity for them.

Figure 8 shows the services that the service providers are considering making available to use in a MaaS platform. All services are considered to make available in a MaaS platform. Public transportation – train/metro/tram is the service that is considered the most by the service providers. But all services having at least 2 service providers considering making that service available. It is shown that MaaS can be a broad concept if it is up to the service providers.

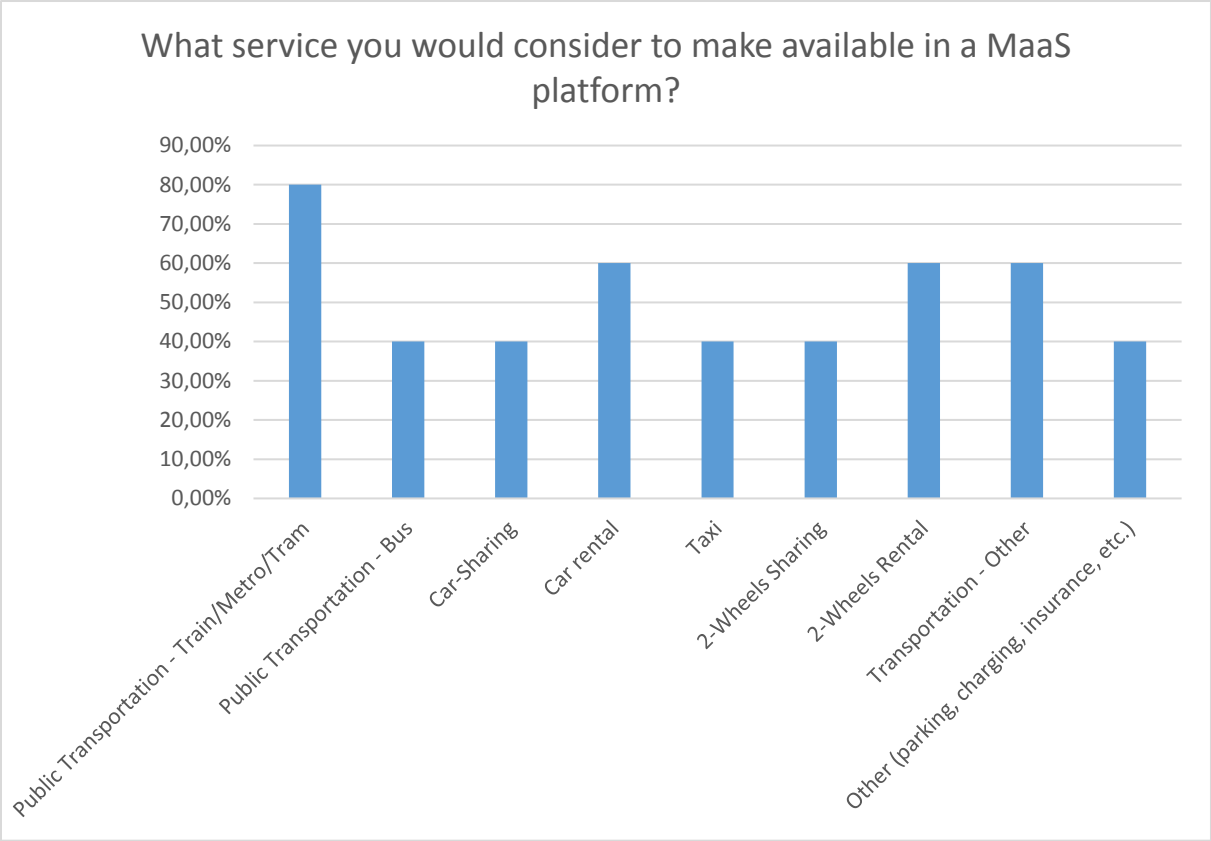


Figure 8: Service of Service Providers

5.2 Results regarding End-Users

This section of the thesis will discuss the results of the questions regarding the preferences of the end-users towards different functionalities of a MaaS platform. The answers of the end-users are shown in Table 9 till Table 18. The numbers under the columns “Unimportant” till “Important” are the number of end-users that gave this specific answer, so these columns show the frequency with which a specific answer was given. The last column, Mean, is the score that is calculated by changing “Unimportant” to 1, “Slightly Unimportant” to 2, “Neutral” to 3, “Slightly Important” to 4, “Important” to 5 and then calculating the mean score over the answer by all end-users. For example, for the functionality “The app provides real time information about my departure times” the calculation of the mean score would be ((1*1)+(2*0)+(3*4)+(4*9)+(5*57))/71 = 4,70. These transformations and calculations were conducted in Microsoft Excel. This transformed data was also transferred to SPSS to help with determining the correlation between the different functionalities in a group. Since the answers to the questions are ordinal data, a non-parametric test such as Spearman's correlation needs to be used to determine the correlation. The data out of the Likert-scale is not normally distributed meaning that it does not meet the conditions to use a parametric test. Therefore, a

non-parametric test such as Spearman's correlation is used. There is a correlation between the different functionalities when there is a significance score below the 0,05. According to Schober, Boer, and Schwarte (2018) a correlation is strong or very strong when the correlation coefficient is above the 0,70. In the sections below all groups of functionalities will be discussed individually.

5.2.1 Planning

Table 9 shows the planning functionalities of a MaaS platform and the opinion of the survey participants towards these functionalities. The most preferred functions of a MaaS platform should have a mean of 4,50. This leads to 5 functionalities in the planning group. These 5 functionalities are show below with the number between the brackets being the mean scores of these functionalities.

- The app provides real time information about my departure times (4,70)
- The app provides real time information about my arrival times (4,58)
- I can change my departure time and date (4,72)
- I can select my departure and destination location (4,89)
- The app provides information on the traffic changes during my journey and recommends updates accordingly (4,52)

When looking at the functionalities that remain, it is clear that with the exception of two functionalities the other functionalities also score relatively high. The two exceptions are “The app limits my options to easily accessible transportation modes” and “The app limits my walking distance”. These functionalities have a mean that scores close to neutral. Meaning the participants to not find these functionalities particularly important. However, they are not completely wasted when adding these functions to a MaaS platform, since they are also not considered particularly unimportant by the end-users.

Table 9: Planning

Definition	Unimportant	Slightly Unimportant	Neutral	Slightly Important	Important	Mean
The app provides real time information about my departure times	1	0	4	9	57	4,70
The app provides real time information about my arrival times	0	0	5	20	46	4,58
I can change my departure time and date	0	0	3	14	54	4,72
The app combines different modes in one journey (e.g. take my private car to X, then the train to Y and then rental bike to destination)	0	2	13	22	34	4,24
I can select my departure and destination location	0	0	2	4	65	4,89
I can select a location on a map and the app will provide directions to this location	0	2	11	23	35	4,28
I can choose my favourite locations and/or routes	0	9	9	29	24	3,96
The app includes additional transfer time	0	3	9	19	40	4,35
The app limits my options to easily accessible transportation modes	4	7	30	19	11	3,37
The app limits my walking distance	4	15	24	21	7	3,17
The app provides information on the traffic changes during my journey and recommends updates accordingly	0	0	5	24	42	4,52

When considering the Spearman's correlations between the different functionalities it can be seen for all significant correlation between the different functionalities; the correlation is also positive. This means that if one functionality in this group scores higher the rest will also score higher. However, none of the correlation coefficients are above the 0,70, meaning that none of the significant correlations are strong correlations.

5.2.2 Personalization

Table 10 shows the personalization functionalities of a MaaS platform and the opinion of the survey participants towards these functionalities. This leads to 1 most preferred functionality in the personalization group. This functionality is:

- The app takes time into consideration when displaying my travel options (4,68)

It is important to notice that of the 6 different things that a MaaS platform can take into consideration when displaying the travel options, the participants only find "time" a crucial factor. However, "costs" and "transport mode" have a mean that is above the 4. This means that participants do find these aspects important to have in a MaaS platform. All other personalization functionalities score around the 3 when looking at their means. Meaning that the participants have a neutral view on these functionalities and do not find them important or unimportant. The exception is "The app personalizes their responses to me (e.g. using my name instead of general terms)", which has a low mean with a 2,17. This is a functionality that the participants would not like to see in a MaaS platform.

Table 10: Personalization

Definition	**Unimportant**	**Slightly Unimportant**	**Neutral**	**Slightly Important**	**Important**	**Mean**
The app takes costs into consideration when displaying my travel options	0	6	9	28	28	4,10
The app takes time into consideration when displaying my travel options	0	0	2	19	50	4,68
The app takes the user ratings into consideration when displaying my travel options	2	18	31	15	5	3,04
The app takes the transport mode into consideration when displaying my travel options	1	1	9	28	32	4,25
The app takes the environmental impact into consideration when displaying my travel options	12	14	17	18	10	3,00

The app takes the current weather situation into consideration when displaying my travel options	4	19	17	21	10	3,20
The app limits the transport modes based on subscription allowance and other payment requirements	5	7	24	27	8	3,37
The app stores and displays information about my previous travels	5	17	19	17	13	3,23
The app is linked with my calendar to adapt my travels to my schedule	13	18	17	16	7	2,80
The app personalizes their responses to me (e.g. using my name instead of general terms)	25	19	19	6	2	2,17

When considering the Spearman's correlations between the different functionalities it can be seen for all significant correlation between the different functionalities; the correlation is also positive. And as can be expected, most of the filter options ("The app takes X into consideration when displaying my travel options") have a significant positive correlation with each other. With the costs being significantly positive correlated with all other filter options and the other options having at least a significant positive correlation with 2 out of the 5 other filter options. However, none of the correlation coefficients are above the 0,70, meaning that none of the significant correlations are strong correlations.

5.2.3 Payment

Table 11 shows the payment functionalities of a MaaS platform and the opinion of the survey participants towards these functionalities. In the payment group this means that none of the functionalities score higher than a 4,50. However, all functionalities have a mean around the 4. Meaning that all payment functionalities are at least considered slightly important by the participants with "single tickets" being the most important and "subscriptions" being the least important. Since all functionalities are at least considered slightly important it might be a good idea to have all payment options on the MaaS platform to give the end-users the option to use the function that best suits their needs.

Table 11: Payment

Definition	Unimportant	Slightly Unimportant	Neutral	Slightly Important	Important	Mean
I can pay for single tickets through payment providers	0	2	11	27	31	4,23
I can pay through prepaid or pay-as-you-go smart card schemes	3	4	21	26	17	3,70
I can pay through pre-defined mobility subscriptions	4	3	23	25	16	3,65
I can pay using payment terminals in or around individual modalities	1	5	17	25	23	3,90
I can pay using direct debit/credit schemes	3	5	16	20	27	3,89

When considering the Spearman's correlations between the different functionalities it can be seen for all significant correlation between the different functionalities; the correlation is also positive. This means that if one functionality in this group scores higher the rest will also score higher. However, none of the correlation coefficients are above the 0,70, meaning that none of the significant correlations are strong correlations.

5.2.4 Booking

Table 12 shows the booking functionalities of a MaaS platform and the opinion of the survey participants towards these functionalities. This leads to 3 most preferred functionalities in the booking group. These 3 functionalities are:

- I can digitally store tickets (offline) on mobile devices (e.g. QR-/ barcodes) (4,58)
- I can cancel the tickets I bought through the app (4,68)
- I can get a refund in case of delays/malfunctions/bad service (e.g. if my train is delayed due to snow) (4,51)

There are other functionalities that score close to the 4,50. These functionalities are “I need to confirm my ticket details before checkout” with a 4,35 and “I can change the tickets I bought through the app” with a 4,44, indicating that these functionalities are considered important as well by the participants. One thing that comes forward here is that the ability to “save tickets on the devices” is more important than the ability to be able to “print out the tickets”. There is one exception in the booking group that scores low compared to the other functionalities in the group, “I can choose a tip (percentage) for ride hailing/ taxi drivers”. This functionality only scores 3 out of 5, placing the mean view of the participants towards this functionality on neutral.

Table 12: Booking

Definition	**Unimportant**	**Slightly Unimportant**	**Neutral**	**Slightly Important**	**Important**	**Mean**
I need to confirm my ticket details before checkout	1	3	8	17	42	4,35
The app applies discount coupons before checkout	3	3	11	24	30	4,06
I can export and print out tickets on paper (e.g. QR-/ barcodes)	8	10	10	20	23	3,56
I can digitally store tickets (offline) on mobile devices (e.g. QR-/ barcodes)	0	2	2	20	47	4,58
I can choose a tip (percentage) for ride hailing/ taxi drivers	6	15	28	17	5	3,00
I can change between anonymous tickets or person-bound tickets	3	9	24	25	10	3,42
I can change the tickets I bought through the app	0	0	7	26	38	4,44
I can cancel the tickets I bought through the app	0	0	3	17	51	4,68
I can get a refund in case of delays/malfunctions/bad service (e.g. if my train is delayed due to snow)	0	1	7	18	45	4,51

When considering the Spearman's correlations between the different functionalities it can be seen for all significant correlation between the different functionalities; the correlation is also positive. This means that if one functionality in this group scores higher the rest will also score higher. However, none of the correlation coefficients are above the 0,70, meaning that none of the significant correlations are strong correlations.

5.2.5 Ticketing

Table 13 shows the ticketing functionalities of a MaaS platform and the opinion of the survey participants towards these functionalities. This leads to 1 most preferred functionality in the ticketing group. This functionality is:

- I can choose a single ticket, day return or other similar time- or use-restricted schemes (4,52)

When looking at the other functionalities in the ticketing group it is noticeable that most of the functionalities score higher than a 3,50 out of 5. This means that the participants do not find these functionalities the most important to have, but they do consider them slightly important to have. So, it is worth considering having these functionalities in a MaaS platform. The exception is the functionality "I can select tickets based on age group". With a score below the 3 this functionality is considered more unimportant than important. Therefore, it might be best to leave this functionality out of a MaaS platform.

Table 13: Ticketing

Definition	**Unimportant**	**Slightly Unimportant**	**Neutral**	**Slightly Important**	**Important**	**Mean**
I can select tickets/time slots for each journey and/or transport mode	0	2	11	25	33	4,25
I can choose a single ticket, day return or other similar time- or use-restricted schemes	0	1	5	21	44	4,52
The app applies joint journey discount (i.e. fare reduction based on travel group size)	3	6	13	28	21	3,82

I can compare ticket offers by price between mobility providers/booking offices	1	6	17	26	21	3,85
I can compare ticket offers by price based on applicable mobility subscriptions	1	4	32	21	13	3,58
I can choose different travel class for public transit tickets	2	5	18	22	24	3,86
I can choose from specific seating options (e.g. window seating or more legroom)	7	7	16	25	16	3,51
I can select tickets based on age group	12	19	14	15	11	2,92
I can select from (third-party) discount offers	2	9	22	22	16	3,58
There is a single ticket that gives access to all transportation modes	2	3	6	20	40	4,31
The app enables business-to-business payment by invoicing my employer (e.g. NS Business Card)	4	3	22	24	18	3,69

When considering the Spearman's correlations between the different functionalities it can be seen for all significant correlation between the different functionalities; the correlation is also positive. This means that if one functionality in this group scores higher the rest will also score higher. However, none of the correlation coefficients are above the 0,70, meaning that none of the significant correlations are strong correlations.

5.2.6 Social Media

Table 14 shows the social media functionalities of a MaaS platform and the opinion of the survey participants towards these functionalities. The functionalities regarding social media are not popular with the participants. With all functionalities scoring in the (slightly) unimportant region. Based on these scores the best advice is to leave the sharing options out of the MaaS platform, since these options are widely considered unimportant by the end-users.

Table 14: Social Media

Definition	Unimportant	Slightly Unimportant	Neutral	Slightly Important	Important	Mean
I can share my real-time location with selected other people during transit	18	18	14	16	5	2,61
The journey I made can be shared on twitter	54	9	8	0	0	1,35
The journey I made can be shared on Facebook	55	9	7	0	0	1,32
The journey I made can be shared on Instagram	55	9	7	0	0	1,32
The journey I made can be shared on LinkedIn	54	9	8	0	0	1,35

The Spearman's correlations between the different functionalities can be seen for all significant correlations between the different functionalities; the correlation is also positive. It is clear that the "sharing your journey" functionalities are all strongly significantly positively correlated with each other, with all correlation coefficients being above the 0,844. This can be explained by the functionalities being the same only on a different social media platform. The functionality "to share your real-time locations" is only significantly correlated with "sharing on twitter" and not with any of the other social media functionalities. But with a correlation coefficient of 0,307 this is not a strong correlation.

5.2.7 Assistance

Table 15 shows the assistance functionalities of a MaaS platform and the opinion of the survey participants towards these functionalities. This leads to 1 most preferred functionality in the assistance group. This functionality is:

- A notification is sent to notify me of changes to my journey (4,72)

A clear difference can be seen between different assistance functionalities that have to some degree the same features. The three notification functions score differently in that "notifying about changes and the departure time" are considered important, while "a notification about

rating your journeys" is a functionality that the participants do not want. The same can be seen in customer service. "Customer service through live chat and phone" are considered far more important than "customer service through social media".

Table 15: Assistance

Definition	Unimportant	Slightly Unimportant	Neutral	Slightly Important	Important	Mean
A notification is sent to notify me of changes to my journey	0	0	2	16	53	4,72
A notification is sent to remind me of my departure time	1	3	12	33	22	4,01
A notification is sent to remind me to rate my journeys	33	17	13	6	2	1,97
The app provides step-by-step guidance	0	7	16	32	16	3,80
The app provides text-to-speech (TTS) directions	11	13	26	12	9	2,93
The app provides offline navigation	3	3	12	23	30	4,04
I can report an issue with the app	3	0	9	30	29	4,15
Twenty-Four Hour Customer Service is available through phone	4	7	20	24	16	3,58
Twenty-Four Hour Customer Service is available through live chat	3	9	18	26	15	3,58
Twenty-Four Hour Customer Service is available through social media	18	14	24	11	4	2,56
The app has an audio function for visually impaired people	2	4	19	15	31	3,97
The app color pattern is distinguishable for the color blind	2	6	19	14	30	3,90
The app has different text sizes for people with far-sightedness	2	4	15	16	34	4,07
The app has button size usable for people with mobility difficulties	2	1	18	17	33	4,10

With the exception of the functionality “A notification is sent to remind me to rate my journeys” pretty much all other functionalities are significantly positively correlated with each other. This can be explained by the mean score of this functionality being lower than the rest of the functionalities. The last four functionalities in Table 15 are the only ones that have a strong correlation with each other with the lowest correlation coefficient being 0,874. All other significant correlations have a correlation coefficient below 0,70.

5.2.8 Ratings

Table 16 shows the rating functionalities of a MaaS platform and the opinion of the survey participants towards these functionalities. None of the rating functionalities are considered important by the participants. They all score around the neutral score. This means that none of the rating functionalities are really needed for a MaaS platform.

Table 16: Ratings

Definition	Unimportant	Slightly Unimportant	Neutral	Slightly Important	Important	Mean
I can rate my overall journey through the app	8	15	30	16	2	2,85
I can see rating given by other people	8	14	25	18	6	3,00
I can rate individual parts of my journey	11	14	25	17	4	2,85

The Spearman's correlations are significant and positive for all rating functionalities. This means that the changes to one of the rating functionalities would have an impact on all other rating functionalities. The correlation coefficient between “rate my overall journey” and “ratings given by other people” is 0,633 and therefore not a strong correlation. The other two correlation have a correlation coefficient above the 0,70 meaning that those correlations are strong.

5.2.9 Enhancing Services

Table 17 shows the enhancing services functionalities of a MaaS platform and the opinion of the survey participants towards these functionalities. Most of the enhancing functions score relatively low. This can be because of different reasons. The first reason is that participants might only want the basic functionalities in a MaaS platform and these enhancing functionalities might be too much to have on a MaaS platform. Meaning that the participants just do not want these functionalities. Secondly, most of these functionalities do not yet exist in the current MaaS applications. Meaning that the participants do not have any experience with the functions. They might not be considered important since users do not have a clear view of how they would use them in an application.

Table 17: Enhancing Services

Definition	**Unimportant**	**Slightly Unimportant**	**Neutral**	**Slightly Important**	**Important**	**Mean**
The app learns from my ratings and adapts my travel options accordingly	11	6	18	27	9	3,24
The app learns from my past travels and adapts my travel options accordingly	7	9	17	30	8	3,32
I can subscribe to car insurance through the app	33	17	13	4	4	2,00
I can subscribe to parking subscription through the app	15	15	12	20	9	2,90
I can book entertainment through the app (e.g. movie or theatre)	37	14	10	10	0	1,90
I can book accommodation through the app	28	11	15	15	2	2,32
The app suggests options for the return trip when booking a one-way trip	3	8	20	28	12	3,54
If I travel for an event then the app will have an option to buy tickets for this event	20	14	16	19	2	2,56

When I book entertainment/accommodations the app can suggests my journey to the venue as well	13	13	18	23	4	2,89
The app can present a Tour Plan for a city to help me with sightseeing	11	7	23	24	6	3,10
The app can show me points of interest within the city I am visiting	7	7	18	32	7	3,35
The app lets me explore facilities along the route	9	8	17	28	9	3,28
I can subscribe to travel insurance through the app	30	13	18	7	3	2,15
I can sign up to become a 'mobility service provider' through the app (e.g. sign up as an Uber driver)	32	10	18	10	1	2,13

With the exception of the functionality "The app learns from my past travels and adapts my travel options accordingly" pretty much all other functionalities are significantly positively correlated with each other. This means that if one functionality in this group scores higher the rest will also score higher. However, there is only one correlation that is strong with a correlation coefficient above the 0,70. This is the correlation between "the Tour Plan" and "the points of interest" with a correlation coefficient 0,861.

5.2.10 Non-Functional End-Users

Table 18 shows the non-functional requirements of a MaaS platform and the opinion of the survey participants towards these requirements. The most preferred requirements of a MaaS platform should have a mean of 4,50. This leads to 4 requirements in the non-functional group. These 4 requirements are:

- The app responds quickly to my inputs (4,63)
- It is easy for me to learn how to use the app (4,68)
- It is easy for me to use the app (4,82)
- The app protects against unauthorized access to the app and its data (4,82)

The two remaining requirements score also above the 4. This means that these non-functional requirements are also considered important by the end-users. The non-functional requirements are all considered important by the end-users. This makes sense since an application that does not function well will normally not be used by users.

Table 18: Non-Functional End-Users

Definition	Unimportant	Slightly Unimportant	Neutral	Slightly Important	Important	Mean
The app responds quickly to my inputs	0	0	6	14	51	4,63
The app responds predictably to my inputs	1	3	15	22	30	4,08
It is easy for me to learn how to use the app	0	0	1	21	49	4,68
It is easy for me to use the app	0	0	0	13	58	4,82
The app autocorrects the errors that I make	0	4	15	26	26	4,04
The app protects against unauthorized access to the app and its data	0	0	3	7	61	4,82

When considering the Spearman's correlations between the different functionalities it can be seen for all significant correlation between the different functionalities; the correlation is also positive. This means that if one functionality in this group scores higher the rest will also score higher. However, none of the correlation coefficients are above the 0,70, meaning that none of the significant correlation are strong correlations.

5.3 Results regarding Service Providers

This section of the thesis will discuss the results of the questions regarding the preferences of the service providers towards different functionalities of a MaaS platform. The answers of the service providers are shown in Table 19 till Table 23. The numbers under the columns “Unimportant” till “Important” are the number of service providers that gave this specific answer, so these columns show the frequency with which a specific answer was given. The last column, Mean, is the score that is calculated by changing “Unimportant” to 1, “Slightly Unimportant” to 2, “Neutral” to 3, “Slightly Important” to 4, “Important” to 5 and then calculating the mean score over the answer by all service providers. These transformations and calculation were conducted in Microsoft Excel. Since the number of responses is low and

sometimes all participants answer the question in the same way it is not always possible to determine the Spearman's correlation as was done for the end-users. In the sections below all groups of functionalities will be discussed individually.

5.3.1 Transportation

Table 19 shows the transportation functionalities of a MaaS platform and the opinion of the survey participants towards these functionalities. The most preferred functions of a MaaS platform should have a mean of 4,50. This leads to 1 functionality in the transportation group:

- The application helps relocate the vehicles to the best location for optimal usage (4,60)

However, all other functionalities score above the 4 meaning that all are at least considered important by the service providers.

Table 19: Transportation

Definition	**Unimportant**	**Slightly Unimportant**	**Neutral**	**Slightly Important**	**Important**	**Mean**
The application helps determine the optimal number of vehicles for a given transportation mode	0	1	0	1	3	4,20
The application helps relocate the vehicles to the best location for optimal usage	0	0	0	2	3	4,60
The services provided can be changed within the application, e.g. make less vehicles available	0	0	0	4	1	4,20
The application helps determine how to improvement of the utilization of the transport assets	0	0	1	3	1	4,00
The application takes into account events that take place so the number of vehicles can be adapted accordingly	0	0	0	3	2	4,40

5.3.2 Analysis

Table 20 shows the analysis functionalities of a MaaS platform and the opinion of the survey participants towards these functionalities. This leads to 1 most preferred functionality in the analysis group:

- The application analyses the demand of the users and presents it (4,60)

However, all other functionalities, with the exception of the filter option, score above the 4 meaning that they are considered important by the service providers. “The filter option” scores a 3,4 showing that it is far less important to have than the other functionalities, but it is still considered more important than unimportant.

Table 20: Analysis

Definition	**Unimportant**	**Slightly Unimportant**	**Neutral**	**Slightly Important**	**Important**	**Mean**
The application analyses the demand of the users and presents it	0	0	0	2	3	4,60
The application analyses the response of the users to the price of the services and presents it	0	0	0	4	1	4,20
The application analyses the response of the users to the quality of the services and presents it	0	0	1	1	3	4,40
The application calculates the key performance indicators of the service providers	0	0	1	1	3	4,40
The application analyses the customer complaints to determine problem areas in the service	0	0	0	3	2	4,40
The application can filter the previous analysis based on your needs	0	1	1	3	0	3,40

5.3.3 Other Services

Table 21 shows the other services functionalities of a MaaS platform and the opinion of the survey participants towards these functionalities. With the score varying from the 3 till the 4 it is shown that these functionalities are not considered unimportant, but also not as important as the functionalities that were shown in the other two Tables for the service providers.

Table 21: Other Services

Definition	**Unimportant**	**Slightly Unimportant**	**Neutral**	**Slightly Important**	**Important**	**Mean**
Service providers can use the application to help to improve the traffic flow	0,00%	20,00 %	20,00 %	40,00 %	20,00 %	3,60
Service providers can use the application to help with traffic management (e.g. indicate road work, accidents, etc.)	0,00%	20,00 %	20,00 %	60,00 %	0,00%	3,40
The application helps optimize the performance of existing infrastructure	0	1	1	2	1	4,00
The application helps the management of the existing parking places in the city	0	1	1	3	0	3,60
The application helps determine whether extra parking places are necessary	0	0	0	5	0	3,20
The application helps the management of the existing charging places in the city	0	1	1	2	1	3,80
The application helps determine whether extra charging places are necessary	0	2	0	3	0	3,40
The application helps to see how transportation assets are being sued around the city to help insurance providers determine their insurance rates	0	1	1	1	2	3,20

5.3.4 Other Features

Table 22 shows the other services functionalities of a MaaS platform and the opinion of the survey participants towards these functionalities. The two functionalities that have to do with environmental impact, "air pollution" and "carbon emissions", are not considered important functionalities of a MaaS platform by the service providers. The other functionalities mentioned in Table 22 score between 3 till the 4. This means that they are not unimportant, but also not as important as the functionalities that were shown in the first two Tables of the service providers.

Table 22: Other Features

Definition	Unimportant	Slightly Unimportant	Neutral	Slightly Important	Important	Mean
The application helps to improve safety by getting insights into places with a lot of accidents	0	1	1	1	2	3,80
The application supports the communication with other providers to help base your decision on all needed information	0	1	1	2	1	3,60
The application shows the air pollution that the transportation modes cause	2	0	1	2	0	2,60
The application shows the carbon emissions that the transportation modes produce	2	0	1	1	1	2,80

5.3.5 Non-Functional Service Providers

Table 23 shows the non-functional requirements of a MaaS platform and the opinion of the survey participants towards these requirements. The most preferred requirements of a MaaS platform should have a mean of 4,50. This leads to 4 requirements in the non-functional group. These 4 requirements are:

- The application responds quickly to my inputs (4,80)

- It is easy for me to learn how to use the application (4,80)
- It is easy for me to use the application (5,00)
- The application protects against unauthorized access to the application and its data (4,60)

Even though the service providers and the end-users are different types of stakeholders their responses to the non-functional requirement have the same meaning. Both stakeholders find the four requirements mentioned above the most important non-functional requirements with the two remaining requirements being important, but not as important as the other four requirements.

Table 23: Non-Functional Service Providers

Definition	Unimportant	Slightly Unimportant	Neutral	Slightly Important	Important	Mean
The application responds quickly to my inputs	0	0	0	1	4	4,80
The application responds predictably to my inputs	0	0	2	0	3	4,20
It is easy for me to learn how to use the application	0	0	0	1	4	4,80
It is easy for me to use the application	0	0	0	0	5	5,00
The application autocorrects the errors that I make	1	0	0	3	1	3,60
The application protects against unauthorized access to the application and its data	0	0	0	2	3	4,60

5.4 Groups

5.4.1 Frequency

In this part of the thesis different groups that filled out the survey will be compared. The first groups that will be compared are the frequent travellers with public transportation (more than once a month) and the infrequent travellers with public transportation (less than once a

month). In order to do this type of analysis the data was transferred from Microsoft Excel to SPSS. This made it possible to use a non-parametric test on the answers to the questions, because the data for the preferences are ordinal. Since the comparison is between the frequent and infrequent travellers and therefore only two groups, the Mann-Whitley U Test is the best method for that according to SPSS. When looking at the paper of Nachar (2008) confirms this by calling the Mann-Whitley U test one of the most powerful non-parametric tests. This leads to several functionalities having the null-hypothesis, of the values being the same for both groups, be rejected. The null-hypothesis is rejected when the $p<0,05$. The functionalities that have different outcomes for both groups are:

- I can change my departure time and date
- I can select my departure and destination location
- I can select a location on a map and the app will provide directions to this location
- The app includes additional transfer time
- I can pay using direct debit/credit schemes
- I can export and print out tickets on paper (e.g. QR-/ barcodes)
- I can choose different travel class for public transit tickets
- The app suggests options for the return trip when booking a one-way trip
- If I travel for an event then the app will have an option to buy tickets for this event
- When I book entertainment/accommodations the app can suggests my journey to the venue as well
- The app can present a Tour Plan for a city to help me with sightseeing
- The app responds quickly to my inputs

For the first two options mentioned above, the frequent traveller has a higher mean score. Both groups find these extremely important to have in a MaaS platform, but the frequent travellers find it even more important than the infrequent travellers. Indicating again that these functionalities should be present in a MaaS platform. The third point is the other way around with the infrequent travellers finding the option to “select a location on a map” very important, with a mean score of 4,47. The frequent travellers however do not find it as important with a mean score of 4,06. This functionality would therefore be more interesting to have if you also focus on infrequent traveller then when you only focus on frequent travellers. The exact same logic can also be used on the next point, “the additional transfer time”. “The direct debit/credit scheme” has a big difference between the mean scores of the two groups

with the frequent travellers scoring much higher (4,36) than the infrequent travellers (3,47). Since the main users of a MaaS platform would be the frequent travellers it might be a good idea to include this functionality in a MaaS platform. “The option to export tickets/print tickets” is more popular under the infrequent travellers than the frequent traveller. This can be because the infrequent traveller is not used to travelling with only a digital ticket and they might want the security of having a paper ticket in their hands. “For choosing the classes” the infrequent travellers also find this more important than the frequent travellers. This might be the case since the frequent travellers have to use public transportation anyway, so they might not care in which class they sit. While the infrequent travellers also want to be comfortable on the few occasions that they use public transportation. The next four options that do not test the same for both groups all fall into the enhancing service group. While all have a mean around the 3 the infrequent travellers find the functionalities “around the return trip, events/accommodations and tour plan” more important than the frequent travellers. This can be explained by the fact the infrequent travellers are more likely to be day trip, which fits better with these enhancing functionalities than the frequent travellers. “The quick response” is extremely important to both groups, but just more important to the frequent traveller than the infrequent traveller.

5.4.2 Familiar

The second groups that will be compared on a different level of familiarity with the MaaS platform. In order to do this type of analysis the data was transferred from Microsoft Excel to SPSS. This made it possible to use a non-parametric test on the answers to the questions, because the data for the preferences are ordinal. Since the comparison is between 5 groups, the Mann-Whitley U Test is no longer the best test to compare the groups. The Kruskal-Wallis Test (Ostertagova, Ostertag, & Kováč, 2014) is an extension of the Mann-Whitley U Test, but in the situation that more than 2 groups have to be compared with each other. This leads to several functionalities having the null-hypothesis, of the values being the same for both groups, be rejected. The null-hypothesis is rejected when the $p<0,05$. The functionalities that have different outcomes for 5 groups are:

- I can choose a tip (percentage) for ride hailing/ taxi drivers
- I can select tickets/time slots for each journey and/or transport mode
- The journey I made can be shared on twitter
- The app learns from my past travels and adapts my travel options accordingly

- I can book accommodation through the app
- The app autocorrects the errors that I make

For the functionality involving “the tip” it is the case that the people considering themselves somewhat too moderately familiar find this far more important to have in a MaaS platform when compared with the other groups. With mean scores variating from 3,45 for the somewhat familiar group to 2,22 for the slightly familiar group. For the second functionality the group that is slightly familiar with MaaS have a neutral perspective towards this functionality, while the rest of the groups find it important to extremely important. While the mean scores for “sharing on twitter” is different for the 5 groups, all groups still consider it not important to have, so the view on this functionality does not change. For the functionality involving “learning from past travel” there is a big difference between the groups. The group that is slightly familiar comes to a mean score of a 2,00 while the group that is extremely familiar comes to a mean score of 3,88. The group that is moderately familiar with MaaS also has a high mean score with 3,79. This shows that people that are better acquainted with MaaS would want this functionality in the MaaS application while the people that are not really acquainted with MaaS do not want this functionality in a MaaS platform. While the mean scores for “booking accommodations” is different for the 5 groups, all groups still consider it not important to have, so the view on this functionality does not change. For the last functionality with a significant difference for the 5 groups, “The app autocorrects the errors that I make”, the mean score is much higher for the people that are not familiar with MaaS. This would mean that for the people that are familiar with MaaS it is not as important that the app autocorrects you. However, if you want to convince people that are not familiar with MaaS to use MaaS this might be a functionality that you can use to convince them.

5.5 Remarks

In this Chapter the evaluation of the solution presented in Chapter 4 is conducted. This was done by conducting a survey with 71 responses for the end-users and 5 responses for the service providers. In section 5.2 and section 5.3 the bullet points show the functionalities that are extremely important to have in a MaaS platform. The last question of the survey, on whether the participants missed any functionalities, did not result in a new functionality that was missed during this research. Functionalities that would make day trips more comfortable would be an addition to a MaaS platform for the infrequent travellers. Different levels of

familiarity with a MaaS platform resulted in the functionality involving “learning from past travels” being rated higher than originally thought. Since it is more important to people that are moderately/extremely familiar with MaaS.

6. Conclusion

In this chapter, the conclusion of this research will be shared. The limitation of this research will also be discussed in this chapter. As well as the possible future research areas that are still left open by this research.

6.1 Conclusion

The objective of this research was to identify which functional requirements and non-functional requirements are preferred by the end-users and the service providers for a Mobility as a service platform. Based on the literature review of both literature and real-life MaaS applications a list of functionalities for both end-users and service providers was created. These lists of functionalities can be found in Table 6 and Table 7.

For evaluation purpose a survey was taken to determine whether this was actually the case. The conclusion based on the evaluation is that the more basic functionalities of a MaaS platform are deemed the most important by the end-users. While the functionalities that have to do with social media are deemed unnecessary for a MaaS application. For the service providers, only the functionalities related to the environmental impact are deemed not important to have in a MaaS platform. The other functionalities suggested in Table 7 are almost never deemed extremely important, but are almost always considered important to have at least.

A comparison between the frequent and infrequent travellers revealed that functionalities that would make day trips more comfortable would be a better addition to a MaaS platform for the infrequent travellers than for the frequent travellers. The comparison between the different levels of familiarity with a MaaS platform resulted in the functionality involving “learning from past travels” being rated higher than originally thought. Since it is more important to people that are moderately/extremely familiar with MaaS than to people that are just slightly familiar with MaaS.

The properties of the artifact are all met by the solution and the evaluation that followed. The evaluation shows which of the functionalities are preferred over the other functionalities. As was also described above. The artifact makes a distinction between end-users and service providers by having separated lists of functionalities for both stakeholders. The lists are based

on literature and existing MaaS applications of which all functionalities should be able to be present in a MaaS platform. The last property is also met, because all functionalities of the end-users and the service providers can be present in the same MaaS platform.

There are several practical implications as a result of this research. This research discovered that while being present in MaaS applications social media does not have a high importance amongst end-users. By not including social media in your MaaS application you could save implementation time and money while not losing something that the users find important. Another practical implication is that users really want the basic functionalities in a MaaS platform. The enhancing functionalities are not necessarily deemed unimportant, but if these functionalities would not be present it would not harm a MaaS providers as much. The practical implication for the service providers is that the functionalities related to the environmental impact are not needed in a MaaS platform. The rest of the functionalities would be required for a MaaS platform.

6.2 Limitations

A limitation of this study is that there were not enough responses from the service providers to meet the requirements to have an adequate number of responses to the survey. This means that the results for the service providers are less reliable than the results for the end-users. For the end-users there are also not enough responses to perfectly represent the population. However, the evaluation of the survey outcomes of the end-users is better than the once of the service providers.

The survey was distributed amongst people that are known to the researcher. This leads to the vast majority of the responders being located in the Netherlands. There were a few exceptions, for example one participant lives in Switzerland. However, since the vast majority of the responders live in the Netherlands, the chances are that the results might not be true for other areas of the world.

This research looked into the preferences of the two stakeholders regarding different functionalities of a MaaS platform. However, these participants are asked a lot of functionalities, it might not be possible to have all these functionalities in a single app,

because this might not be technological or economical possible for the MaaS developer. If these things are taken into account the participants might respond differently.

6.3 Future Work

As already mentioned in the limitations section of the report, the vast majority of the responders live in the Netherlands. It might be interesting for future work to see if the results stay the same in a country where the bike culture is not as strongly present as is the case in the Netherlands (Haustein, Kroesen, & Mulalic, 2020). This would also result in more responses which would also meet the requirement set for the sample population that is needed to have enough statistical power for the survey results.

While this research does look at existing MaaS applications to determine which functionalities can be in a MaaS platform, it does not look at what is missing from the existing MaaS applications. The current MaaS application might already be pretty close to what the consumers want. Therefore, it would be interesting for future work to see which functionality people are missing from the current MaaS applications.

Another possibility for future work is to use different data collection methods. For this research the objective was to identify the preferences of the end-users and service providers. This was done using a survey with Likert-scale questions. However, with a different data collection method, like interviews or focus groups, different information regarding the preferences of end-users and service providers can be discovered. This would add a different perspective to the preference and therefore would be interesting for future works.

The last future work opportunity is more of the practical nature. A lot of functionalities were tested in this paper to determine the preferences of the stakeholders towards these functionalities. However, it might not be technologically possible to have all these functionalities in a single app. Future works could look more into the development side of a MaaS platform to see whether this would be possible.

Reference

Ashkrof, P., Correia, G. H. de A., Cats, O., & Van Arem, B. (2020). Understanding ride-sourcing drivers' behaviour and preferences: Insights from focus groups analysis. *Research in Transportation Business and Management*, *37*, 100516. https://doi.org/10.1016/j.rtbm.2020.100516

Banister, D. (2008). The sustainable mobility paradigm. *Transport Policy*, *15*(2), 73–80. https://doi.org/https://doi.org/10.1016/j.tranpol.2007.10.005

Berander, P., Damm, L.-O., Eriksson, J., Gorschek, T., Henningsson, K., Jönsson, P., … Lundberg, L. (2005). Software quality attributes and trade-offs.

Blasius, J. (2012). Comparing Ranking Techniques in Web Surveys. *Field Methods*, *24*(4), 382–398. https://doi.org/10.1177/1525822X12443095

Blumberg, B., Cooper, D. R., & Schindler, P. S. (2011). *Business Research Methods*. McGraw-Hill Higher Education. Retrieved from https://books.google.nl/books?id=uTidcQAACAAJ

Caiati, V., Feneri, A. M., Jittrapirom, P., Rasouli, S., & Timmermans, H. (2020). *An analysis of the potential adoption of Mobility as a Service across different age groups and lifestages: A mixed-methods approach*.

Caiati, V., Rasouli, S., & Timmermans, H. (2019). Bundling, pricing schemes and extra features preferences for mobility as a service: Sequential portfolio choice experiment. *Transportation Research Part A: Policy and Practice*, *131*. https://doi.org/10.1016/j.tra.2019.09.029

Centraal Bureau voor de Statistiek. (2021). Hoeveel reisden inwoners van Nederland en hoe? Retrieved March 2, 2021, from https://www.cbs.nl/nl-nl/visualisaties/verkeer-en-vervoer/personen/mobiliteit

Cerfontaine, C. (2019). *Report: Mobility As A Service (MAAS)*. Retrieved from https://www.uitp.org/sites/default/files/cck-focus-papers-files/Report_MaaS_final.pdf

Deming, W. E. (1986). *Out of the Crisis : Quality, Productivity and Competitive Position*. Cambridge : Cambridge university press. Retrieved from http://lib.ugent.be/catalog/rug01:000162160

Den Boer, P. B. (2020). *Inner Join Privacy : incorporating functionality-privacy trade-offs in Mobility-as-a-Service Solution design methods*. University of Twente. Retrieved from http://essay.utwente.nl/85371/

Díaz, J., Pozo, R., González, A., Wilby, M., & Sánchez Ávila, C. (2020). Hierarchical

Agglomerative Clustering of Bicycle Sharing Stations Based on Ultra-Light Edge Computing. *Sensors*, *20*, 3550. https://doi.org/10.3390/s20123550

Durand, A., Harms, L., Hoogendoorn-Lanser, S., & Zijlstra, T. (2018). Exploring Mobility-as-a-Service: insights from literature and focus group meetings. https://doi.org/10.13140/RG.2.2.11838.54088

Ebeling, C. E. (2004). *An introduction to reliability and maintainability engineering* (2nd ed.). McGraw-Hill. Retrieved from https://books.google.nl/books?id=iFumyeVLIEAC

Economic Commission for Europe. (2020). *Transport Trends and Economics 2018–2019: Mobility as a Service*. UN. Retrieved from https://books.google.nl/books?id=ZkvmDwAAQBAJ

EMot. (2021). Retrieved February 2, 2021, from https://www.emot.jp/

Fahy, J., & Jobber, D. (2015). *Foundations of Marketing* (5th ed.). McGraw-Hill Education.

Geld terug bij vertraging | Klantenservice | NS. (2021). Retrieved February 18, 2021, from https://www.ns.nl/klantenservice/geld-terug/geld-terug-reguliere-reizen.html

Gregor, S., & Hevner, A. (2013). Positioning and Presenting Design Science Research for Maximum Impact. *MIS Quarterly*, *37*, 337–356. https://doi.org/10.25300/MISQ/2013/37.2.01

Haustein, S., Kroesen, M., & Mulalic, I. (2020). Cycling culture and socialisation: modelling the effect of immigrant origin on cycling in Denmark and the Netherlands. *Transportation*, *47*(4), 1689–1709. https://doi.org/10.1007/s11116-019-09978-6

Hernandez, J., Garcia, R., Schonowski, J., Atlan, D., Chanson, G., & Ruohomäki, T. (2020). Interoperable Open Specifications Framework for the Implementation of Standardized Urban Platforms. *Sensors*, *20*, 2402. https://doi.org/10.3390/s20082402

Hevner, A., R, A., March, S., T, S., Park, Park, J., … Sudha. (2004). Design Science in Information Systems Research. *Management Information Systems Quarterly*, *28*, 75.

Holmberg, P.-E., Collado, M., Sarasini, S., & Williander, M. (2016). *Mobility as a Service - MaaS : Describing the framework.*

Jittrapirom, P., Caiati, V., Feneri, A. M., Ebrahimigharehbaghi, S., Alonso Gonzalez, M., & Narayan, J. (2017). Mobility as a Service: A Critical Review of Definitions, Assessments of Schemes, and Key Challenges. *Urban Planning*, *2*. https://doi.org/10.17645/up.v2i2.931

Kujala, S. (2003). User involvement: A review of the benefits and challenges. *Behaviour & IT*, *22*, 1–16. https://doi.org/10.1080/01449290301782

Landy, F. J., & Conte, J. M. (2013). *Work in the 21st century: An introduction to industrial*

and organizational psychology (4th ed.). Hoboken, NJ, US: John Wiley & Sons, Inc.

Milani, F. (2019). *Digital Business Analysis*. https://doi.org/10.1007/978-3-030-05719-0

Nachar, N. (2008). The Mann-Whitney U: A Test for Assessing Whether Two Independent Samples Come from the Same Distribution. *Tutorials in Quantitative Methods for Psychology*, *4*. https://doi.org/10.20982/tqmp.04.1.p013

NS-Business Card | NS Zakelijk | NS. (2021). Retrieved February 18, 2021, from https://www.ns.nl/zakelijk/ns-business-card

Ostertagova, E., Ostertag, O., & Kováč, J. (2014). Methodology and Application of the Kruskal-Wallis Test. *Applied Mechanics and Materials*, *611*, 115–120.

Peffers, K., Tuunanen, T., Gengler, C., Rossi, M., Hui, W., Virtanen, V., & Bragge, J. (2006). The design science research process: A model for producing and presenting information systems research. *Proceedings of First International Conference on Design Science Research in Information Systems and Technology DESRIST*.

Reisplanner | Reisinformatie | NS. (2021). Retrieved February 18, 2021, from https://www.ns.nl/reisplanner/#/

Rodriguez-Sanchez, M. C., & Martinez-Romo, J. (2017). GAWA – Manager for accessibility Wayfinding apps. *International Journal of Information Management*, *37*(6), 505–519. https://doi.org/https://doi.org/10.1016/j.ijinfomgt.2017.05.011

Schober, P., Boer, C., & Schwarte, L. (2018). Correlation Coefficients: Appropriate Use and Interpretation. *Anesthesia & Analgesia*, *126*, 1. https://doi.org/10.1213/ANE.0000000000002864

Signorile, P., Larosa, V., & Spiru, A. (2018). Mobility as a service: a new model for sustainable mobility in tourism. *Worldwide Hospitality and Tourism Themes*, *10*, 0. https://doi.org/10.1108/WHATT-12-2017-0083

Sochor, J., Arby, H., Karlsson, I. C. M., & Sarasini, S. (2018). A topological approach to Mobility as a Service: A proposed tool for understanding requirements and effects, and for aiding the integration of societal goals. *Research in Transportation Business & Management*, *27*, 3–14. https://doi.org/https://doi.org/10.1016/j.rtbm.2018.12.003

Technology Scotland, & Scotland IS. (2018). Mobility as a Service: Positioning Scotland for an Emerging Global Market. Retrieved from https://maas-alliance.eu/wp-content/uploads/sites/7/2018/02/MaaS-Positioning-Scotland-for-an-Emerging-Global-Market_PUBLIC.pdf

UMOS-Alliance. (2020). Retrieved December 2, 2020, from https://umos-alliance.eu/#page-content

WhimApp Service and Support. (2020). Retrieved May 20, 2020, from https://helpcenter.whimapp.com/hc/en-us

Wiegers, K., & Beatty, J. (2013). *Software Requirements* (3rd ed.). Microsoft Press. https://doi.org/10.3362/9781780449357

Appendix A: Integration Levels

Figure 9 provide an overview of the different integration levels (Sochor et al., 2018).

Figure 9: Integration Levels

Appendix B: Publication Schema

Table 24 is the publication schema for a DSR study (Gregor & Hevner, 2013).

Table 24: Publication Schema

Table 3. Publication Schema for a Design Science Research Study	
Section	**Contents**
1. Introduction	*Problem definition, problem significance/motivation, introduction to key concepts, research questions/objectives, scope of study, overview of methods and findings, theoretical and practical significance, structure of remainder of paper.* For DSR, the contents are similar, but the problem definition and research objectives should specify the ***goals*** that are required of the artifact to be developed.
2. Literature Review	*Prior work that is relevant to the study, including theories, empirical research studies and findings/reports from practice.* For DSR work, the prior literature surveyed should include any prior design theory/knowledge relating to the class of problems to be addressed, including artifacts that have already been developed to solve similar problems.
3. Method	*The research approach that was employed.* For DSR work, the specific DSR approach adopted should be explained with reference to existing authorities.
4. Artifact Description	A concise description of the artifact at the appropriate level of abstraction to make a new contribution to the knowledge base. This section (or sections) should occupy the major part of the paper. The format is likely to be variable but should include at least the description of the designed artifact and, perhaps, the design search process.
5. Evaluation	Evidence that the artifact is useful. The artifact is evaluated to demonstrate its worth with evidence addressing criteria such as validity, utility, quality, and efficacy.
6. Discussion	*Interpretation of the results: what the results mean and how they relate back to the objectives stated in the Introduction section. Can include: summary of what was learned, comparison with prior work, limitations, theoretical significance, practical significance,* and *areas requiring further work.* Research contributions are highlighted and the broad implications of the paper's results to research and practice are discussed.
7. Conclusions	*Concluding paragraphs that restate the important findings of the work.* Restates the main ideas in the contribution and why they are important.

Appendix C: Survey End-Users

Mobility as a Service - Travellers

* Required

Introduction

Dear Participant,

<You can change the language of this page at the top of your screen / U kunt de taal bovenaan uw scherm selecteren.>

First, we would like to thank you for your participation. Your contribution is valuable for our research.

This survey aims to identify relative importance of a set of functionalities of a mobility-as-a-service (MaaS) platform.
In the first part of the survey, you will be introduced with the concept of MaaS).
The functionalities presented in this survey are related to those proposed for the *traveller* **.

It will take about 10 minutes to complete the survey.

Your participation in this study is voluntary. There are no foreseeable risks associated with this project. However, if you feel uncomfortable answering any questions, you can withdraw from the survey at any point. Yet, it is very important for us to gather your opinion.

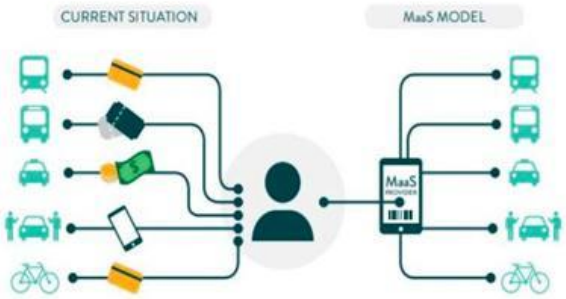
If you have any questions regarding the survey, please contact us at: t.deijkers@student.tue.nl

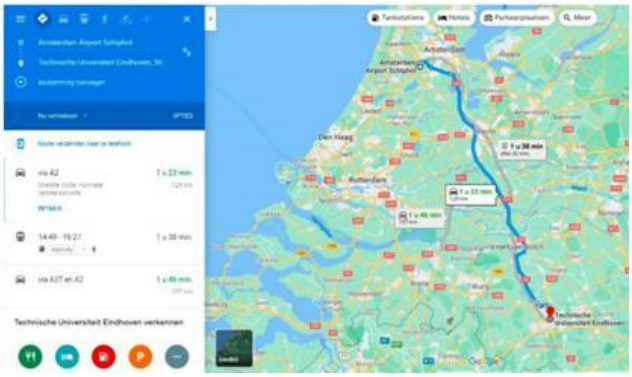
Please click NEXT to start the survey.

** For the survey regarding the functionalities of the MaaS platform for the 'Mobility Service Providers', please follow the link <https://forms.office.com/Pages/ResponsePage.aspx?id=R_J9zM5gD0qddXBM9g78ZGgU_soPV1FPv31WrxZklppUOU9OWEQ5QTM3Uk9ONDZYSlg4RFRSVTU3SC4u>.

Mobility as a Service

Mobility as a Service (MaaS) is the integration of, and access to, different transport services (such as private transport, public transport, ride-sharing, car-sharing, bike-sharing, scooter-sharing, taxi, car rental, ride-hailing and so on) in one single digital mobility platform. Through this platform it is possible to plan your trip, receive traffic information and pay for your travel. Examples of mobility as a service platforms are the NS reisplanner and Google Maps. The first image shows the purpose of mobility as a service. The second image shows the Google Maps example. In this image you see that there are different transportation modes available to choose, like your private car or public transportation.





1 How familiar are you with mobility as a service platforms? *

- ◯ Not at all familiar
- ◯ Slightly familiar
- ◯ Somewhat familiar
- ◯ Moderately familiar
- ◯ Extremely familiar

Generic Questions

In this section you will be asked several generic questions

2 What is your age category? *

- ◯ Under 18 years
- ◯ 18-24 years
- ◯ 25-34 years
- ◯ 35-44 years
- ◯ 45-54 years
- ◯ 55-64 years
- ◯ 65 years and above

3 What is your location of residence? *

- ◯ Urban

- ◯ Suburban
- ◯ Village
- ◯ Rural

4 Which Transport Modes do you often use (answer for your pre-Covid times)? *

- ☐ Walking
- ☐ Bicycle
- ☐ Car
- ☐ Motorcycle
- ☐ Bus
- ☐ Metro/Tram
- ☐ Train
- ☐ Scooter/Moped
- ☐ Boat/Ferry
- ☐ Other

5 How often do you use public transportation (answer for your pre-Covid times)? *

- ◯ Daily
- ◯ Several Times a Week
- ◯ Weekly
- ◯ Several Times a Month
- ◯ Monthly
- ◯ Several Times per Year
- ◯ Never

○ Other

Planning

6 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality. *

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important
The app provides real time information about my departure times	○	○	○	○	○
The app provides real time information about my arrival times	○	○	○	○	○
I can change my departure time and date	○	○	○	○	○
The app combines different modes in one journey (e.g. take my private car to X, then the train to Y and then rental bike to destination)	○	○	○	○	○
I can select my departure and destination location	○	○	○	○	○
I can select a location on a map and the app will provide directions to this location	○	○	○	○	○
I can choose my favourite locations and/or routes	○	○	○	○	○
The app includes additional transfer time	○	○	○	○	○

The app limits my options to easily accessible transportation modes	○	○	○	○	○
The app limits my walking distance	○	○	○	○	○
The app provides Information on the traffic changes during my journey and recommends updates accordingly	○	○	○	○	○

Personalization

7 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality. *

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important
The app takes costs into consideration when displaying my travel options	○	○	○	○	○
The app takes time into consideration when displaying my travel options	○	○	○	○	○
The app takes the user ratings into consideration when displaying my travel options	○	○	○	○	○
The app takes the transport mode into consideration when displaying my travel options	○	○	○	○	○
The app takes the environmental impact into consideration when displaying my	○	○	○	○	○

travel options

The app takes the current weather situation into consideration when displaying my travel options	○	○	○	○	○
The app limits the transport modes based on subscription allowance and other payment requirements	○	○	○	○	○
The app stores and displays information about my previous travels	○	○	○	○	○
The app is linked with my calendar to adapt my travels to my schedule	○	○	○	○	○
The app personalizes their responses to me (e.g. using my name Instead of general terms)	○	○	○	○	○

Payment

8 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality. *

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important
I can pay for single tickets through payment providers	○	○	○	○	○
I can pay through prepaid or pay-as-you-go smart card schemes	○	○	○	○	○
I can pay through pre-defined					

mobility subscriptions	○	○	○	○	○
I can pay using payment terminal in or around individual transport modes	○	○	○	○	○
I can pay using direct debit/credit schemes	○	○	○	○	○

Booking

9 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality. *

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important
I need to confirm my ticket details before Checkout	○	○	○	○	○
The app applies discount coupons before checkout	○	○	○	○	○
I can export and print out tickets on paper (e.g. QR-/ barcodes)	○	○	○	○	○
I can digitally store tickets (offline) on mobile devices (e.g. QR-/ barcodes)	○	○	○	○	○
I can choose a tip (percentage) for ride hailing/taxi drivers	○	○	○	○	○
I can change between anonymous tickets or person-bound tickets	○	○	○	○	○
I can change the tickets I bought through the app	○	○	○	○	○

I can cancel the tickets I bought through the app	○	○	○	○	○
I can get a refund in case of delays/ malfunctions/bad service (e.g. if the train is delayed due to snow)	○	○	○	○	○

Ticketing

10 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality.

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important
I can select tickets/time slots for each journey and/or transport mode	○	○	○	○	○
I can choose a single ticket, day return or other similar time- or use-restricted schemes	○	○	○	○	○
The app applies joint journey discount (i.e. fare reduction based on travel group size)	○	○	○	○	○
I can compare ticket offers by price between mobility providers/booking offices	○	○	○	○	○
I can compare ticket offers by price based on applicable mobility subscriptions	○	○	○	○	○
I can choose different travel class for public transit tickets	○	○	○	○	○
I can choose from specific seating options	○	○	○	○	○

(e.g. window seating or more legroom)					
I can select tickets based on age group	○	○	○	○	○
I can select from (third-party) discount offer	○	○	○	○	○
There is a single ticket that gives access to all transportation modes	○	○	○	○	○
The app enables business-to-business payment by invoicing my employer (e.g. NS Business Card)	○	○	○	○	○

Social Media

11 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality. *

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important
I can share my real-time location with selected other people during transit	○	○	○	○	○
The journey I made can be shared on twitter	○	○	○	○	○
The journey I made can be shared on Facebook	○	○	○	○	○
The journey I made can be shared on Instagram	○	○	○	○	○
The journey I made can be shared on LinkedIn	○	○	○	○	○

Assistance

12 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality. *

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important

A notification is sent to notify me of changes to my journey	○	○	○	○	○
A notification is sent to remind me of my departure time	○	○	○	○	○
A notification is sent to remind me to rate my journeys	○	○	○	○	○
The app provides step-by-step guidance	○	○	○	○	○
The app provides text-to-speech (TTS) directions	○	○	○	○	○
The app provides offline navigation	○	○	○	○	○
I can report an issue with the app	○	○	○	○	○
Twenty-Four Hour Customer Service is available through phone	○	○	○	○	○
Twenty-Four Hour Customer Service is available through live chat	○	○	○	○	○
Twenty-Four Hour Customer Service is available through social media	○	○	○	○	○
The app has an audio function for visually impaired people	○	○	○	○	○
The app color pattern is	○	○	○	○	○

distinguishable for the color blind					
The app has different text sizes for people with far-sightedness	○	○	○	○	○
The app has button size usable for people with mobility difficulties	○	○	○	○	○

Ratings

13 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality. *

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important
I can rate my overall journey through the app	○	○	○	○	○
I can see rating given by other people	○	○	○	○	○
I can rate individual parts of my journey	○	○	○	○	○

Enhancing Services

14 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality. *

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important
The app learns from my ratings and adapts my travel options accordingly	○	○	○	○	○
The app learns from my past travels and adapts my travel options accordingly	○	○	○	○	○
I can subscribe to car insurance through the	○	○	○	○	○

app					
I can subscribe to parking subscription through the app	○	○	○	○	○
I can book entertainment through the app (e.g. movie or theatre)	○	○	○	○	○
I can book accommodation through the app	○	○	○	○	○
The app suggests options for the return trip when booking a one-way trip	○	○	○	○	○
If I travel for an event that the app will have an option to buy tickets for this event	○	○	○	○	○
When I book entertainment/accommodations the app can suggests my journey to the venue as well	○	○	○	○	○
The app can present a Tour Plan for a city to help me with sightseeing	○	○	○	○	○
The app can show me points of interest within the city I am visiting	○	○	○	○	○
The app lets me explore facilities along	○	○	○	○	○
I can subscribe to travel insurance through the app	○	○	○	○	○

I can sign up to become a “mobility service provider” through the app (e.g. sign up as an Uber driver)	○	○	○	○	○

Non-Functional

15 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality. *

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important
The app responds quickly to my inputs	○	○	○	○	○
The app responds predictably to my inputs	○	○	○	○	○
It is easy for me to learn how to use the app	○	○	○	○	○
It is easy for me to use the app	○	○	○	○	○
The app autocorrects the errors that I make	○	○	○	○	○
The app protects against unauthorized access to the app and its data	○	○	○	○	○

16 Is there a functionality that you missed during this survey?

Please do not forget to submit the survey.

Thank you for your participation and valuable contribution.

If you are interested in the results, or would like to get more information about the survey, please contact us at: t.deijkers@student.tue.nl

Appendix D: Survey Service Providers

Mobility as a Service – Service Providers

* Required

Introduction

Dear Participant,

<You can change the language of this page at the top of your screen / U kunt de taal bovenaan uw scherm selecteren.>

First, we would like to thank you for your participation. Your contribution is valuable for our research.

This survey aims to identify relative importance of a set of functionalities of a mobility-as-a-service (MaaS) platform.
In the first part of the survey, you will be introduced with the concept of MaaS).
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It will take about 5 minutes to complete the survey.

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If you have any questions regarding the survey, please contact us at: t.deijkers@student.tue.nl

Please click NEXT to start the survey.

** For the survey regarding the functionalities of the MaaS platform for the 'Mobility Service Providers', please follow the link <https://forms.office.com/Pages/ResponsePage.aspx?id=R_J9zM5gD0qddXBM9g78ZGgU_soPV1FPv31WrxZklppUMjdORVVBQkRXR0U3RVhRV0NBRUY2SzJURC4u>.

Mobility as a Service

Mobility as a Service (MaaS) is the integration of, and access to, different transport services (such as private transport, public transport, ride-sharing, car-sharing, bike-sharing, scooter-sharing, taxi, car rental, ride-hailing and so on) in one single digital mobility platform. Through this platform it is possible to plan your trip, receive traffic information and pay for your travel. Examples of mobility as a service platforms are the NS reisplanner and Google Maps. The first image shows the purpose of mobility as a service. The second image shows the Google Maps example. In this image you see that there are different transportation modes available to choose, like your private car or public transportation.

1 How familiar are you with mobility as a service platforms? *

- ◯ Not at all familiar
- ◯ Slightly familiar
- ◯ Somewhat familiar
- ◯ Moderately familiar
- ◯ Extremely familiar

Generic Questions

In this section you will be asked several generic questions

2 What service you would consider to make available in a MaaS platform? *

- ☐ Public Transportation – Train/Metro/Tram
- ☐ Public Transportation - Bus
- ☐ Car-Sharing
- ☐ Car Rental
- ☐ Taxi
- ☐ 2-Wheels Sharing
- ☐ 2-Wheels Rental
- ☐ Transportation - Other
- ☐ Other (parking, charging, insurance, etc.)

3 Do you consider MaaS as a business opportunity? *

- ○ Yes
- ○ No
- ○ Maybe

Transportation

4 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality. *

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important
The application helps determine the optimal number of vehicles for a given transportation mode	○	○	○	○	○
The application helps relocate the vehicles to the best location for optimal usage	○	○	○	○	○
The services provided can be changed within the application (e.g. make less vehicles available)	○	○	○	○	○
The application helps determine how to improve the utilization of the transport assets	○	○	○	○	○
The application takes into account events that take place so the number of vehicles can be adapted accordingly	○	○	○	○	○

Analysis

5 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality. *

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important
The application analyses the demand of the users and presents it	○	○	○	○	○
The application analyses the response of the users to the price of the services and presents it	○	○	○	○	○
The application analyses the response of the users to the quality of the services and presents it	○	○	○	○	○
The application calculates the key performance indicators of the service providers	○	○	○	○	○
The application analyses the customer complaints to determine problem area in the service	○	○	○	○	○
The application can filter the previous analysis based on your needs	○	○	○	○	○

Other Services

6 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality. *

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important
Service providers can use the application to help to improve the traffic flow	○	○	○	○	○
Service providers can					

use the application to help with traffic management (e.g. indicate road work, accidents, etc.)	○	○	○	○	○
The application helps optimize the performance of existing infrastructure	○	○	○	○	○
The application helps the management of the existing parking places in the city	○	○	○	○	○
The application helps determine whether extra parking places are necessary	○	○	○	○	○
The application helps the management of the existing charging places in the city	○	○	○	○	○
The application helps determine whether extra charging places are necessary	○	○	○	○	○
The application helps to see how transportation assets are being sued around the city to help insurance providers determine their insurance rates	○	○	○	○	○

Other Features

7 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality. *

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important
The application helps to improve safety by	○	○	○	○	○

getting insights into places with a lot of accidents					
The application supports the communication with other providers to help base your decision on all needed information	○	○	○	○	○
The application shows the air pollution that the transportation modes cause	○	○	○	○	○
The application shows the carbon emissions that the transportation modes produce	○	○	○	○	○

Non-Functional

8 Please indicate for each of the functionalities whether you consider it "important" or "unimportant" for a mobility as a service application to offer this functionality. *

	Unimportant	Slightly unimportant	Neutral	Slightly important	Important
The app responds quickly to my inputs	○	○	○	○	○
The app responds predictably to my inputs	○	○	○	○	○
It is easy for me to learn how to use the app	○	○	○	○	○
It is easy for me to use the app	○	○	○	○	○
The app autocorrects the errors that I make	○	○	○	○	○
The app protects against unauthorized	○	○	○	○	○

access to the app and
its data

9 Is there a functionality that you missed during this survey?

Please do not forget to submit the survey.

Thank you for your participation and valuable contribution.

If you are interested in the results, or would like to get more information about the survey, please contact us at: t.deijkers@student.tue.nl