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The willingness to pay of various types of bike parking-users at train stations for different types of facilities and stations

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The willingness to pay of various types of bike parking-users at train stations for different types of facilities and stations

By

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Cover photo: P. Appelhof, 2019

Preface

After enjoying my student days for 7 years, it's time to close it all. This thesis report is the last step of the process in which I have personally developed a lot. Both during my days at the campus as in ‘the big city’ Delft. When I started my bachelor's in Civil Engineering, I never expected it would end in a master of Transport and Planning. I am more than happy with all the decisions I have made over time that led me to this point: to do my thesis project in cooperation with NS Stations.

Nevertheless, the process would have been different without the help and support given to me while writing this thesis. First of all, I would like to thank my graduate committee for all their guidance and feedback during this process. You were always positive about my work, certainly in the beginning, when I did not see the added value of my research yet. I would like to thank Niels for his positive criticism and insistence on using more infographics. Thank you Danique, for giving me those little pushes when I felt stuck. You had the ability to explain my own thoughts to me. After a conversation, I always had a clear picture of the next steps in the process. Sabine, I would like to thank you for your critical questions about the practical side of the work. It really made the report more valuable and understanding. I would like to thank Maarten for his critical and honest opinion about the quality and feasibility of the project. And lastly, I want to express my gratitude to Nejc, who was not even part of this committee at the beginning. Your advice on how to design a stated choice experiment was very welcome. Also, your critical note on my English is appreciated.
Many thanks to all NS colleagues who made me feel welcome, even though we mainly spoke online. I am very grateful for the opportunity to get to know NS. It was a great experience to look inside such a large company, which has to focus on so many different aspects.

Moreover, I would like to thank my family, friends and fellow students for their support, walks and talks while we were mainly working from home. A special thanks to Babette, with who I always could discuss the methodology, the process and the rest of our daily business. It made graduating from home a lot more fun, but also when we were able to go to campus again. I want to thank my lovely housemates who never judged my habits and were always there for fun, even if I did not feel like socialising. I also enjoyed the runs to start a day and good meals to reward the end of the day. Last but not least, I want to thank Bart for always being there for me. You have the ability to make days off together more stressful than a day at work. Luckily, you can always make me feel comfortable and make me smile. This process would have been a lot harder without your support.

Simone Hoskam
Delft, June 2020

Executive summary

Bike-train usage contributes to more sustainable and also more reliable transport. Nowadays, approximately 45% of the train passengers in the Netherlands access the station by bike. Therewith, the focus of policy makers shifts to the total “door-to-door” travel experience. Bicycle usage is stimulated, and the facilities are adapted accordingly. From a lot of perspectives, this can be seen as a positive trend. Unfortunately, it also has negative consequences in terms of capacity problems in parking facilities and costs. To be able to guide a better service to multimodal travellers, more insights should be gathered regarding their experience and willingness to pay for certain aspects.
Most studies focus on the characteristics of bike-train users and their behaviour. In consequence, the quality of the parking facility is considered very limited. The impact of this quality on the user experience is considered even less. For example, the impact of a free of charge parking period is not known. More aspects influencing the users' experience and behaviour might exist as well. Studies also often focus on one station or one area, which makes it hard to draw general conclusions. Lastly, the relationship between the willingness to pay and the expected subscription price is unknown. By getting a better understanding of the attributes influencing the choice behaviour of facility users, an insight is given into the preferences of passengers concerning bicycle parking. The effects of pricing policies on the user experience and utilisation at various facilities are of great interest to NS (Dutch Railways). For a full overview, there has to be differentiated to types of facilities and types of stations. The following research question is answered during this thesis:

What is the willingness to pay of various types of bike parking-users at train stations for different types of facilities and at different types of stations?

Literature addresses several attributes which are influential when using the bike-train combination. Attributes can be split into user characteristics, parking facility characteristics and station characteristics. Based on an ongoing data collection effort (Keten Belevings Monitor or KBM), user characteristics of guarded bike parking users can be analysed. It can be found that young people, between 18 and 24 years old, are the main bike-train users, while people over 65 are less present. Furthermore, users are often frequent travellers (at least once a week) and going to work or school. Of all commuters, 90% travels frequently. Social and recreational purposes are performed on a less frequent basis and are in general performed by older people. Based on these characteristics, five traveller profiles can be identified which each consist of at least 5% of the current bike-train users. These can be labelled as commuters to work, students commuting to school, youth travelling for leisure activities and adults with a leisure purpose, divided into medium and low frequent travellers (respectively between 1 and 3 times a month and less than once a month).
Distribution of users towards different types of stations can be made as well. Suburban stations tend to be more used by commuters to work. This also results in more frequent travellers at suburban stations. Social and recreational travellers tend to be more attracted to intercity stations. Also, long-term parking occurs more often at intercity stations.

The users' experience differs among the population, depending on the provided services, such as the presence of staff, the presence of a repair shop and the pricing policy. This study into the data of the ongoing KBM confirms these findings. Additionally, an in-depth research is performed on this data to identify which elements influence the overall user experience. Through factor analysis, five elements of the facility can be identified:

1. Service: the presence and attitude of the staff and the feeling of safety
2. Overview: effort to search for a parking spot, clarity of parking and where to find information
3. Appearance: the care and cleaning of parking facilities
4. Accessibility: accessibility of facility in terms of time, price and easiness
5. Bike security: risk of theft or damage of bicycle when stored

The service-related attributes are of impact on the valuation of the five elements of experience. Together these attributes can explain up to 69.4% of the overall user experience. A strong impact of the overview on the experience is shown, followed by the appearance and accessibility. The quality of service and security were of less influence on the experience, however, this is partly compensated by the positive impact on experience by the presence of staff.

To study the effects of user characteristics on the experience, a comparison is made between the experience of the various factors as identified before. Service is higher valued by women, elderly, travellers with a lower frequency and a social recreational trip purpose. This is similar for overview and appearance, with exception of the gender, where men rate overview higher than women. Accessibility is valued lower by younger travellers and travellers with a longer parking duration due to the price aspect. For infrequent travellers, the entrance system influences the experience of accessibility of the parking. They prefer staffed parking. The last factor influencing the experience is bike safety. This is highest appreciated for travellers with a low frequency, social recreational trip purpose, and a longer parking duration.

The impact of station characteristics on the experience is studied as well. In general, service is valued lower at bike parking's at intercity stations compared to sprinter stations in a suburban area. Overview and appearance are lower rated at rural stations, as half of the dedicated locations struggle with capacity problems. Accessibility has the highest score on suburban intercity stations. The asked price is lower at suburban stations, €0.50 after 24-hours free parking versus €1.25 after 24-hours free parking at intercity stations. Additionally, intercity stations are more likely to be staffed. However, self-service bike parking is not less valued than staffed facilities by frequent users. The score of bike security is higher when staff is present and at station types with higher train frequencies.

By now, various attributes have been viewed which have an impact on the user experience and therewith on the user preferences. Literature indicated the influence of the walking time and the shelter for unguarded facilities on the preference of facility users as well. To be able to draw conclusions regarding the impact on preference and the willingness to pay, data is collected using a survey. This consists of three parts, a stated choice experiment, additional questions to confirm the users' opinion and an adaptive choice experiment regarding subscription price. The attributes included are presented in Table 1. The survey is distributed amongst members of the NS panel. In total, 624 responses are obtained. 512 of the respondents are current bike-train travellers, while 112 access the station in a different way. By analysing both groups, the difference in their WTP can be analysed.

Table 1, Aspects considered during survey

Alternatives		**Characteristics**		**Context (fixed)**	
Station	Operation & Location	**Personal**	Age	**Travel**	Purpose
			Gender		Distance
Facility	Security		Bike	**Parking facility**	Capacity
	Repair shop		Car ownership		Search time
	Shelter		Level of education		Opening hours
	Walking time (1 - 4 min)	**Travel**	Trip Purpose	**Experience**	Overview
	Price (€0.25 - €2.50)		Trip Frequency		Appearance
	Free period (0 – 24 h.)		Parking Duration		Accessibility
			Parking Period		Bike safety
		Experience	Current preference		
			Damaged/stolen		

In the stated choice experiment, alternatives are evaluated by individuals, who make a choice based on the potential (dis)utility of each alternative. Various models are specified to analyse the impact of the attributes via utility functions. In these models, the free parking period has both a linear and a quadratic component. This quadratic component has a negative value which indicates the positive contribution of the free parking period flattens over time. Additionally, an interaction between the cost and free parking period is identified. When analysing the impact of characteristics on the various attributes, the correlation between characteristics is taken into consideration. For example, parking during the night and parking duration have a high correlation.
For the final analysis, a panel mixed logit model with nest structure is used. Figure 1 represents the number of utils lost or gained by one unit increase of the attribute, including the identified interactions. The yellow bar shows the value of the attribute. The blue bars underneath the attribute present the adapted value if the characteristic applies to a traveller. The value of the attributes marked by * needs to be multiplied by their attribute level, as is indicated in Table 1.

The general user has a preference for the guarded facility. The utility is negatively impacted by costs or walking time. A longer free parking period has a positive impact, even as the presence of surveillance and a bike repair shop. The impact of these attributes are influenced by age, current parking facility, type of bike, availability of a car, parking frequency, parking duration and if the user is parking during the weekend or not. Some of them influence the general preference for the guarded facility, while others influence a single attribute.

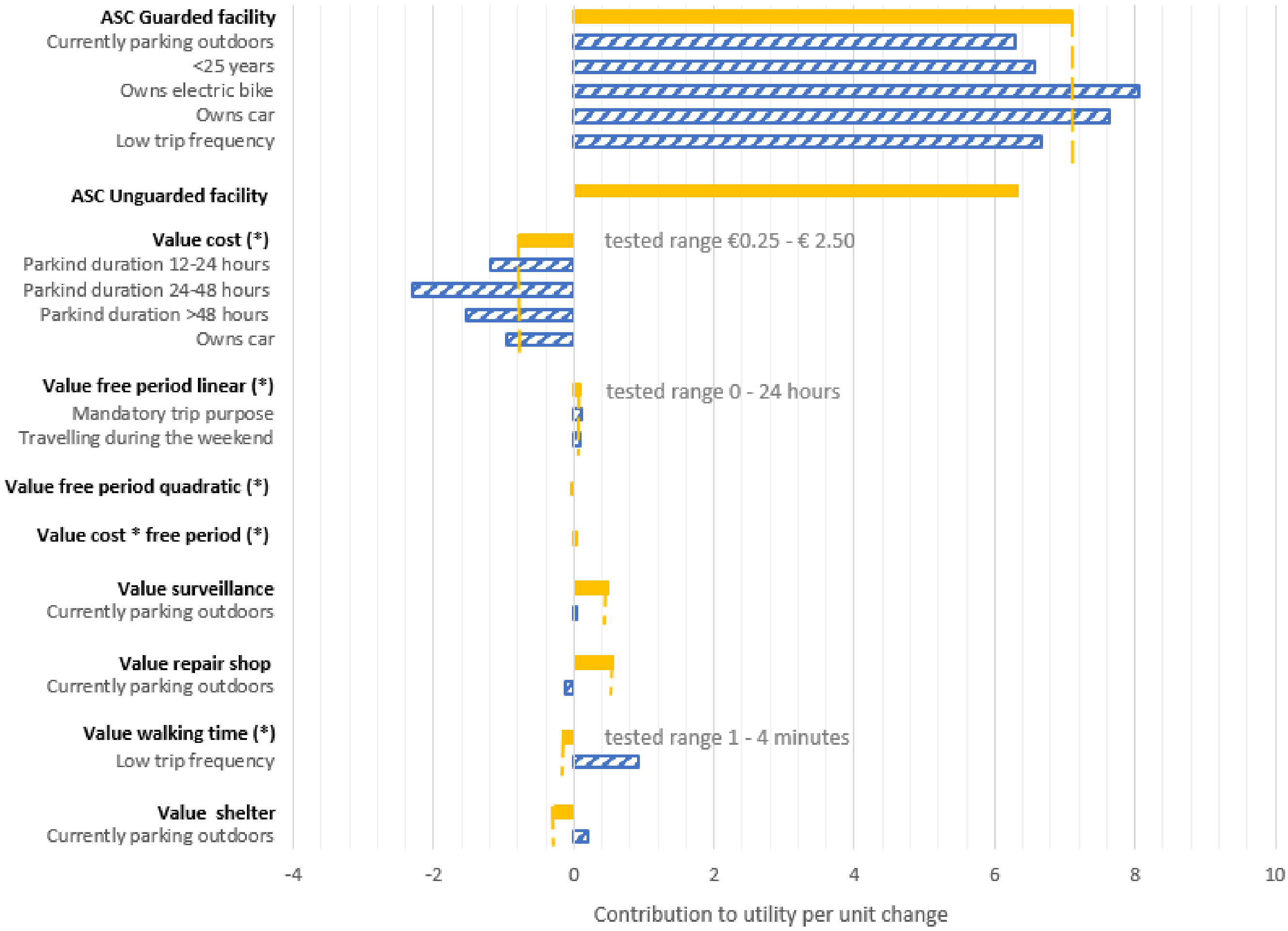

Figure 1, Utility contribution per unit change of individual attributes

Furthermore, an analysis is made for respondents who currently access the train station by another mode. Possible new facility users have a stronger preference for the guarded facility and are less influenced by a certain pricing policy: the negative impact of cost is lower and the free period has a smaller impact. Both the presence of shelter and surveillance have a greater positive contribution while the presence of a repair shop is not significant.

Based on the values of the model, the WTP for the various attributes can be determined. On average, current facility users are willing to pay €0.20 for the presence of staff, €0.18 for the presence of a repair shop, and €0.18 for a minute less walking time to the platform. Future bike-train users indicate to be willing to pay €0.38 for the presence of staff and €0.16 for a minute less walking time. The WTP for the repair shop is not significant. By composing the facilities as currently present at train stations, the average WTP for 24 hours of paid parking can be determined, which depends on the free parking period. Table 2 provides the WTP after a free parking period of 0, 12 and 24 hours. The numbers for the WTP of an individual vary depending on the parking duration, car ownership, current parking location and trip frequency. The WTP can be increased most by guaranteeing people a free parking spot. Reducing the walking distance can also be highly beneficial. Mainly frequent travellers are sensitive to these two aspects.

Table 2, WTP various parking facilities of NS, depending on free parking period

	Current users			Possible new users		
	0 hours	**12 hours**	**24 hours**	**0 hours**	**12 hours**	**24 hours**
Self-service bicycle parking	€0.55	€0.79	€1.22	€0.50	€0.82	€1.14
Staffed	€0.75	€0.99	€1.42	€0.88	€1.21	€1.53
Staffed + repair shop	€0.93	€1.17	€1.60	€0.88	€1.21	€1.53

Additionally, the utility functions can be used to determine the probability of choosing one of the options. Next to the previously indicated characteristics, the probability is also depending on age and type of bike, as shown under the alternative specific constant (ASC) for the guarded facility in Figure 1. With the known information of current bike-train users. The effect of the pricing policy, existing of a combination of price and free parking period, can be studied. This is done for the three parking situations at NS stations. Up to 10% more bike-train travellers will park in a guarded facility in case staff and a repair shop are present. An increase in cost is not linearly related to the loss of users. An increase from €0.25 to €0.75 has more impact on patronage than from €1.75 to €2.25. Also increasing the free parking period has a limited effect.
Of the respondents who indicate to choose not to park at one of the dedicated facilities, only 6% state they would not perform the train trip. This entails either switching to another main mode or not performing the trip at all. The rest keep travelling by train. 87% indicated they would choose another access mode and 8% to park the bike somewhere else, which might be a violation of local rules.

Explorative research shows that the option for a monthly subscription does not attract new users to the guarded facility. Only users who often chose to park in the guarded facility are willing to take a subscription. The price they are willing to pay for the subscription is higher than expected from their daily WTP and travel frequency. Possible other benefits of having a subscription are taken into consideration.

Given the findings of this study, a couple of recommendations for practice can be made. Firstly, it is important to keep a close eye on the user experience via ongoing research. A price increase will lower the user experience when no other value is added to the service. However, not all users have the same opinion regarding the various aspects of the facility. Potential bike-train travellers can be attracted by making bicycle lockers available for daily usage at stations with a low guarded facility demand. Additionally, the quality of the self-service bike parking facility should be promoted, as mainly infrequent travellers do not feel comfortable using them. In general, clear communication about an adapted price policy is important. Combined tickets might convince train travellers to use the guarded bike parking facility when accessing the station.
The knowledge regarding user experience and the willingness to pay can be further expanded as well. Not all elements with a significant impact are identified yet. Also, the direct impact of the pricing policy on the users' experience is not known. It might be of interest to study the impact of the parking facility on the entire train experience as well. Furthermore, the opinion of facility users who park on the egress side or who do not perform a train trip at all is not taken into consideration. This is necessary when striving for a complete overview of bike parking usage.

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24-hours free policy: policy implemented by NS which provides free of charge parking of the bicycle in the parkin facility for the first 24 hours. After 24 hours a fee must be paid.

Attributes of parking facility: various characteristics of a parking facility, such as level of security and presence of a repair shop, which determine the experienced quality

Bike-train travellers: people performing a train-trip where the bike is used as an access or egress mode.

Factor: several statements (variables), from the *KBM*, which can be grouped or clustered to a factor because of a high correlation in grading. It suggests that those variables could be measuring aspects of the same underlying dimension.

Fiets & Service: bike (repair) shop concept, operated by NS

Frequent train-users: travellers who use the train at least once a week, also called heavy travellers.

Guarded facility: bike parking facilities where bikes are protected for theft, by staff (staffed facility) or by entrance gate and camera's (ZSF)

Home-based: a trip starting at the home end, where going to the train stations is the access leg. In this research assumed as the standard. The opposite is activity-based trip.

Infrequent train-users: travellers who use the train less than once a month, also called light travellers.

KBM (Keten Belevings Monitor): *bike parking facility monitor*. An annual survey by NS, distributed amongst bike parking facility users, to track how their services are performing. The survey starts with 22 statements which users need to grade between 1 and 10. Furthermore, the users are asked to provide an overall score for the parking experience. In case a (repair) shop is present, users are also asked to evaluate this experience. Lastly, several questions about their demographics are included.

Long-term parking: parking for a period of more than 24 hours.

Multimodal traveller: travellers who make use of more than one mode of transport within a journey. Almost all train trips are part of a multimodal trip.

OV-chipcard: a travel card system used in the Netherlands for all public transport usage.

Second bike: a bike parked and used at the activity side of the trip.

Sheltered parking: a parking facility where a bike is protected against several weather conditions, at least trough coverage. Indoors is another option.

Type of station: a classification and simplification of the various stations, based on location and operation status.

Willingness to pay (WTP): the maximum amount a customer is willing to pay for a service.

ZSF (Zelf Service Fietsenstalling): *self-service bicycle parking.* guarded parking which is secured by an automated entrance gate and cameras. Users can open the gate with their personalized travel card. An intercom with a connection to the call centre is present in case of questions.

1. Introduction

The bicycle plays an important role as an access and egress mode for public transport, especially for train trips (e.g. Martens, 2007; Van der Spek & Scheltema, 2015). In 2018, approximately 45% of the train passengers in the Netherlands accessed the station by bike (NS, 2018). Yet, in science, the accessibility of public transport stations is often seen as the main weakness of the multimodal trip (Heinen & Buehler, 2019). As bike-train usage contributes to more sustainable and also more reliable transport, the focus of policy makers shifts to the total "door-to-door" travel experience. Therewith, also the focus of the Dutch train operator (NS) has shifted (NS, 2019). Bicycle usage is stimulated and the facilities are adapted accordingly. From a lot of perspectives, this can be seen as a positive trend. Unfortunately, it also has negative consequences in terms of capacity problems in parking facilities and in costs. To be able to guide a better service to multimodal travellers, more insights should be gathered regarding their experience and willingness to pay for certain aspects. Previous research has not identified all elements influencing the experience of parking facility users (Heinen & Buehler, 2019). Studies also often focus on one station or one area, which makes it hard to draw general conclusions (de Dios Ortúzar & Willumsen, 2011). Lastly, the relationship between the willingness to pay and the expected subscription price is unknown. The effects of pricing policies on the user experience and utilisation at various facilities are of great interest to NS.

In this chapter, first, some background information about the parking facilities at train stations is provided in section 1.1. The drawbacks of the current system with increasing numbers of cyclists will be elaborated on in the problem statement, in section 1.2. Thereafter the objective and research question are defined in section 1.3. Section 1.4 elaborates on the scope of this research. Finally, the report outline is presented in section 1.5.

1.1. Variation in parking facilities at train stations

Near train stations, several types of parking facilities exist. Bicycle parking is split into two groups, namely unguarded and guarded facilities. These can, in turn, be divided into many more variants. There exist unguarded facilities without coverage, with coverage and built-up facilities. Guarded facilities appear with staffing, as self-service, or with lockers. The division in types of facilities can be found in Figure 1.1.

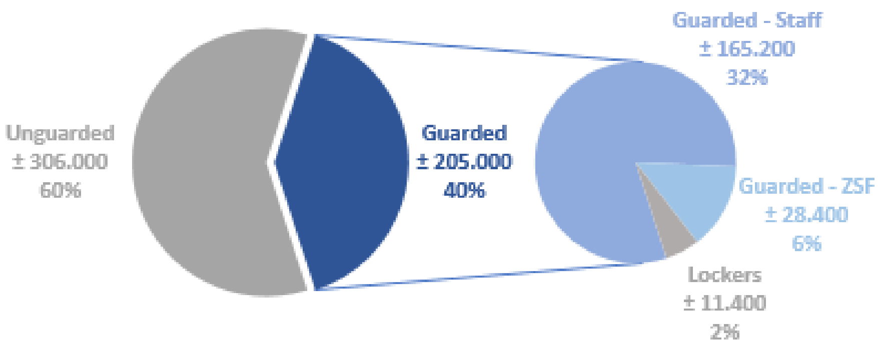

Figure 1.1, Division of parking facility spots 2020 (ProRail)

The simplest and cheapest form of parking is the outdoors unguarded ground-level facility, with or without coverage. These are often free for users. As they are maintained by ProRail and the municipality, the supervision varies by the policy of the municipality. If hardly any supervision is present it often results in messy and overcrowded racks (Van der Spek & Scheltema, 2015). When high demands are placed on the spatial quality of the station environment, a bicycle flat solution can be applied. These are often offered at larger stations.

Guarded facilities are in general built and maintained by ProRail and/or the municipality, and operated by NS. In case of low secured demand, below 200 places, bicycle lockers are used as an addition to outdoor facilities. Users with a subscription have their own key. At middle-sized train stations with bicycle demands below 1500 spots, self-service bicycle facilities (*ZSF*) are used. These are unmanned and the parking is accessible via an entrance that can be opened by an OV card. The physical appearance of these facilities is important, with transparent entrance gates, a camera system, and a direct connection with the call centre (van Dijk, 2014). Because of the improved quality and safety, in comparison with simple outdoor facilities, users are asked for a fee. In most cases, the fee applies after 24 hours of free parking. The last option of guarded facilities is manned indoor facilities. These facilities provide in general good qualitative parking for your bike with enough space and security. In some cases, also a bike repair shop is present. The applied pricing policy varies per location as they are often built and operated through cooperation between NS, ProRail and the local municipality. The aim of NS is an unambiguous system of first 24-hour free in all facilities (NS, 2019). However, this is not always feasible in cooperation with the municipality.

1.2. Problem statement

In the past, the overall quality of the parking spots was lower than it is nowadays (Fietsersbond, 2017). At larger stations, outdoor ground-level facilities were supplemented by staffed indoor facilities with a direct payment fee. The indoor facilities had enough capacity to easily park your bike. Main users were commuters with a monthly subscription. In the meantime, the outdoor facilities were overcrowded while the demand kept increasing. Because minimal supervision was present, the facility was often used as a bike graveyard. It resulted in a messy street scene. Additionally, stations that experience capacity issues are mainly located in dense urban areas where space is rare and expensive. Both a clean street scene and extending capacity problems are reasons why new facilities are nowadays often integrated into the station building. The expenses of high construction costs are in most cases shared by ProRail and the municipality. High investments are accepted because it results in improved quality of the main facilities (NS, 2019). This makes the station and train use more attractive and therefore the city as well. To keep the train accessible by bike, most parking facilities are going to a 24-hour free policy.

The improved system also resulted in some new challenges, as visualised in Figure 1.2. The implementation of a first 24-hour free pricing policy lowers the threshold for the use of indoor parking facilities. As a result, the share of bikes as access or egress mode increased, next to the overall increase in train travellers. Travellers who make a trip regularly consider parking a second bike at the activity-side of their trip, for the last mile. While one bike is parked there for a few days, at least 2 or 3 people could have used the same space for a one-day trip. The high quality also attracts users who are away for a longer period and want to store their bikes safely (Jonkeren et al., 2018). As capacity problems occur at some locations, a different utilisation of the parking facilities is desired. Possibilities to keep extending the facility are often limited for these locations. Measures in limiting long-term parking should ensure that the need to expand the number of bicycle parking spaces can be reduced (Jonkeren et al., 2018). However, the parties (NS, ProRail, and the municipalities) share the ambition that travellers should be able to choose the bicycle-train combination and the use of the bicycle for access and egress should not be discouraged. Additionally, the experienced quality of the facilities is an important key performance indicator for NS.
Most research regarding bike-train usage is performed on the entire multimodal trip, where the parking facility is considered as an attribute (Heinen & Buehler, 2019). The quality of the parking facility is not considered. Furthermore, various studies are limited to one station (e.g. Molin & Maat, 2015; Van der Spek & Scheltema, 2015), or the stations within one city (Maat & Louw, 2012). This makes it hard to predict the impact of a general policy (de Dios Ortúzar & Willumsen, 2011). Geurs et al. (2016) considered a variation in the type of train stations in the Randstad area. A substantial variation of effects by station type was found. However, the focus was on bicycle-train integration policies. Other possible attributes influencing the experience of a guarded facility are again not investigated. Furthermore, as the research area was still limited to one region, the interest exists to extend it to national level. Hence, more insights are needed into the current users and their user experience of the guarded parking facilities.

The other part of the problem, as portrait in Figure 1.2, is the exploitation costs of the facilities. These are significant due to the presence of employees at staffed facilities. Because of the first 24-hour free policy, the majority of the users do not have to pay. Therewith, also the subscriptions and cost coverage ratio dropped. NS wants to increase this by increasing revenue. One way of doing this is by asking for a (higher) contribution from all facility users. Nevertheless, the parking facility is an important factor in the entire journey of the traveller and thus should stay attractive for usage (NS, 2019). It is known that the asked fee is of influence on the total perception of the railway journey (Givoni & Rietveld, 2007). To not harm the travellers experience, a value should be added to their opinion regarding various situations, the willingness to pay. This can be defined as the maximum amount a customer is willing to pay for a service, e.g. parking your bike at a train station.
Not much is known about the influence of certain pricing schemes (e.g. first 24-hours free) at bicycle parking facilities. Studies only consider the variation between a directly paid and a free parking facility (e.g. Geurs et al., 2016; Molin & Maat, 2015; Puello & Geurs, 2015). Additional attributes, as a repair shop, are only limited discussed. The term marginal willingness to pay is used to refer to the valuation of a specific attribute. Molin & Maat (2015) studied the impact of the attributes walking time and price. According to Van Mil et al. (2018), consumers are willing to pay €0.11 for a minute less time to park, which includes walking to the platform and average search time. Dijk (2014) performed a study at various stations in the Netherlands. It provides a rough indication of the willingness to pay of travellers. It is also the only known research that included the willingness to pay for a subscription. During this research, no attributes of the facility were specified. Therefore, scientific support is missing. All in all, more research is required to determine a good price policy for both the operator and user of the facility, as the current situation is not well reflected in literature. Both the availability of a free parking period and a subscription price should be considered.

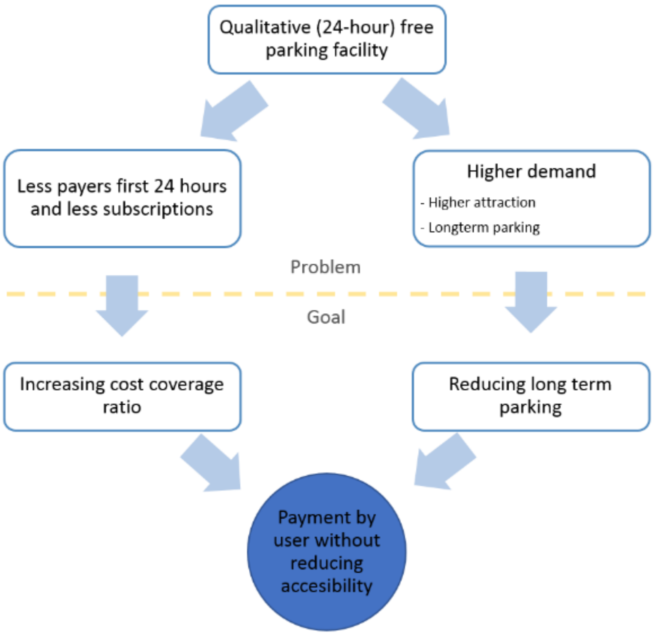

Figure 1.2, Problem statement, originating from paid facilities

This twofold problem, as visualised in Figure 1.2, results in the goal of this research to get more insights into both the experience and the willingness to pay of various types of bike parking users at train stations. By getting a better understanding of the attributes influencing the choice behaviour of facility users, an insight is given into the preferences of passengers concerning bicycle parking. For a full overview, there has to be differentiated towards types of facilities and types of stations. The effect of a policy change is also meaningful for NS and will therefore be examined. A higher price may result in travellers changing their (multimodal) trip (e.g. Molin & Maat, 2015; Shelat et al., 2018). This makes the WTP a crucial factor when defining the best price, both for operator and user, and is therefore of growing interest (Hensher, 2010).

1.3. Research objective and question

As stated in the previous section, the information known about the influence of bike parking policies at train stations is limited. This is even more restricted when different types of stations are considered. Bike parking is often seen as part of policies aimed to improve cycling or train ridership. Only a few studies consider bike parking as a topic on its own. Therefore, not all elements influencing either the experience or the willingness to pay (WTP) of parking facility users are identified. Also, full understanding is lacking about the impact of different attributes of the facility on the WTP. In addition, the impact of the free parking period is never considered before. Lastly, the relationship between the willingness to pay and the expected subscription price is unknown. All in all, the known studies are not sufficient to support changes in the current pricing policy. Additional research is needed to achieve the goal of NS stations: to make parking facilities less cost demanding without reducing the accessibility of public transport. Therefore, this research aims to contribute to a better understanding of the influence of different price policies, when different attributes of a parking facility are considered.

Given the literature gap as described before, in combination with the goal of this research, the following research question needs to be answered:

What is the willingness to pay of various types of bike parking-users at train stations for different types of facilities and at different types of stations?

To be able to provide an answer, some sub-questions are formulated.

1. Who are the users of the bike parking facility?
2. Which elements determine the perceived quality of a parking facility at train stations and which are the most important?
3. How do elements of a parking facility influence the experience of various users?
4. Which elements have a significant impact on the preference of facility users?
5. To what extent is the willingness to pay of a parking facility affected by its characteristics and the station where it is situated?
6. To what extent is the willingness to pay expressed in a subscription price?
7. What potential changes will facility users make in their trip if a proposed pricing scheme is considered to be too expensive?

Guided by sub-question 1, 2, and 3, the situation as currently occurs at bike parking facilities of train stations is investigated. Both literature and the ongoing data collection of the yearly chain experience tracker (Keten Belevings Monitor or KBM) of NS are used during this process. More details about the method will be provided in Chapter 2, methodology. Sub-question 4 aims to provide more insights into the stated preferences of facility users. To answer this question, a survey is composed, based on previous findings, and distributed amongst members of the NS-panel. Additionally, the results of the survey are used to draw conclusions about the willingness to pay of the parking facility users, providing answers to sub-question 5, 6, and 7. To start with, the willingness to pay is computed in various situations for various users. Also, the effect of the availability of a subscription is viewed. As of last, the impact of a new pricing policy is studied. To end the research, a conclusion is formulated regarding the willingness to pay of various types of bike parking-users at train stations for different types of facilities and at different types of stations. In addition, recommendations are given regarding policy and further research.

1.4. Scope

During this study, the impact of a pricing policy in the guarded facilities will be studied, based on possible users. Bicycle lockers will not be considered as these are currently only available with a subscription. These also entail different elements of service. The findings must be suitable to create a simple and unambiguous system, with possibilities for differentiation, by NS. Therewith, the focus is on the access side of the train trip. Parking facility users at the egress side own a second bike. These are often parked for a longer period. However short-term parking is preferred, as it results in better utilization. In addition, not all users of the facility are bike-train travellers. Some facility users have their destination at a nearby office or shop. As the share of these users varies strongly for each

station, this is not considered. A different pricing policy might be considered for them in the future, but it is outside this scope.
The layout of the parking facilities will remain the same. The focus is on the influence of various generic elements of parking facilities, as the presence of staff and walking time. An important aspect in the utilisation of guarded parking facilities is the capacity. Currently, capacity problems occur at several stations. By the implementation of a pricing policy, this might be prevented. Hence, in future scenarios, sufficient capacity is assumed. No predictions will be made about future demand in terms of growth. It only examines the influence of paid parking on the demand.
When implementing a payment scheme, a payment system needs to be used as well. No direct research will be done towards the different payment mechanisms. Next to that, a limited amount of additional time is considered for entering the facility, ease of use is assumed.

1.5. Report outline

The research is divided into three main parts: I. the bike parking users and their experience, II. stated preferences of parking facility users, and III. the users' willingness to pay and market shares. The structure of this report is visualised in Figure 1.3. The blue numbers indicate the sub-questions answered in the corresponding section. Before answering the sub-questions during the sections, chapter 2 will discuss the methodologies used to provide answers.
The first part starts with a literature review regarding the various factors influencing the bike-train experience, as presented in Chapter 3. Chapter 4 analyses the various users of the bike parking facility by their characteristics and their utilisation. Traveller profiles are created based on user characteristics. Chapter 5 discusses elements of the experience of these various users and how the experience is influenced by various attributes of the facility.
The goal of section II is to identify the elements with a significant impact on the preference of facility users. The findings from section I are used for this. The development of the survey, which is used for the remainder of this research, is described in chapter 6. Chapter 7 explores the provided answers by using discrete choice models. Previously identified user characteristics are added to reveal dependencies with the elements.
Section III focuses on translating the findings to the willingness to pay of the users. Chapter 8 discusses the range of the willingness to pay for guarded parking facilities at train stations. This chapter also elaborates on the impact of a subscription as part of the pricing policy. Chapter 9 discusses the effects of an adapted pricing policy.
This research is concluded in chapter 10. Besides, the findings will be discussed and further recommendations for both policies and future research are provided.

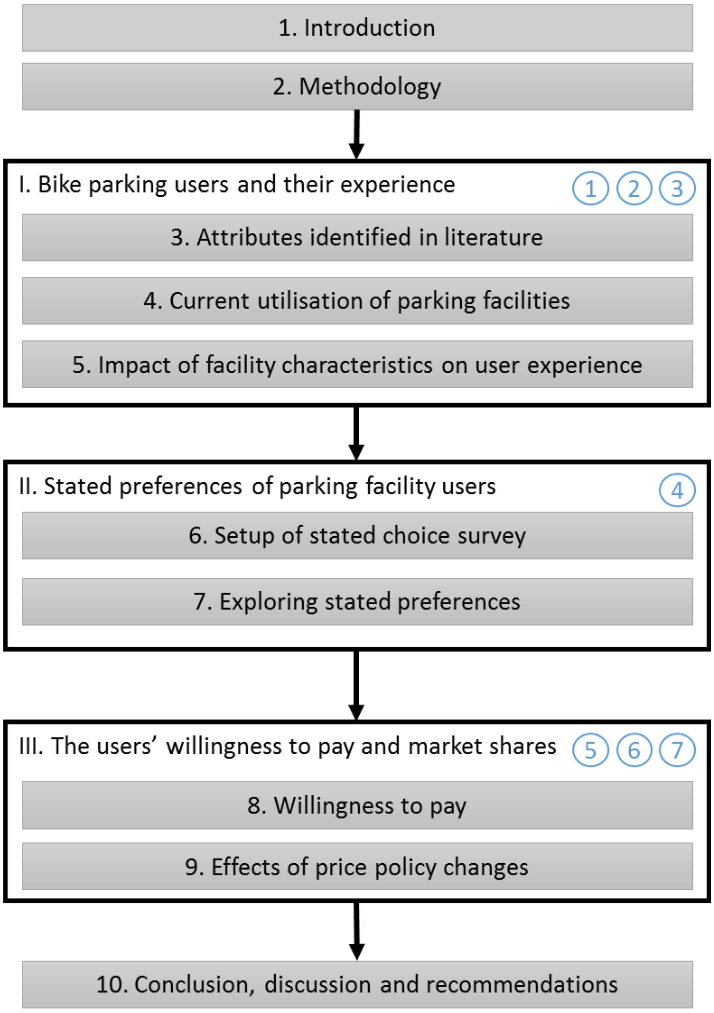

Figure 1.3, Visualisation of the report structure, with relevant sub-questions in blue

2. Methodology

In support of the research approach presented in section 1.3, this chapter provides a brief overview of the theories behind the applied research methods and the rationale for using them. First, in section 2.1, the characteristics of influence as described in the literature are clustered. Section 2.2 describes how the user characteristics at current parking facilities are identified. 2.3 discusses how the experience of current users is investigated by the means of factor analysis. These insights are used as input to further exploration of the willingness to pay. Section 2.4 discusses the use of a stated choice experiment to collect more data to do so. The applied modelling methods of the stated choice data are discussed in section 2.5. Section 2.6 discusses how the models are translated to results. As of last, section 2.7 explains how an adaptive choice experiment is used to gain insights into the effect of a subscription price on the WTP.

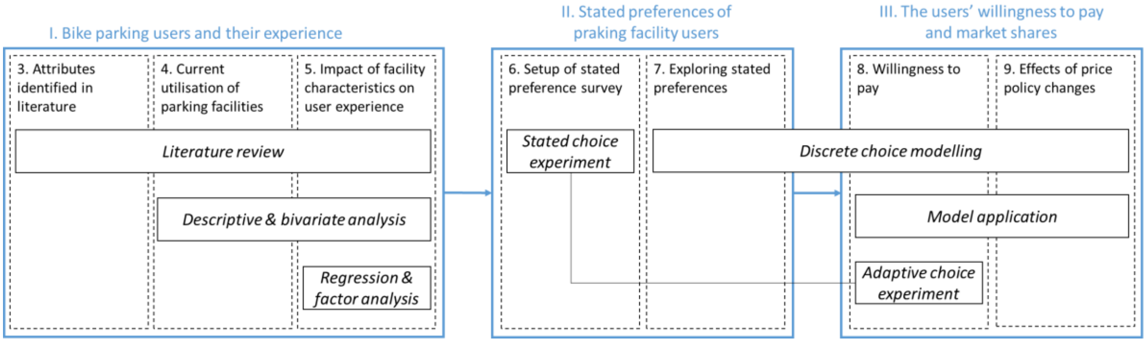

Figure 2.1, Visualisation of the research methodology

2.1. Literature review

The first section of this report aims to get more insights into the users of the bike parking facilities near train stations and their experiences. This starts with a review of existing literature. The aim is to gain more insights regarding the current utilisation and experience. In particular the heterogeneity in preferences, and which elements cause these differences. Multiple studies investigated the influence of the bike as an access mode on multimodal travel choices (e.g. Heinen & Buehler, 2019). Nevertheless, most of the studies consider parking as one of the many factors on the bicycle or public transport use. The chapter aims to elaborate on the existing knowledge about parking facility usage. Therefore, literature is collected by using the index tool Scopus and Google Scholar. To start, several combinations of keywords are used, e.g.: accessibility, bicycle / bike, choice modelling, multimodal transport, parking facility, public transport, station, train, and willingness to pay. Also, the Dutch translations are used as many studies are performed in the Netherlands. After collecting a bunch of relevant literature, snowball sampling is applied (Bryman, 2008). Also, several articles have been brought to the attention. The main focus is on Dutch studies, as familiarity with cycling results in a different attitude towards cycling (Shelat et al., 2018).

2.2. Descriptive and bivariate analysis of the users

Some additional information is known within NS regarding the bike-train combination. Via a yearly conducted survey of NS, the chain experience monitor (Keten Belevings Monitor or KBM), data is collected regarding the performances of various services. The bike parking facility is one of these services where users are asked to fill in a questionnaire. The survey is held in every guarded bicycle parking. This entailed 99 garages at 85 stations in September 2019. The goal is to reach 150 responses with various demographics for every facility. As the survey exists amongst others of personal characteristics, it shows a good representation of the facility users. The relationship between user characteristics is analysed by the means of a chi-square test (A. Field, 2009). The findings will be used to analyse the difference in the attitude of users via an independent t-test. Later this method is also used to see if differences in motivation and experience are significant.

2.3. Factor analysis to determine elements influencing user experience

The last method used to fulfil the research performed in section I. is factor analysis. The previously mentioned chain experience monitor starts with 22 statements. The respondents need to grade each of them between 1 and 10. Furthermore, the users are asked to provide an overall score of the parking. In case a (repair) shop is present, users are also asked to evaluate the experience of this. Finally, several questions about their demographics are included. To gain more insight into the experience of the facility users at various garages, an in-depth analysis is performed during this study on the data of the KBM. Due to COVID-19, people were strongly advised to limit travelling and therefore train trips since March 2020. As this has an impact on the occupancy of the facility, the data of the KBM 2019 is used for this analysis. The questionnaire gets updated every year which results in some small variations of the questions over the years.
By performing a factor analysis, complexity will be limited. The number of statements is reduced to clear out the underlying variables: factors. Each statement has a loading onto each factor. These loadings can be computed into an equation, to compute a person's score on a factor. The factor scores can be used in further analysis of the user experience. The way of performing the factor analysis for this research is based on the methods used in the book of A. Field, (2009) and further elaborated below. Analysis program SPSS is used.

Checking the data of the KBM-survey on adequacy

Before starting a factor analysis, the adequacy of the dataset needs to be verified. The sample size can be checked by the Kaiser–Meyer–Olkin measure of sampling adequacy (KMO). This number, between 0 and 1, represents "the ratio of the squared correlation between variables to the squared partial correlation between variables". A value close to 1 indicates relatively compact patterns of correlations which will result in a clear and reliable factor pattern. Furthermore, the interrelation of variables is checked. Correlation is considered to be too high when a value larger than 0.8 occurs. Correlations are considered to be too low in case of a value below 0.3. A more objective way is checking the results of Bartlett's test, to check if there is a significant difference from an identity matrix.

Among the responses of the form, quite a few of them are incomplete. In case users didn't find themselves opinionated about a statement, they left the answer blank or crossed "not applicable". This is occurring most often with the questions regarding the presence of staff or the pricing of the parking. But also other statements are left blank randomly. As excluding cases listwise would reduce the dataset massively, excluding cases pairwise was considered for analysis.

Extracting and rotating determined factors

The principal component analysis is considered to extract factors. This makes the conclusions limited to the collected sample. Generalization of the results can only be achieved if analysis with different samples reveals the same factor structure.
Either by looking at the scree plot or sticking to Kaiser's criterion, where factors should have an eigenvalue larger than 1, the numbers of factors to extract can be determined. Through factor rotations, loadings of variables are maximized to only one factor. As the underlying factors are assumed to be related to each other, an oblique rotation is considered. For the analysis in SPSS the method "direct oblim" is applied. The default setting of the delta being 0 is used, which does not allow a high correlation between factors.

Composing scores for individual users

By extracting and rotating the factors, the factor structure becomes clear. As oblique rotation is applied, a pattern matrix and a structure matrix appear. The pattern matrix contains the factor loadings, the regression coefficients for each variable on each factor. The structure matrix also considers the relationship between factors, as it contains the correlation coefficients for each variable on each factor. The pattern matrix is interpreted because of the unique contribution, which is easier. However, some values in the pattern matrix might be suppressed because of the relationship between factors. Therefore both matrices are checked. Only factor loadings with an absolute value greater than 0.4 are considered which explains around 16% of the variance of a variable.

Finally, equations are constructed that describe each factor score in terms of the measured variables. First, the factor loadings need to be adjusted by multiplying the matrix of factor loadings by the inverse of the original correlation matrix. Conceptually speaking, the correlation coefficients are divided by the factor loadings. By using the regression method, the initial correlations between variables are considered when adjusting the factor loadings. This method is considered because of the better understanding. The downside is that the scores can also correlate with other factor scores from a different factor.
The results are computed into the matrix of factor score coefficients. This shows the relationship between each variable and each factor while considering the original relationships between pairs of variables. As such, this matrix represents a purer measure of the unique relationship between variables and factors. However, the pattern of the loadings remains the same as for the factor score coefficients. The resulting scores will have a mean of 0. The variance will be equal to the squared multiple correlations between the estimated factor scores and the true factor values.

As stated in the analysis of the data, quite some responses are incomplete. As a result, no factor scores could be determined for these participants. To overcome the problem and being able to analyse the results of the survey, another way of determining the scores for the different factors of the various participants is considered. The factor score coefficient matrix is used to construct factor equations. To not consider the missing values, only the substantive variables for a factor are considered. This is determined based on the pattern matrix. The factor equation is divided by the sum of the coefficients to compensate for the missing values in the formula. If a respondent didn't fill in an answer for one of the variables of a factor, no score for that factor is generated. So again pairwise exclusion is applied.

The impact of the determined facility characteristics can be explored by the use of a multiple regression line. Multiple regression analysis determines the contribution of these attributes to the overall score, which will variate for each attribute. It overall results in an R-value, representing the simple correlation, and R^2, explaining the variance by the factors. Service-related attributes are implemented as dummy variables. For the factors centred values are used, to increase the interpretability.

2.4. Stated choice experiment

By now, various elements influencing the experience of various users are described, which fulfil section I. To be able to answer which of the found elements also have a significant impact on the preference of facility users, as is the goal of section II, additional information is needed.

A choice experiment is considered to reach this goal as humans are in general bad in valuing an object or service. Two types of choice data exists: revealed preference (RP) and stated preference (SP). The majority of the studies regarding feeder modes are based on RP data (Heinen & Buehler, 2019; La Paix & Geurs, 2016). By evaluating real situations, high reliability and validity exist. The drawback is lacking information on non-revealed attributes and the inability of testing hypothetical situation. Also, a strong correlation between variables, such as time and costs, might appear (Cherchi & Ortúzar, 2002). Therefore stated preference data seems to be more suitable for this research. Another major advantage is the ability to capture the response to diverse attribute combinations which are not otherwise observed in the market (Hensher, 1994). However, the variation in choice and reality should be kept in mind.

To construct an experimental design for the stated choice experiment, the software program Ngene is used (ChoiceMetrics, 2018). A table with numbers is constructed that determines which attribute levels to combine into alternatives. Each attribute is assigned to a column, each statement is represented in a row and the number in the cells indicates an attribute level. Dominant alternatives should be avoided because it does not reveal any information about trade-offs. As a rough rule of thumb, the probability of an alternative should be <0.90 (ChoiceMetrics, 2018).

Multiple design options are possible for creating the choice sets. In a full factorial design, all possible combinations appear. This is only suitable for very small numbers of attributes and levels. A fractional

factorial design only contains a fraction of these possible combinations. Another option is efficient designs. This design aims to find designs that are statistically as efficient as possible in terms of predicted standard errors of the parameter estimates (ChoiceMetrics, 2018). It tries to maximize the information from each choice situation. An important factor determining the number of choice situations is the attribute level balance. Each attribute level should appear an equal number of times for each attribute (ChoiceMetrics, 2018). By this, parameters can be estimated well on the whole range of levels. Priors are required, which can be obtained from literature and a pilot study.
Different types of efficient designs exist: A-efficient, D-efficient, and S-efficient. The designs use the asymptotic variance-covariance (AVC) matrix for their predictions. It contains the variance of the parameters and the covariance between the parameters. The usage of the AVC depends on the type of efficient design. A-efficient only considers the variances, which is useful if these have the largest impact. D-efficient takes the determinant of the AVC matrix, which tries to estimate the overall best design. S-efficient aims to reach significance for the parameter which is hardest to estimate. A D-efficient model will be used in the remainder of this research. Bayesian efficient design is used for the final design (ChoiceMetrics, 2018). Instead of assuming fixed prior parameters, the priors are considered to be random parameters, based on the experienced deviation in the pilot survey.

2.5. Discrete choice modelling

To analyse the collected data of the stated choice experiment, discrete choice modelling is applied. By this method, the effect of an individual attribute on the choice can be estimated. This matches the research goal to identify the impact of different attributes of a parking facility on the WTP. The theory of discrete choice modelling is given below, even as applied models.

2.5.1. Utility maximization

The majority of choice models in transport are based on the utility maximization assumption (e.g. Chen et al., 2015; Heinen & Buehler, 2019; Hensher, 2010). It is assumed that travellers act rationally and have well-defined preferences. Alternatives are described by a set of attributes. The deviation can be made between observed and unobserved attributes. The alternatives on offer are considered by individuals on potential costs and benefits, the utility. Within a population, the characteristics generally have different influences on the choice made and therefore the heterogeneity of the preference is ubiquitous. The calculation of the utility is shown in equation 1 and 2

$$U_i = V_i + \varepsilon_i \qquad (1)$$
$$V_i = \Sigma \beta_k * x_{ik} \qquad (2)$$

The utility U_i of alternative i exist of a systematic part Vi and a random part ε_i. In the case of a linear relationship, V_i is an expression of the attributes x_{ik} and their weight β_k (parameters to be estimated). Also, other relationships than linear might be considered. Depending on the assumptions regarding the distribution of the random utility component, different choice probability formulations arise. The utility for the individual is maximized by choosing the alternative having the highest utility.

2.5.2. Model specification

To estimate the parameters weight β_k, several models exist. In this research, Multinominal Logit (MNL) and Mixed Logit (ML) models are applied. A comparison is made between the quality of the models.

Multinominal logit model
The most used discrete choice model is the MNL (Train, 2009). An independent and identically distribution (i.i.d.) of the random component ε_i is assumed. It means that the various error terms have a similar variance but are assumed to be uncorrelated. This not fully holds for this study. The two bike parking facilities on offer might be correlated. Also, panel effects occur, the correlation between the choices of one respondent. However, MNL assumes independence of each choice, and can therefore not include panel effect. The presence of interactions between user characteristics and considered attributes compensate for the lack of homogeneity.

A Nested Logit model is investigated, to check if all alternatives are uncorrelated. A Mixed Logit model is investigated to include both nests and panel effects. The MNL will be used as a base model, amongst others because of short computation times.

Nested logit model

In case multiple levels exist within the choice alternatives, so-called nests, a NL model can be applied (de Dios Ortúzar & Willumsen, 2011; Train, 2009). A nest occurs when two or more alternatives are correlated. This model assumes that the so-called IIA (Independence from Irrelevant Alternatives) trait holds within each nest, but not between different nests. However, panel effects can not be taken into account.

Mixed logit model

A mixed logit model (ML) can make up for both flaws of the MNL (McFadden & Train, 2000; Train, 2009; Yáñez et al., 2011). Nesting effects are captured by defining separate shared error components that account for the nesting part of the error term (Cherchi et al., 2008). Panel effects are captured by the ability to consider all choices made by one respondent. As it is no closed-form solution, parameter weights have to be computed via simulation. This results in an increase in computation time compared to MNL.

2.5.3. Model performance measures

After computing models, their performance needs to be accessed by the goodness of fit. Several statistical measurements are available. For discrete choice models, the likelihood ratio index is often used (Train, 2009). A comparison is made between the estimated model and the base model. In the base model, all alternatives have an equal chance to be chosen because all parameters are set to zero. So it checks the likelihood of the model is better than a random number. The higher the log-likelihood of the estimated model, the better the fit. The likelihood ratio index (ρ^2) is calculated by the following equation:

$$\rho^2 = 1 - LL(ß) / LL(0) \qquad (3)$$

LL(ß) = final loglikelihood of the model
LL(0) = null loglikelihood

An extension to this equation can be made by correcting for the used number of parameters (K), the adjusted ρ^2. This is useful when a comparison is made between different models. The following equation is used:

$$\text{adjusted } \rho^2 = 1 - (LL(ß) - K) / LL(0) \qquad (4)$$

Also, the likelihood ratio test can be used to test the performance of different models, for example when implementing nests. If the null hypothesis can be rejected, the IIA property does not hold and nests are present. Biogeme computes the value for each model individually. Where LL(0) is the log-likelihood of the null model and LL(ß) of the final model. The threshold value χ^2 is associated with the applicable significance level. The equation used is:

$$-2(LL(0) - LL(ß)) > \chi^2 \qquad (5)$$

In addition, it should be checked whether the parameter for a nest is significantly different from 1. This can be done by:

$$\mu_{\text{nest}} - 1/\sigma_{\mu,\text{nest}} \qquad (6)$$

2.6. Model application

The last section of this report aims to find the variation in the users' willingness to pay. The utility functions can be used to determine the WTP of various attributes, both of the average facility user as of the individuals. By comparing the utility of each factor with the price segmentation, conclusions can be drawn, as shown in equation 7.

$$WTP = ß_n / ß_{cost} \qquad (7)$$

A new pricing policy may result in travellers changing their multimodal trip (e.g. Molin & Maat, 2015; Shelat et al., 2018). This can be studied based on the utility functions as well. The utility for the individual is maximized by choosing the alternative having the highest utility. For a MNL, the choice probability P of individual n for alternative i can be determined as described in equation 8.

$$P_{ni}= e^{V_{ni}} / \Sigma\ e^{V_{nj}} \qquad (8)$$

For an ML model, the choice probability is described by equations 9 and 10. Were $L_{ni}(ß)$ represents a density function. As the formula does not take a closed-form solution, it has to be computed via simulation

$$P_{ni}= \int L_{ni}(ß) * f(ß) *dß \qquad (9)$$

$$L_{ni}(ß) = e^{V_{ni}(ß)} / \Sigma\ e^{V_{nj}(ß)} \qquad (10)$$

By computing the probability for each individual, the impact of certain measurements on facility utilization can be studied. Also, the choice for other options becomes clear.

2.7. Adaptive choice experiment

Additional to the stated choice experiment, a second choice experiment is added to the survey to indicate a price users are willing to pay for a monthly subscription. In case an open question is asked, a wide range will appear (van Dijk, 2014). Most people will fill in a random number, below their actual price, so steering is required. Therefore, this indirect method is used to discover the maximum subscription price users are considering for a certain facility. Also, not all feasible prices can be asked as it results in too many questions. This might annoy respondents and result in inconsistent answers or quitting the survey early. By the use of an adaptive choice experiment, the questions can be limited to 3 per respondent.

As the price will be depending on various attributes, the situation and free parking period are provided. The free period will always be lower than the average parking period of the respondent. The follow-up question is depending on the answer given in the previous question(s). If the respondent indicates to be willing to pay price x for a monthly subscription, the second question will be higher. When the answer for price x is no, the second question will be lower. The provided price ranges are based on discussions with various experts of NS Stations.

Based on the expected travel frequency, a comparison is made between the WTP for a monthly subscription and the calculated WTP for 24 hours of parking.

I.
Bike parking users and their experience

The goal of the first part of this research is to get more insights into the experience of bike parking facility users. This starts with a review of existing literature, to gain more insights regarding the current utilisation and experience. The findings are reported in chapter 3.
This information is complemented by analysing the answers of the yearly performed chain experience tracker of NS. In chapter 4, the respondents of the survey are analysed. It provides insights into their characteristics and the utilisation of the facility. This addresses the first sub-question: *Who are the users of the bike parking facility?*
Furthermore, the answers of the survey are used to get a better understanding of the user experience by determining elements of influence, as it provides an answer to sub-question two: *Which elements determine the perceived quality of a parking facility at train stations and which are the most important?* The elements are discussed in chapter 5. It also includes a comparison to view the variation in experience over various user characteristics, to answer sub-question three: *To which extent do experiences of bike parking facilities vary by users?*

3. Attributes identified in literature influencing bike-train usage

Different research topics are dedicated to the combination of bike and train. In these studies, several attributes are mentioned which are of influence using this combined modality. By knowing the influence of attributes, differentiation in WTP can be further investigated. To structure the different attributes affecting the usage, they are clustered into three categories in this research:

- User characteristics
- Parking facility characteristics
- Station characteristics

The user characteristics describe the attributes which are related to current bicycle-train users, as these are the main users of the facility. Personal profiles are connected to travel choices. In literature, the characteristics of the parking facility are also mentioned of influence on the WTP. Better services enlarge the utility of the travellers, depending on the type of traveller. The last group of attributes describe the impact of the station on the travellers' experience and therefore on the WTP. This is not extensively investigated before.

Of each attribute, their relationship to the WTP is expressed in a table, even as a short description. + indicates a positive impact on the WTP; +- indicates that a relationship is found but it is not sure whether this is positive or negative; and - indicates a negative impact on the WTP. Multiple attributes are related to each other. This is discussed in the remainder of the sections.

3.1. User characteristics

The first group of attributes that is elaborated on is the user characteristics. The focus is on the characteristics of bicycle-train traveller. However, many of the attributes might also apply to other parking facility users. Attributes are related to the travellers, e.g. age and gender, and to the journey they are performing, such as purpose. They are presented in Table 3.1. Travel characteristics are depending on the needs of the individual user. Therefore not all travel characteristics are transferable between different areas (de Dios Ortúzar & Willumsen, 2011). However, relating the trips to homogeneous groups of people, travel characteristics will remain stable and transferable within the same cultural context.

Personal characteristics

In many choice behaviour studies, gender is of significant influence on the choice outcome. According to Shelat et al. (2018), men are more likely to access the train station by bike. In addition, this varies per culture according to Leferink (2017). However, women are expected to be slightly more sensitive to safety (Maat & Louw, 2012), and therefore to have a higher utility for secured parking. By studies performed in the Netherlands, no significant variation in choice behaviour is shown, both in cycling as access mode and type of parking (e.g. Givoni & Rietveld, 2007; Maat & Louw, 2012; Molin & Maat, 2015).

Molin & Maat (2015) found that age is of significant influence on the WTP for a parking facility at train stations. The higher WTP might be explained by the higher desire for service, as older respondents tend to be more positive about the quality of it (Monsuur et al., 2017). But also income (Van Mil et al., 2020) and bike quality (Maat & Louw, 2012) have an important role in the WTP. People with a higher income are in general more willing to pay for certain services. Especially if time-saving is considered, as higher income is linked to a higher value of time. These users also tend to have a higher quality bike.

Of the parking facility users with a low-quality bike, nine out of ten would choose the unguarded parking (Molin & Maat, 2015). Of good quality bikes, one-third of the users choose guarded parking. Splitting the research group among student and employed shows that users with a job are even more attracted to the guarded facility when they have a decent bike (Maat & Louw, 2012; Molin & Maat, 2015; Van der Spek & Scheltema, 2015). On the other hand, people who live in relatively prosperous

neighbourhoods are less inclined to cycle to the station (Puello & Geurs, 2015). Students have a stronger preference for free facilities.
Related to age and income is also car ownership. It can be expected that high car ownership will generally result in a lower level of bicycle and transit (Givoni & Rietveld, 2007; Van Mil et al., 2020). Car ownership amongst bicycle-rail commuters is slightly lower according to various studies, even as amongst cyclists in general. Nevertheless, bicycle-rail users often still own a car just like other rail users, indicating choices are available (Molin et al., 2016; Shelat et al., 2018). In the case of lowering the utility for the bike-train combination, the availability of a car is more likely to result in a modal shift (Puello & Geurs, 2015).

Travel characteristics
As travel characteristics are depending on the needs of the individual user, they are in many cases related (Jonkeren et al., 2019). One of them is the age, where mainly younger people travel to school and pensioners are the biggest share in leisure activities. The group in between are mainly commuters to work. Commuters to school are generally in favour of the free facility while commuters to work are more often considering a guarded facility (Molin & Maat, 2015).
Commuters to work or study also have the highest share in bike-train combination, 47% and 44% respectively (Givoni & Rietveld, 2007; Shelat et al., 2018). This influences the travel frequency as well because they perform the same trip more regular. Maat & Louw (2012) conclude that for every extra day per week that the bicycle is parked, the chance increases by 38% that this is done under surveillance. However, people with low travel frequency tend to be more positive towards quality (Monsuur et al., 2017). This also applies to incidental activities such as shopping (Shelat et al., 2018).
The trip purpose also influences the departure time, especially in the case of commuting. In some of the big cities, there is an overlap between the people accessing the train by bike and people taking their bike for egress (Jonkeren et al., 2018). A bicycle on the home side generally arrives at the station earlier in the morning (at the start of the morning rush hour) than the second bicycle leaves (at the end of the morning rush hour). In the evening this image is mirrored. The parking demand is greatest at this moment. This increases the preference for a guarded facility, to increase the chance of a free spot.
The last attribute depending on the trip purpose is the parking duration. Commuters generally park their bike for eight to ten hours. Their bike is parked during daytime which provides less need for secured parking, due to social security (Arbis et al., 2016). When bikes are used as egress mode, they are parked overnight and also for a longer period of time. These are more likely to choose guarded parking (Maat & Louw, 2012; Van der Spek & Scheltema, 2015). Also, students might consider a guarded facility if they are going to their parent's house for the weekend.

Table 3.1, Relevant user characteristics from literature

Factor	Relationship	Description and source
Personal characteristics		
Gender	+-	Women have a higher sensitivity to safety (Maat & Louw, 2012). However no variance in choice behaviour (e.g. Givoni & Rietveld, 2007; Molin & Maat, 2015).
Age	+	Older people have a higher WTP because of better service experience (Monsuur et al., 2017) and safety desire (Molin & Maat, 2015).
Income	+	The majority of bike-train users have an above-average income (Shelat et al., 2018) which enlarges the WTP (Van Mil et al., 2020). However, Molin & Maat (2015) did not find any significant influence. But students, which have a low income, showed a strong preference for free parking
Bike quality	+	Better bike quality enlarges the desire for guarded parking, especially for higher incomes. (Maat & Louw, 2012; Van der Spek & Scheltema, 2015)
Car ownership	-	Availability of cars makes a change in utility more likely to result in a modal shift (Puello & Geurs, 2015).
Travel characteristics		
Purpose	+ -	Commuters to work are more often considering a guarded facility (Molin & Maat, 2015). Furthermore, the series of activities travellers would like to perform has an impact on their mode choice and sensitivity (Shelat et al., 2018)
Frequency	+	Increasing trip frequency enlarges the chance to park under surveillance (Maat & Louw, 2012). However, people with a low travel frequency tend to be more positive towards quality (Monsuur et al., 2017)
Departing time	+	Parking during rush hour increases the preference for a guarded facility, to increase the chance of a free spot (Jonkeren et al., 2018).
Parking period	+	Parking during daytime provides less need for secured parking, due to social security (Arbis et al., 2016). Therefore people parking for longer periods are more likely to park guarded (Maat & Louw, 2012; Van der Spek & Scheltema, 2015)

3.2. Parking facility characteristics

The next group of attributes of influence on the willingness to pay are the characteristics of the parking facility. The experience of a parking facility can be determined by the layout of the facility and the provided services within the facility, see Table 3.2. In literature, most of these characteristics are described in terms of attractiveness and preference. WTP is discussed very limitedly but can be deducted.

Table 3.2, Relevant parking facility characteristics from literature

Factor	Relationship	Description and source
Layout		
Sheltered	+	Indoor parking facilities are higher appreciated than covered outdoors and uncovered facilities (Heinen & Buehler, 2019; Puello & Geurs, 2015). Their presence already increases satisfaction (Martens, 2007).
Walking distance	-	The walking time and distance have a strong influence on the utility (Arbis et al., 2016; Molin & Maat, 2015). Only users with a strong preference for security are willing to walk further.
Average search time	-	Capacity shortage is a dissatisfier to access the train station by bike (Molin & Maat, 2015). WTP increases in case of capacity problems at the free facility.
Service		
Security	+	The presence of camera security or a guard is improving the experience (Puello & Geurs, 2015). Also, train frequency can be considered in the experience of security (Arbis et al., 2016).
Crew available	+	Facility managers not only prevent theft but also anti-social behaviour (van Dijk, 2014). It improves the service and therefore the WTP (Van der Spek & Scheltema, 2015).
Bike repair	+	Repair and maintenance service is seen as a satisfier and increases the attractiveness for some of the users (Heinen & Buehler, 2019; Van der Spek & Scheltema, 2015; van Dijk, 2014). Mainly in case of a higher income (Maat & Louw, 2012).
Opening hours	+ -	Closing the facility when no trains are operating improves the feeling of safety (Leferink, 2017) and therefore the WTP. However, clear communication is subsequent (van Dijk, 2014).

Layout
Several studies conclude that covered indoor parking facilities are higher appreciated than covered outdoors and uncovered facilities (Heinen & Buehler, 2019; Puello & Geurs, 2015). It increases the likelihood of cycling as access or egress to the station up to 2.9 times. Mainly older people with a higher income find a sheltered facility important (Molin & Maat, 2015). Users indicate an increase in satisfaction with the presence of sheltered facilities (Martens, 2007). This appreciation, together with security, is also reflected in the impact of walking distance. The distance to the station entrance for secured bicycle parking can be larger, in case of a preference for security, without a strong reduction in patronage (Arbis et al., 2016; Molin & Maat, 2015). However, for other users, with less preference for security, the walking time has a strong influence on the utility. The walking distance to the platform should be limited according to the Fietsersbond (n.d.). The Dutch cyclist association calls for a maximum walking distance between secure parking facilities and the station entrance of 200 meters. Van Mil et al. (2018) showed by multinomial logit modelling that, on average, consumers are willing to pay €0.11 for a minute less time to park, which includes walking to the platform and average search time. Capacity shortage is a dissatisfier to access the train station by bike (Molin & Maat, 2015). Travellers who make their trip on a high frequency tend to have different travel behaviour. They have less margin in the transfer which results in shorter available search time. If the capacity is not sufficient, it increases the risk of wrong parked bikes. Besides harming the appearance, it also results in safety and security issues (Van der Spek & Scheltema, 2015). The guidelines require an overcapacity of 20% for both secure and regular parking facilities so that cyclists can easily find a free parking space, even during busy days and hours (Martens, 2007). However, these numbers are hardly met at some stations. Available space indicators might reduce the impact of the problem.

Services
Services are provided in many ways. The most known services are providing personal security and safety from bicycle theft and vandalism. The risk of bicycle theft is for some users a big discourage to access the station by bike (Rietveld, 2000). The availability of bicycle lockers stimulates bicycle-train travellers up to 2.5 times more than a simply sheltered unguarded parking facility. This number increases by the presence of camera security or a guard (Puello & Geurs, 2015). For example, the presence of guarded parking makes Delft Station three times as attractive as Delft Zuid (Maat & Louw, 2012). Furthermore, train frequency can be considered in the experience of security (Arbis et al., 2016). Passengers are more likely to park their bike in unsecured parking if there is a high train frequency. The other travellers provide security. Also closing the facility when no trains are operating improves the feeling of safety (Leferink, 2017). However, clear communication at the entrance about opening hours is important. It prevents disappointments and therefore lowering the utilisation for subsequent visits (van Dijk, 2014). Opening hours is one of the aspects determining the accessibility of a facility (Van der Spek & Scheltema, 2015).
The available crew also improves the atmosphere (Fietsersbond, 2017; Van der Spek & Scheltema, 2015). They keep the parking tidy and they relocate bicycles that are parked too long or incorrectly. Staff is most appreciated by infrequent and older users. Also, the presence of repair services might be stimulation to choose for, in general, an intercity station (Puello & Geurs, 2015). This is mainly applicable to bike-train users with a higher income (Maat & Louw, 2012). Repair and maintenance service is seen as a satisfier and increases the attractiveness for some of the users (Heinen & Buehler, 2019; Van der Spek & Scheltema, 2015; van Dijk, 2014).

3.3. Station Characteristics
In the entire multimodal trip a passenger is performing, the station has a major influence on their travel experience. This applies to all access modes to the station. The WTP may vary for each station, based on various attributes, see Table 3.3. The characteristics are divided into environment and connectivity related attributes. Based on the characteristics the stations can be assigned to a certain station typology, which will be elaborated on later.

Table 3.3, Relevant station characteristics from literature

Factor	Relationship	Description and source
Environment		
Distance	+	Cyclists with a longer travel distance are more likely to park secured (Maat & Louw, 2012).
Buildings	+ -	The type of buildings in the environment have a strong effect on the purpose and frequency of the users (Molin & Maat, 2015; Puello & Geurs, 2015; Shelat et al., 2018)
Connectivity		
Train	+	Travellers prefer to cycle to a further station with better connectivity than walking to the nearest station. (Puello & Geurs, 2015; Weliwitiya & Johnson, 2019).
Public Transport as access	-	The availability and competition with regional transport have a negative influence on the WTP (Molin & Maat, 2015; Van Mil et al., 2020).

Environment
According to various researches, the attractiveness of cycling is strongly depending on the environment of the station (Van Hagen, 2002). A higher perceived quality of the station environment increases the frequency of bicycle usage for access and egress trips (Jonkeren et al., 2019). In case of active modes, the built environment is more relevant compared to car and public transport, as travellers are more exposed to the surroundings (Ton et al., 2019). The quality can be determined by the cycling distance and route attractiveness. The quality of cycling lanes is quite uniform in the Netherlands and can therefore be left out (Leferink, 2017). The level of elevation is also of importance, but less relevant in the Netherlands. Maat & Louw (2012) state that longer access distance is resulting in a higher likelihood to park secured. Correspondence can be found with the quality of the bikes and age of cyclists.
The cycling distance is also related to the built environment. Land use largely determines how far a station is located from residential areas on the access side or the destination on the egress side. The location and accessibility of businesses, schools and homes near the station is an important attribute in choosing the bike as access mode (Molin & Maat, 2015; Shelat et al., 2018). Also, the presence of a university has a big influence on the percentage of bikes in the access/egress mode and more important the type of users, who will have a different utilisation as discussed before. In general, small and medium-size cities have a positive correlation to bicycle usage. Furthermore, city centres are more attractive for cycling in comparison to suburbs (Heinen & Buehler, 2019).

Connectivity
In general, cyclists are willing to take longer bike rides to shorten their train journeys. Therewith, train passengers often decide to bike to a further railway station with a higher train frequency, if nearby, instead of walking to the nearest station (Jonkeren et al., 2019; Puello & Geurs, 2015). Only 3 percent of the total number of trips where a station was skipped relates to an intercity station in city centres. So the catchment area enlarges with a higher train frequency (Shelat et al., 2018). Preference is enlarged when more direct train connections and better facilities are present, also due to experience of safety. If a comparison is made between Delft and Delft Zuid, which are located within 3 km from each other, an extra transfer halves the attractiveness of Delft Zuid (Maat & Louw, 2012). However, the implementation of a pricing policy can reverse these effects.
The choice for the bike is also depending on the station accessibility by regional PT-modes (Van Mil et al., 2020). Some travellers choose a station where they can vary between the bike and public transport as access/egress mode, for example in case of bad weather. In addition, the availability and the competition with regional transport are of influence on the WTP (Molin & Maat, 2015; Van Mil et al., 2020). Often smaller cities and villages have more limited access to public transport, including train (Molin et al., 2016). The station accessibility by regional PT-modes can be expressed in price, directness and travel time (Van Mil et al., 2020).

Typology
Currently, different facilities are on offer depending on the function of the station in the total passenger journey (Van Hagen, 2002). To distinguish between the different types of stations, Holland Railconsult, in collaboration with NS, formulated an objective typology. It clearly shows how a station functions in its environment and the NS network. It justifies the combination of micro and

macro-accessibility (Van Hagen, 2002). The micro-accessibility is the area of influence on the station while the accessibility of the stations by rail with different train types is called macro-accessibility. The research resulted in a division based on 13 criteria in total. All stations are unambiguously assigned to a type based on qualitative and quantitative characteristics. In practice, the categorisation resulted to be complex when stations are the point of view, as it was developed for the travellers (NS Operator-department). This is a problem that has been discussed several times and the distribution is hardly used anymore. In the new vision of NS, which focuses more on mobility hubs, this division also no longer applies. Therefore a different typology, based on solely micro and macro-accessibility, is considered during this research.

To distinguish between different types of stations in this research, we go back to the basics of the micro and macro-accessibility: the location of the station (city centre, suburban or rural area) and its operating status (intercity or sprinter). This results in five types, which are visualised in Figure 3.1: city centre with intercity; suburban with intercity; city centre with sprinter; suburban with sprinter; and rural with sprinter. The division of various stations into the groups can be found in Table A.1. It only entails stations with guarded parking facilities, as these are further investigated in this research.

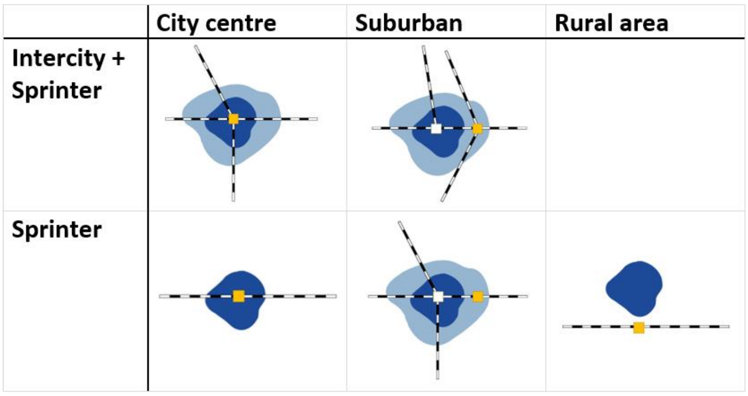

Figure 3.1, Division of stations based on location and operating status (viewed station in yellow)

The type of station is proven to be of influence on the attraction of cyclists to a station (Jonkeren et al., 2018). Only 3 percent of the total number of trips where cyclists passed by a station (skipped) relates to an intercity station in city centres. This shows that these stations attract cyclists from a wide area and that cyclists who live nearby almost always choose this station. This complies with the findings of Puello & Geurs (2015): train passengers often decide to bike to a further railway station with a higher train frequency, instead of walking to the nearest station. Accordingly, a suburban sprinter station has by far the largest share in the total number of skipped stations. This can be explained by the fact that this type of station is often located in or against a residential area, on the edges of a large city. A larger station is located in the city centre.

When considering the distance travelled by a cyclist to access a station, based on zip code, it is shown that suburban stations with a sprinter operating status have the lowest distance distribution. Rural stations have on average the largest range of attraction. These seem to attract two types of users: people living nearby, about 2 km, and a bit further away, about 5 km away, for who it is still the nearest station. City centres with only sprinters operating, catch 50% of their users within 2.2 kilometres from the station, as they are small cities, but the other 50% will travel up to 9 km. Both city centre stations as suburban stations operating intercity trains do have a similar pattern. The city centre does have a slightly bigger catchment area for the last 10% of the users.

3.4. Synthesis

The willingness to pay (WTP) is a crucial factor when defining the best price, both for operator and user. Traveller might adapt their multimodal trip in case of a different parking policy. To be able to study the impact, the attributes influencing the usage of the parking facility near train stations are identified. They are clustered into three categories during this study: user characteristics, parking facility characteristics and station characteristics. The characteristics of a station and facility are expected to have a direct influence on the choice. The user characteristics influence to what extent the attributes are affecting the choice. The attributes belonging to these categories are presented in Figure 3.2, even as their influence on the WTP. Also, various attributes are influenced by each other, this is represented by the arrows. For example, age has a significant correlation with the experience of safety, bike repair service and the presence of crew. Furthermore, the user demographics are correlated to travel characteristics.

To distinguish between different types of stations in this research, we go back to micro and macro-accessibility: the location of the station and its operating status. This results in 5 categories: city centre with intercity; suburban with intercity; city centre with sprinter; suburban with sprinter; and rural with sprinter.

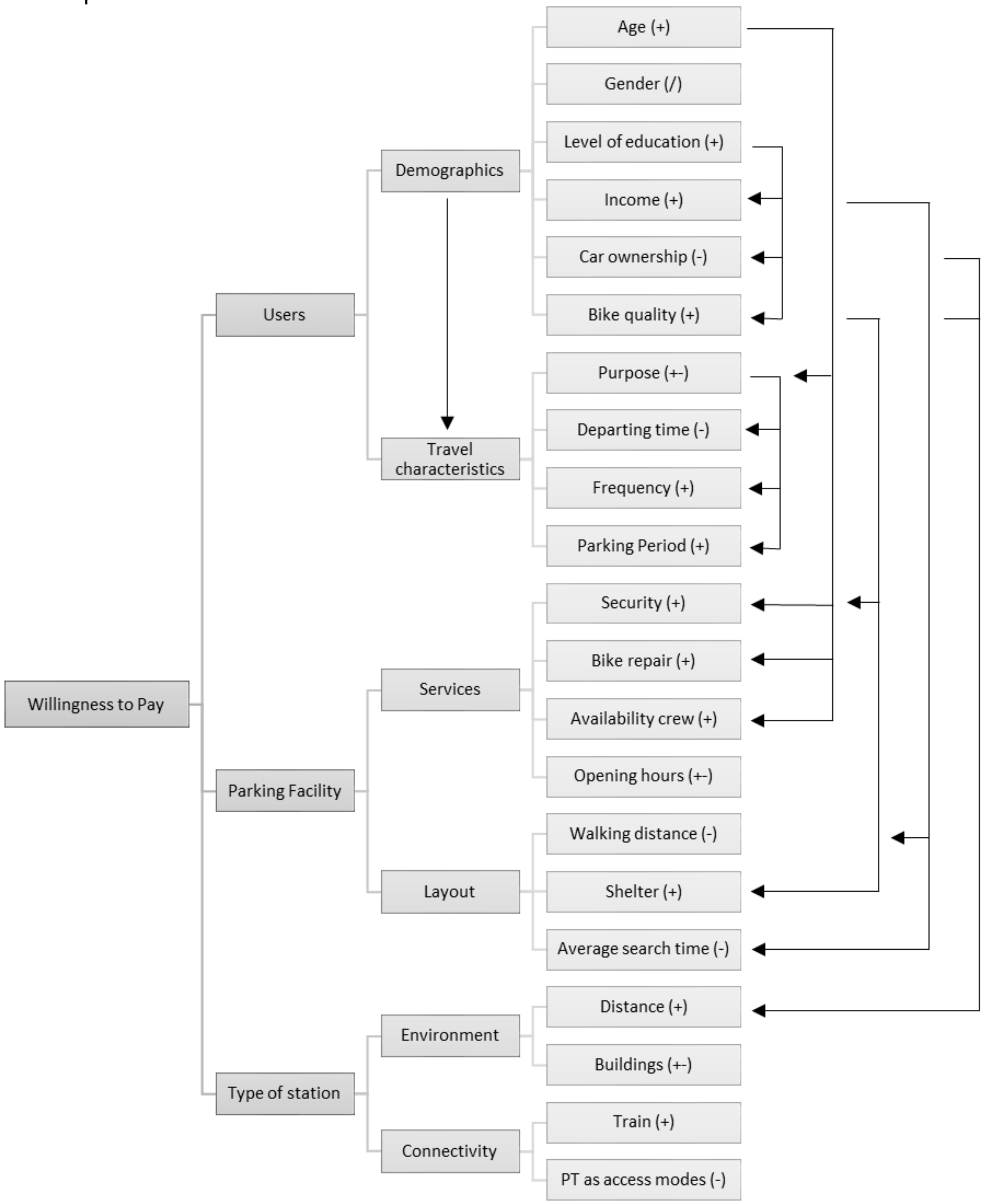

Figure 3.2, Attributes, their interactions and the influence on the WTP

4. Current utilisation of parking facilities

The literature review distinguished three aspects influencing the way passengers utilize parking facilities. One of them is the user characteristics. In the KBM, several questions about the characteristics of the user and their trip are included. These are regarding age, gender, trip purpose, parking duration and travel frequency. First, in section 4.1, the various users of the parking facilities are highlighted. The motivation for various travellers to park guarded is viewed in section 4.2. The travellers are grouped into traveller profiles, based on previous findings, in section 4.3. In section 4.4. the travellers' characteristics are viewed regarding the station types. As of last, the chapter is concluded in section 4.5.

It is known that the facility is not only used by bicycle-train travellers. In the KBM of 2020, a question is added to indicate these numbers. All outliers are presented in appendix A. However, it should be noted that the survey is yearly distributed in September. Due to COVID-19, non-compulsory trips were discouraged and the numbers might be biased. While people are strongly advised to limit travelling and therefore train trips, people who need to go to a nearby shop or office will still park their bike at the station. For the remainder of this chapter, the results of the KBM 2019 are used.

4.1. Characteristics of users

The literature identified both personal characteristics (e.g. gender, age, income, bike quality and car ownership) and travel characteristics (e.g. travel purpose, frequency, departing time and parking period) to be of influence on the bike-train usage. By knowing the distribution of these characteristics, the impact of a new policy can be studied.

Gender

Of the respondents, a bit less than 52% is female and about 47% male. The remaining did not answer or responded with other. This indicates that the higher share of males using the bike as access mode, which is stated in the literature, is not applicable in the Netherlands (Leferink, 2017; Shelat et al., 2018).

Age

In Figure 4.1, a bar chart represents the age of the respondents. It is clearly shown that younger people, between 16 and 22 years old, are the main users. Respondents being 65+ are less occurring with 747 of the respondents or 6%. The average age of the respondents is 37. Givoni & Rietveld (2007) already concluded that percentages of train travellers accessing the station by bike is decreasing with increasing age. This is explained by the desire of young adults for efficiency because of busier lifestyles. The benefits of being physically fit removes barriers (Jonkeren et al., 2019). Adults with small children are less likely to use the bike as an access mode due to combined trips and capacity.
When the data is divided into groups found in literature, a different distribution appears. People under 18 years are 11% of the respondents. The youngest is 12 years old and this category therefore only includes six different ages. Young adults, between 18 and 25 years old, only include a small range of the ages as well. However, this group is always well represented in public transport due to a free travel card for students. This results in a contribution of 25%. The category ranging between 26 and 45 years contains 27% of the respondents. The age between 46 and 65 is the most occurring with 31%. This skewness should be considered when analysing the data, especially in the case of youth and young adults.

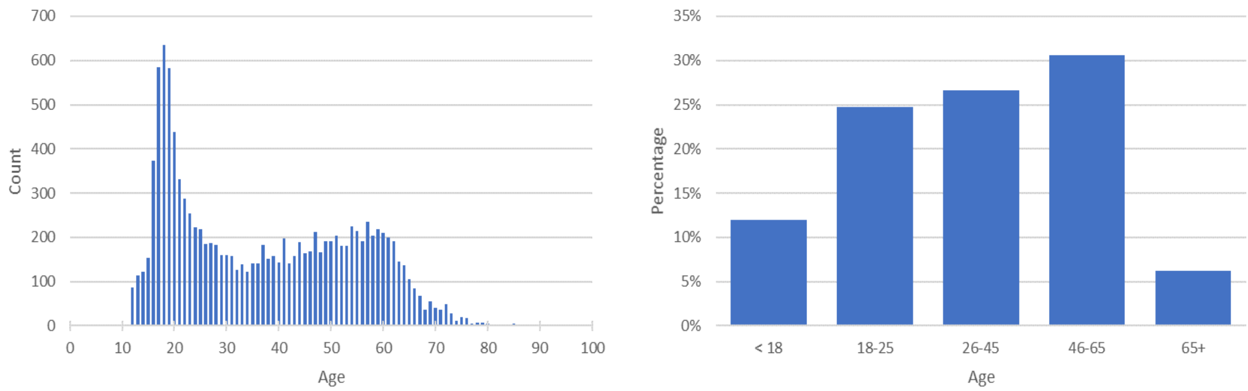

Figure 4.1, Distribution of age amongst bike-train users (KBM 2019)

Trip purpose
In the survey, users are asked about the main purpose of their journey. The distribution is presented in Figure 4.2.a. As already found in literature, most people travel to commute to work (51%) or school (31%). The share of students is slightly higher than the 26% found by (Givoni & Rietveld, 2007). In the survey, the option business trip was added, which was related to 5% of the travellers. For leisure activities, 4% is going to visit family or acquaintances, 1% states to go shopping and 4% defines their trip destination as other. From other researches, it is known that these trips are mainly leisure related. 4% did not answer the question.
The moment of performing the survey (on weekdays) should be considered. At this moment more commuters and students are travelling, and less social and recreational travellers. However, social and recreational travellers also tend to have a lower preference for the bike as an access mode according to Givoni & Rietveld (2007). The series of activities travellers would like to perform also has an impact on their mode choice (Shelat et al., 2018). In the case of more activities, it is more likely to use a private mode as the number of transfers also increases with public transportation.

Travel frequency
Literature indicates that frequent travellers have a stronger preference to access the station by bike, which is clearly visible in the numbers as well (Figure 4.2.b.). The majority of the facility users are frequent users, with 63% parking more than 4 times a week and 22% for 1 to 3 times a week. This group can also be labelled as heavy users. The group of users 1 to 3 times a month, medium travellers, is a lot smaller with 7% or 800 respondents. The infrequent or light users, less than once a month, are represented by respectively 3%, 2%, 1% and 1%. When considering unique persons, only 10% of the train travellers is categorised as heavy, but they perform 60% of the trips.

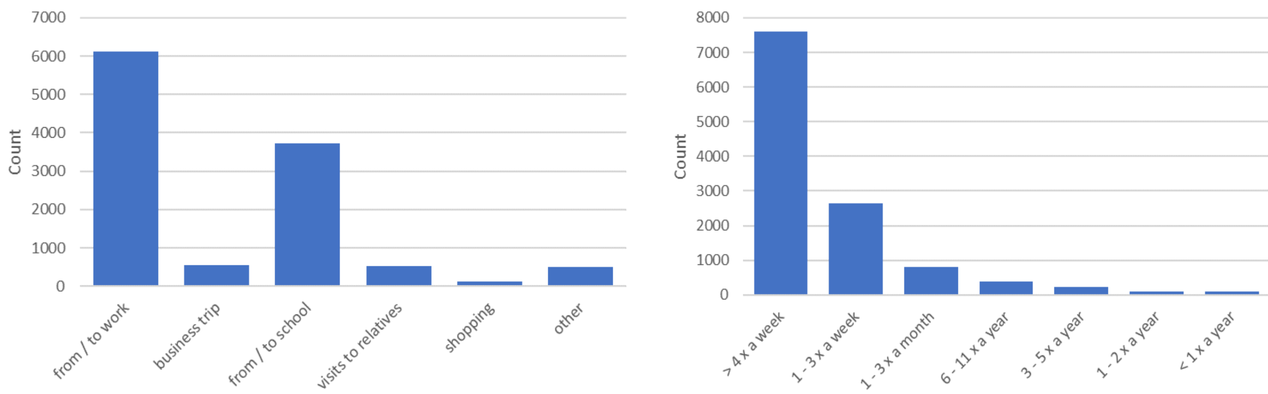

Figure 4.2, Distribution of parking facility users based on (a) trip purpose (b) parking frequency (KBM 2019)

Parking duration
In 2019, the majority parked their bike in the facility for less than 24 hours. Respondents with an parking duration between 24 and 48 hours and more than 48 hours are almost equal.

4.2. Motivation guarded parking

Why users choose to park inside is an important question in the understanding of user habits. Respondents were able to choose multiple answers. Safety is by far the biggest motivation to park inside, with 87% of all respondents. Parking your bike dry is the motivation for 42% of the users. User-friendliness and always a spot available are the least chosen answers with respectively 18% and 14%. The results of "other" are harder to interpret. It is chosen by 10% of the respondents. Some respondents emphasize their previous choice, especially bike safety and user-friendliness, or use the space to complain about different aspects. However, several of them mention the shorter walking distance than the other parking facility or it is the only available parking at their station. As of last, charging the electrical bike was mentioned by various people. The overall variation is discussed below, based on the various characteristics. All findings are marked as significant unless indicated differently.

Gender

Gender segregation shows that women have a slight preference for indoor parking for reasons as safety and user-friendliness (88% and 19% to 85 % and 17%). This was also mentioned by Maat & Louw (2012). Surprisingly men find available places more important than women (14% to 13%).

Age

Figure 4.3.a. shows the strong preference for safety for the bike as well. The deviation between groups with this motive is not significant with a p-value of 0.3. The 65+ category has a higher appreciation for the user-friendliness of the staff. As expected, this is only a motivation for a small part of the youngest people. Remarkable is the low percentage (9%) for the availability of spots amongst the youngest users. This might suggest that they are more attracted to parking their bike in the wrong places or are better at finding an empty spot.

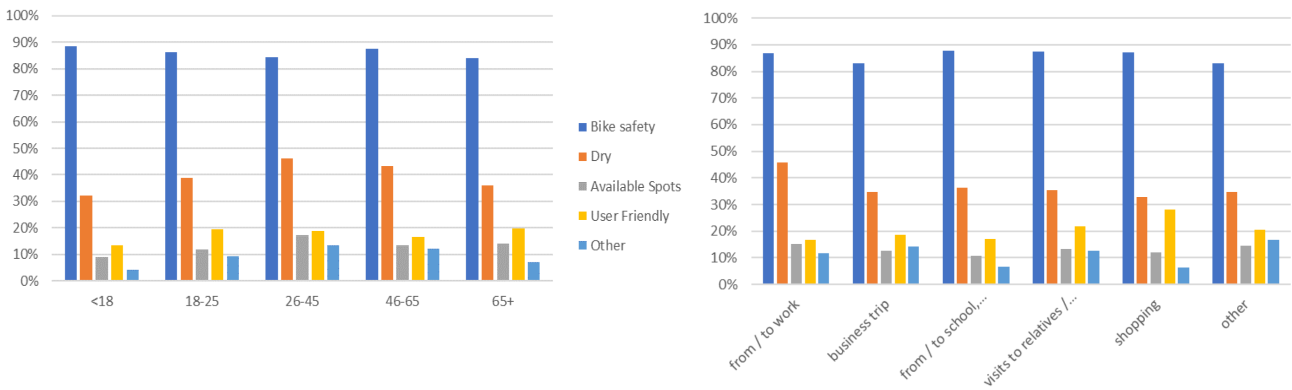

Figure 4.3, Motivation to park inside by (a) age (b) trip purpose (KBM 2019)

Trip purpose

The findings for trip purpose are shown in Figure 4.3.b and strongly match the expectations. Leisure activities score higher for bike safety and user-friendliness. Remarkable is the high percentage of each of the answers for commuters. It represents the strong preference for quality of these, in general, frequent travellers to park inside instead of outdoors. The user-friendliness is less important for them. The numbers for trip purpose seem to be influenced by the age categories as well. Travellers going to school do have a lower score for parking their bike dry even as for the availability of spots.

Trip frequency

Frequent travellers do have the highest share in both parking their bike safe and dry, as also stated by Maat & Louw (2012). Furthermore, this group has the highest percentage of users indicating the desire for a free spot. Frequent travellers tend to arrive later at the station which results in less available time to find a parking spot, as already mentioned in the literature. They do care less about the user-friendliness of the staff (Monsuur et al., 2017). Remarkable is the decrease of respondents indicating bike safety with a decreasing trip frequency. It might be that cyclists care less about their bike getting wet if it is just occasionally.

Parking duration
The outcome of the reasons to park inside in comparison to the parking duration is as expected from the literature. People who park their bike for longer periods seem to care more about the safety of their bike. However, the deviation is not marked as significant, with a p-value of 0.14. Interesting is the higher score for available spots when the parking duration increases. It might be that people who park for longer periods want to be sure their bike is well parked. Long term parkers are less influenced by user-friendliness.

4.3. Travellers profiles

Travel characteristics are depending on the needs of the individual users, which causes relationships (Jonkeren et al., 2019). According to the choice model analogy, trip purpose determines in the first place if people are performing a trip (de Dios Ortúzar & Willumsen, 2011). This relationship is confirmed when testing for correlation of various attributes comparing to trip purpose. All further discussed combinations are proven significant by either the Pearson correlation coefficient or the likelihood ratio test (A. Field, 2009).

Comparing the variation in age over the trip purposes shows little revealing. Travellers going from or to work are mainly between 26 and 65 years old, with an equal deviation between 26 to 45 and 46 to 65 years. The average age of performing a business trip is a bit higher. Also, leisure activities are more performed by older people, with a share of 35% of them being 65+. Of the travellers going to school, 35% is younger than 18 and the majority, 55% is between 18 and 25 years old. These are often frequent travellers due to their free travel card.
It is known that commuters are the main users of the bicycle parking facility. Figure 4.4.a. shows that they are in general frequent users, even as users travelling to or from school. In literature, it is mentioned that some of the users would like to have an option to vary the access mode, for example in case of bad weather or performing a journey with various destinations in-between. These users are mostly represented in the category 1 to 3 times a week, about 30% of the travellers going to work and 20% of the travellers to school. It also entails part-time workers. Business trips are performed on a less frequent basis even as visiting relatives. Especially respondents who are performing their trip to go shopping are in general infrequent travellers. People stating another trip purpose than the indicated ones have quite some division in the trip frequency.
Up next is the comparison between trip purpose and the parking duration. Remarkable is that 20% of the people visiting relatives park their bike for more than 24 hours. This is the biggest share if they travel 1 to 3 times a week. Of the commuters, mainly the frequent travellers, more than once a week, park their bike for longer periods. These might be owners of a second bike at the activity end. The people who travel more than 4 days a week have the highest share in long term parking, which is remarkable. This might be caused by asking the respondents on a Monday after their bike has been parked for the weekend. Both shopping and business trip only entails long term parking on an occasional basis, which is as expected as it is often performed as a day trip.

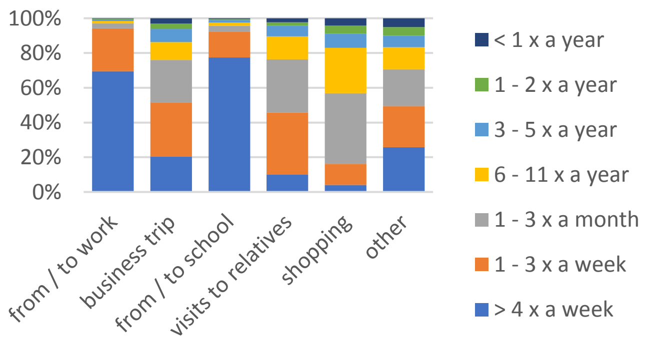

Figure 4.4, Share by trip purpose over trip frequency (KBM 2019)

From these combined characteristics, five traveller profiles can be generated, which each includes at least 5% of the travellers. In total, these profiles resemble 79% of bike-train users.

1. Commuters to work or for business purpose who travel at least once a week. Their age generally ranges between 25 and 65 years, with an average of 45 years old. This entails 41% of the bike-train travellers.
2. Students travelling from or to school. Their average age is 21. In general, they travel more than once a week. 24% of the respondents matches these characteristics.
3. Young travellers, below 25 years old, who travel for leisure activities are still in general high frequent travellers. In total, 6% of all bike-train travellers fulfil these requirements.
4. The remaining group performing leisure activities are on average 57 years old. About 41% of them travels on a medium frequent basis, which is between 1 to 3 times a month. 8% of the travellers are in this profile.
5. 35% of the leisure activities of adults are performed on a low frequent basis, so less than once a month. This group entails 5% of the bike-train travellers.

4.4. Distribution over locations

The users as described before are also compared to different types of stations, where a distinction is made between the location and the operating status. The majority of the respondents were asked when using the facility of an intercity station in the city centre, 7975 or 66%. Thereafter comes the sprinter station in city centres, with 17% of the respondents. The suburban located stations have about 800 respondents and the stations located at rural grounds have 448 or 4% of the respondents. This is not representative of the distribution of travellers over the type of stations. However, as the type of parking facility is depending on the guarded facility users and therefore the number of travellers, smaller stations are less likely to be guarded.
When deviating to the type of station it can be seen that young people, below 18 years old, are mainly using sprinter stations in a centre or rural area, and intercity stations in city centres. These are mainly going to school when compared to the trip purpose. On the other hand, commuters are mainly using stations in suburban areas, where residential areas are located. Therefore sprinter stations have a higher share of frequent travellers. Infrequent travellers, for social or recreational reasons, tend to be more attracted by Intercity stations.
The parking duration is in general longer on intercity stations, which might be due to second bikes on the egress side of the journey. This is less usual on smaller stations as there is less employment in the surrounding.

4.5. Conclusion

The literature identified the relationship between bike-train usage and various user characteristics. To be able to study the impact of a new policy, information is desired regarding the distribution of users' characteristics. From the KBM survey, a bunch of information is available about the travellers. It can be found that young people, between 18 and 24 years old, are the main users of the facility. These are often frequent travellers to school. Also, commuters to work often travel frequently. Commuters are in 90% of the cases frequent travellers. Social and recreational trips are usually on a less frequent basis. These are in general performed by older people. Most of the users park their bike for less than 24 hours. For leisure activities, long term parking occurs on the home side of the journey, while commuters tend to have a longer parking duration in case of second bike usage, for the activity side of the journey.

In general, the safety of the bike is the most important reasons for a secured parking facility. Frequent travellers and/or commuters find this important. Even as parking their bicycle dry. This also applies to people with longer parking duration. This can be explained by the impact of bad weather on your bicycle when it is often outside or for a longer time. Bike safety is also important for people performing leisure activities. These are also more attracted by user-friendliness, even as older people. Older people seem to be more attracted by the availability of spots as well.
Also, the distribution over different types of stations can be viewed. Suburban stations tend to be more used by adults. These stations are generally close located to residential areas. This results in more commuters and frequent travellers at suburban stations. Social and recreational travellers tend to be more attracted to intercity stations. Also, more long-term parking occurs at intercity stations.

Based on the user characteristics, five traveller profiles can be identified which each consists of at least 5% of the current bike-train users. The biggest group of users, 41%, are commuters to work or for business purpose. This is followed by students with 24%. Both are high frequent travellers. With a lower share are the travellers with a leisure-related motive. Young travellers still travel on a high frequency but tend to park for longer periods of time. Of the older leisure-related travellers, almost half of them travels on a medium frequent basis, which entails 8% of the total bike-train travellers. In 5% it entails low frequent travellers.

5. Impact of facility characteristics on user experience

To get more insights into the users' experience at parking facilities near train stations, additional analyses are needed. The literature already identified effects of the layout, e.g. shelter, walking distance and average search time, and of the provided service, e.g. type of security and a repair shop. Furthermore, the environment and the connectivity of the train station are of impact on the experience of the user. However, these findings are not quantified.
This chapter elaborates on the experience of various parking facility users regarding the characteristics of the facility and the type of station, based on the yearly performed chain experience monitor. First, the appreciation of facilities with various services at various types of stations is viewed in section 5.1. Section 5.2 identifies the elements which determine the user experience. The influence of earlier determined attributes is analysed by the means of regression analysis in section 5.3. By this method, the individual impact can be calculated. The factors regarding experience are compared to various user characteristics and types of stations in section 5.4. Conclusions are given in 5.5. In the original document, the detailed grades of the facilities are presented in this chapter. Given the confidentiality of that information, only a qualitative comparison is presented in this public version of the document. In overviews, grades are replaced by *.

5.1.Appreciation of services at various stations

The guarded facilities receive on average around an 8 for their customer experience. The differences between the grading of the five station types are analysed, as literature indicated a variation in utilisation (Molin & Maat, 2015; Puello & Geurs, 2015; Shelat et al., 2018). Rural stations stand out and are graded more negatively compared to the others. Based on repeated independent t-tests, only no significant difference can be found between the overall scores of the sprinter stations located in a city centre and a suburban area. Both are regional train stations that function to connect users to the remaining of the network. This study into the data of the ongoing KBM confirms these findings.

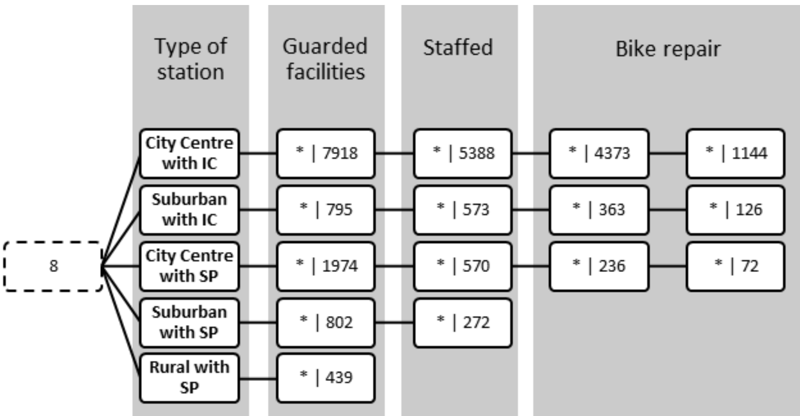

Figure 5.1, Average scores and number of respondents of chain experience monitor, based on typologies and characteristics

Literature also indicated a variation in user experience depending on the provided services, such as the presence of staff, the presence of a repair shop and the pricing policy (e.g. Van der Spek & Scheltema, 2015; Molin & Maat, 2015). Based on the data of the ongoing data collection effort, the various services at guarded facilities can be observed. These services are presented in Figure 5.1 as well. First is the variation in security. Self-service parking (Zelf Service Fietsenstalling or ZSF in Dutch) are secured by an automated entrance gate and camera's (46 facilities), while other facilities are secured by the presence of staff (62 facilities). The overall grade is higher in case staff is present. However, parking facilities without staff mainly occur at smaller stations, which already variates in the overall grade.

Some of the parking facilities include a bike repair shop, owned by NS or a third party. This is an optional service to the customer. Analysis shows that the overall grading of facilities with a shop present, which was the case for 4972 of the respondents, is higher. It might be that users consider the presence of extra staff as an extra level of security. The overall grading even increases further when people used the service which was the case for 1342 people. However, the difference in the mean score of using the service or not has a p-value of 0.061 and is therefore only proven to be significant within a 90% confidence interval. This study into the data of the ongoing KBM confirms the findings in the literature.
The last variety of different parking facilities is the price policy. There are facilities where you always need to pay (25 facilities, 2536 respondents), where the first 24 hours are for free and paid thereafter (24 facilities, 8348 respondents) and parking's where you can park your bike for free but will be removed after x days (12 facilities, 881 respondents). It should be considered that not all respondents graded the statements regarding pricing. This mainly occurred at statements with a 24-hours free policy, where no grade could be composed for some of the people. The reasons for this might be that most users only park for less than 24 hours and therefore are never confronted with the pricing scheme and decide to leave it blank. No significant variation can be found between the price policy and the overall grade of the parking. This does not conclude that pricing doesn't make a difference in the experience of the user.

5.2. Elements of experience

Next to an analysis of the impact of various services on the overall grade, a factor analysis is performed on the statements of the KBM survey, to gain more insights into the user experience. Clusters of large correlation coefficients, the factors, suggest that statements are measuring aspects within the same dimension. The factors can be seen as the characteristics of the facilities which influence the experience of the users. A personal score, of each respondent, can be computed for each factor, based on the person's grades of the included statements. Later, they will be used for further analysis of the experience by different users. The way of performing the factor analysis for this research is based on the methods used in the book of A. Field, (2009) and further elaborated in methodology.

By the Kaiser–Meyer–Olkin measure of sampling adequacy (KMO) the sample size is verified to be adequate for the factor analysis, with a KMO score of 0.926. Also, the interrelation of variables is checked. High correlation occurs between the statements "I think this bicycle parking looks neat" and "I experience this bicycle parking as clean" ("Ik vind dat deze fietsenstalling er verzorgd uitziet" and "Ik ervaar deze fietsenstalling als schoon"). However, both variables are maintained as Barlett's test shows a significant difference from the identity matrix.

With an adequate dataset, the factors can now be determined. Both looking at the scree plot (Figure B.1) as sticking to Kaiser's criterion result in extracting five factors. Thereafter, oblique rotation is applied to maximize loadings of variables to only one factor but to take the correlation between variables into account. The factor structure becomes clear in the pattern matrix and the structure matrix. By looking at the pattern matrix (Table 5.1), each factor can be labelled based on the different statements with loading to the factor. The five factors are labelled as:

1. Service: the presence and attitude of the staff and the feeling of safety
2. Overview: effort to search for a parking spot, clarity of parking and where to find information
3. Appearance: the care and cleaning of parking facilities
4. Accessibility: accessibility of facility in terms of time, price and easiness
5. Bike security: risk of theft or damage of bicycle when stored

The factor loadings are the regression coefficients for each statement on each factor. For example, it can be found that the easiness to find a spot contributes to the parking overview, almost twice as much as the clarity of where to find information about the facility. The third factor, the parking appearance, shows negative values. This indicates a negative contribution of the variables to the factor.
The structure matrix, presented in Table B.1, considers the relationship between factors, as it contains the correlation coefficients for each variable on each factor. It shows that several variables load onto more than one factor, as shared variance was allowed. These variables reveal various

relationships between factors, as expected. For example, a clean parking has the most influence on the appearance but also increases the experienced level of service because of the increase of quality of the product.

Table 5.1, Pattern matrix factor analysis

	Parking Service	Parking Overview	Parking Appearance	Parking Accessibility	Parking Bike safety
I think there is sufficient amount of staff in this bicycle parking	,853				
I appreciate the presence of staff in this bicycle parking	,844				
I find the staff in this bicycle parking customer friendly	,844				
I feel safe in this bicycle parking	,599				
I can easily find a place to park my bike		,901			
I experience the number of available parking spaces in this bicycle parking as sufficient		,836			
I have a good overview in this bicycle parking		,744			
I can easily find my bike in this bicycle parking		,614			
I think the signs that indicate the route in this bicycle parking are clear		,509			
I know where I can get information about this bicycle parking		,474			
I think this bicycle parking looks neat			-,943		
I experience this bicycle parking as clean			-,916		
I find the look of this bicycle parking attractive			-,884		
I experience the lighting in this bicycle parking as pleasant			-,549		
I think parking my bike in this bicycle parking is cheap				,769	
I can enter this bicycle parking at any time				,697	
I experience a good price-quality ratio in this bicycle parking				,613	
I experience the entrance to this bicycle parking as easily accessible				,549	
I experience the current method of paying for this bicycle parking as easy				,499	
I experience the route from this bicycle parking to the train as pleasant					
I'm not afraid that my bike will get damaged in this bicycle parking					,574
I'm not afraid that my bike will be stolen in this bicycle parking					,559

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 21 iterations.

The relationship between the factors also becomes clear in the correlation matrix, which shows the correlation coefficients between factors. The matrix is provided in Table B.2. Again, factors 1 to 4 are related to each other, and the variables measured can be interrelated. The dependence was already expected and therefore no cause of concern. Factor 5 is not strongly correlated to any of the other factors against expectations. It was expected that a clean and structured parking would increase the feeling of bike safety.

By adjusting the factor loadings to factor score coefficients, equations can be constructed that describe each factor in terms of the measured variables. The matrix of factor score coefficients is presented in Table B.3. The columns represent the factors. The score coefficient of each variable for each factor is presented in the rows. This shows the relationship between each variable and each factor while considering the original relationships between pairs of variables. As such, this matrix represents a purer measure of the unique relationship between variables and factors. However, the pattern of the loadings remains the same as for the factor loadings. Table B.4, the covariance matrix of the scores, reveals the relationship between factor scores.
Overall it resulted in the following equations. If a respondent didn't fill in an answer for one of the variables of a factor, no score for that factor is generated.

Parking_Service = (Q_presence_staff * 0.3 + Q_enough_staff * 0.306 + Q_friendly_staff * 0.303 + Q_feeling_safety * 0.190) / (0.3 + 0.306 + 0.303 + 0.190)

Parking_Overview = (Q_finding_space * 0.290 + Q_clear_overview * 0.238 + Q_clear_signs * 0.166 + Q_parking_information * 0.170 + Q_finding_bike * 0.192 + Q_enough_spaces * 0.265) / (0.290 + 0.238 + 0.166 + 0.170 + 0.192 + 0.265)

Parking_Appearance = (Q_lighting * 0.167 + Q_clean_parking * 0.304 + Q_neat_parking * 0.314 + Q_appealing_parking * 0.297) / (0.167 + 0.304 + 0.314 + 0.297)

If paid parking policy:
Parking_Accessibility_paid = (Q_access_time * 0.327 + Q_entrance * 0.249 + Q_payment_system * 0.213 + Q_price_quality * 0.257 + Q_price_cheap * 0.350) / (0.327 + 0.249 + 0.213 + 0.257 + 0.350)
If "x days free parking" policy:
Parking_Accessibility_free = (Q_access_time * 0.327 + Q_entrance * 0.249) / (0.327 + 0.249)

Parking_Accessiblity = Accessibility_free + Accessibility_paid

Parking_Bike_security = (Q_stolen_bike * 0.473 + Q_damaged_bike * 0.489) / (0.473 + 0.489)

Table 5.2 shows the report of the various factor scores of the parking facility users. Only 51.5% of the respondents get a score for parking service because not all initial statements were graded. Almost everyone was able to form an opinion about the appearance of the parking and the perceived quality of bike security (94.3% and 96.8%). When looking at the mean scores, the highest appreciation is given for the service of the parking. The overview has the lowest overall score.

Table 5.2, Average score of factors

	Mean	Std. Deviation	N	Percent
Parking_Service	*	1.24	6191	51.5%
Parking_Overview	*	1.66	9274	77.2%
Parking_Appearance	*	1.59	11327	94.3%
Parking_Accessiblity	*	1.32	8517	70.9%
Parking_Bike_security	*	1.79	11629	96.8%

5.3. Impact on overall facility experience

The service-related attributes are of impact on the appreciation of the five elements of experience. Multiple regression analysis determines the contribution of each of these attributes to the overall score. The categorial attributes are implemented as dummy variables. For the factors, centred values are used, to increase the interpretability. Table 5.3 shows the unstandardized coefficients for the multiple regression. It overall results in an R-value of 0.83, representing the simple correlation, and R^2 of 0.694, explaining the variance by the factors. So, in total, 69.4% of the overall score can be explained.

The first number to explain is the constant. As centred values are used, the constant should be interpreted as the predicted overall score in case the respondent scored average on the various factors and non of the dummy variables is true. The baseline categories are the absence of a shop, no manned security (ZSF) and a facility where it is possible to park your bike for free. Users with an average experience are expected to score an 8 on the overall grading. In case users have to pay after 24 hours this score will be reduced by 0.025 and by 0.081 if they have to pay from the beginning. It can be concluded that the implementation of any payment policy influences the overall experience negatively. However, the dummy for 24-hours free policy is not significant. The impact of this attribute strongly varies over the user depending on their parking duration. Another variation in experience can be made between the facilities being secured by cameras or staff. Manned facilities will on average have a higher score of 0.136. Also, the presence of a repair shop increases the overall grading by 0.051.

Up next, the gradient for each attribute resulting from the factor analysis is discussed. These represent the change in the outcome associated with a unit change in the predictor. Because of the mean centring, B is the effect of the factor on the overall score for people with an average score on the remaining factors. So if a user scored 1 grade higher than the average for appearance, his overall

grade will increase by 0.209. It can be concluded that the overview (B is 0.265) has the strongest impact on the overall score. As all B-values are greater than 0 and significant (p<0.001), it can be concluded that they all contribute to predicting the overall score. Also, the standard error should be considered. Having a small standard error, even a small deviation from zero indicates a meaningful value of B, as samples will have a similar B-value.
The factors regarding parking service and bike security are implemented by the use of interaction variables. Parking service only receives a score in case the facility is manned. If staff is present, the score for service will increase the overall score by 0.127 in case the service score is 1 point higher than the service mea. For bike security, this impact is smaller, by an increase of 0.041 when scoring higher than the bike security.

Table 5.3, Unstandardized coefficients of multiple regression

	B	Std. Error	Significance
Constant	8	0.041	0.000
Dummy attribute			
paid policy vs Free	-0.081	0.031	0.010
24-hour policy vs Free	-0.025	0.029	0.383
manned vs camera	0.136	0.020	0.000
Bike repair present	0.051	0.020	0.024
Factor attribute			
Parking_Appearance score	0.209	0.010	0.000
Parking_Accessibility score	0.191	0.010	0.000
Parking_Overview score	0.265	0.008	0.000
Interaction Manned * Parking_Service score	0.127	0.011	0.000
Interaction Manned * Parking_Bike security score	0.041	0.007	0.000

5.4. Variation in identified elements by users

The variation in experience can be further explained when the characteristics of the users are examined. Also, the type of station is of influence on the experience. Therefore, this section is dedicated to finding variables influencing the perception of the facility. To do this, a comparison is made towards the previously determined factors with both user characteristics (known from the KBM) and the type of station. Significant differences in experience within the various variables are examined. The mean score of each category regarding each factor is presented in appendix C.1, in Table C.1 to Table C.5. An extended analysis of the scores can be found in appendix C.2.

Not all variations will be captured in this analysis. Literature shows a variation in behaviour depending on the home-end or the activity-end of the journey (Van der Spek & Scheltema, 2015). This is limited known from the respondents. Also, the quality of bikes, which is often mentioned as on impact on the parking behaviour (e.g. Maat & Louw, 2012), is unknown. However, older people generally own better-quality bikes. Furthermore, the region where people live relates to the WTP, according to experts of NS. In the past, it turned out that people from the south of the Netherlands were more sensitive to offers because of their higher WTP for different products. Lastly, some variations occur regarding the facilities. Many variations in the quality of parking occur due to the sufficiency of capacity. This differs per station and is hard to capture in any grouping. As stations are not accessed individually.

Gender shows little impact on the experience of the parking facility. Women give a higher score for the service and appreciate the presence of staff more because of a higher feeling of safety for themselves and the bike. This is consistent with the findings of Maat & Louw (2012). Men grade a facility higher on overview.
Age appears to have the biggest impact on the parking facility experience. Older people give a higher score for the overview. As known from literature (Givoni & Rietveld, 2007), young people are often more in a hurry to catch a train. This results in a lower grade for overview. Furthermore, the service is better appreciated by older people. This is also visible in their preference for staff in the facility, which is also described by Monsuur et al. (2017). However, older people grade bike safety lower than other facility users. This is due to their better quality bikes. According to Molin & Maat (2015),

older people have a higher desire for safety. As of last, the younger facility users are more sensitive to the pricing, which results in a lower grade for accessibility. Molin & Maat (2015) indicated that this is related to income.
The relation found in characteristics of the travellers also appears in the factor scores. Travellers with a social recreational trip purpose and/or low trip frequency give a higher score on service, overview and appearance. Monsuur et al. (2017) described a similar effect. Also, bike safety is experienced better by these travellers. In case this would be poorly graded by a traveller, the chance of shifting to another access mode is higher for low frequent travellers.
The travellers who are parking their bike for a longer period of time stand out with their lower score for accessibility. This can be linked to the price asked. These users in general have a better experience of bike safety. This is also an important factor for travellers with a longer parking duration to choose for the guarded facility (Maat & Louw, 2012; Van der Spek & Scheltema, 2015). Similar to low frequent travellers, they would be more likely to switch to another access mode in case of low appreciation.

In general intercity stations seem to score lower for service. However, no service is present at any rural station, as these are all ZSF parking facilities. Furthermore, rural stations score badly for overview and appearance. This is because half of the dedicated locations struggle with capacity problems. Molin & Maat (2015) also describe capacity problems as a huge dissatisfier. A suburban intercity station scores the best on accessibility. This is related to both the pricing policy as the entrance system. Frequent travellers, and especially the younger ones, tend to be more influenced by the pricing policy. The asked price is lower at suburban stations. Infrequent travellers are more influenced by the way of entering the facility, which is more likely to be staffed at intercity stations. For frequent users, the entrance system of a ZSF is not less appreciated than of staffed facilities. For the score of bike security, it appears to be higher when staff is present and at station types with higher train frequencies. Arbis et al. (2016) mentioned this effect before.

5.5. Conclusion

The five station types show differences in how their bike parking facilities are appreciated, resulting from the data of the KBM 2019. Only no significant difference can be found between the overall scores of the sprinter stations located in a city centre and suburban area. Significant differences can be found between the presence of various attributes in the facilities, as staff and bike repair shop.

Factor analysis is performed on the statements of the KBM survey to get more insights into how the overall user experience is composed. Clusters of large correlation coefficients, the factors, suggest that the questions are measuring aspects within the same dimension. The factors can be seen as the characteristics of the facilities which influence the experience of the users. This results in five factors: service, overview, appearance, accessibility and bike security.

Via a regression analysis, all attributes and factors together can explain 69.5 % of the variation in the overall score of user experience. Not all factors are equally important for creating the overall score. In order: overview, appearance, accessibility, bike security and service. Even though security is by far the most frequent reason to park a bike inside, bike security is not of a big influence on the experience. However, the lack of it is a dissatisfier. Furthermore, the presence of staff for security and a bike repair shop have a positive impact on the experience. Also, a longer period of free parking increases the overall experience.

Various characteristics have a significant impact on the experience. These are age, gender, purpose, parking duration and frequency. An overview of impact is provided in Figure 5.2. Some of the characteristics identified in literature, as bike quality and car ownership, are not asked in the KBM analysis. Overall, the highest score might be expected from an adult man who undertakes a trip for leisure activities on an infrequent basis. Preferably they park the bike at a station in a suburban area that has an intercity operating status, and therefore also will have staff for security and a bike repair shop. However these facilities do in general have a more expensive pricing scheme, if parked more than 24 hours, which is a little drawback.

Impact of user characteristics on experience of guarded parking facilities

Age

- Older people ...
  - have a higher score for overview
  - have a higher appreciation for service
  - are afraid of damaging their bike
  - are more influenced by the entrance
  - prefer staffed facility over self-service parkings
- Young people …
  - are more in a hurry to catch a train
  - are more price sensitive

Gender

- Women ...
  - have a higher appreciation for service
  - have a preference for staff available because of security
- Men ...
  - score higher for overview
  - are less sensitive for bike security

Purpose

- Mandatory activities ...
  - score less on bike security
- Social recreational activities ...
  - score higher on service, overview and appearance
  - only access the station by bike in case of feeling safe

Parking duration

- Long term parkers ...
  - take more time to park their bike
  - see the parking facilities as less accessible because of the price
  - value bike security higher

Frequency

- Frequent travellers ...
  - are more in a hurry to catch a train
  - are more influenced by price
  - are more familiar with the entrance system
- Infrequent travellers ...
  - score higher on overview, appearance and bike safety
  - are more influenced by the entrance system
  - are more sensitive for presence of staff

Figure 5.2, Impact of user characteristics on the experience of guarded parking facilities

II.
Stated preferences of parking facility users

By now, elements of a parking facility influencing the users' experience are established. Up next the preferences of parking facility users can be identified, as is the goal of this section. Chapter 6 describes the setup of the stated choice experiment which is used for the remainder of this study. The fourth research question as formulated at the beginning of this research is: *Which elements have a significant impact on the preference of facility users?* This answer is provided in chapter 7 after estimating a logit model.

6. Setup of stated preference survey

The next step is to test the level of impact of the previously identified attributes as staff and pricing policy. A stated choice experiment is used to be able to control the situation and the correlation between alternatives. The design of the stated choice experiment is described in 6.1. The full setup of the questionnaire is presented in section 6.2. To test and improve this survey, a pilot is carried out. The results and improvements are discussed in section 6.3. This chapter is concluded in section 6.4. The final survey can be found in appendix E.

6.1. Stated choice experiment

During the stated choice experiment, hypothetical situations are presented to the respondents. They are asked to select a choice of their preference while varying combinations of attributes are presented in the alternatives. The number of situations included should be limited due to the reliability of the collected data. To be able to do so, the number of attributes considered should be restricted to 6 or 7 (ChoiceMetrics, 2018). However, more important is that all relevant attributes are included. Otherwise, different respondents make different assumptions about the missing attributes. A selection is required of the attributes collected in the preliminary investigation. This is further elaborated below. Thereafter, the details of these attributes are described and how these are composed to the experiment.

6.1.1. Selecting attributes

The attributes mentioned during the preliminary research are listed in Table 6.1. A selection is made based on expected influence; singularity; possibility to differentiate by NS for policymaking; and the ease for respondents to imagining the differences between levels. A *v* indicates meeting the requirement, *?* shows there is doubt about the variable and *0* indicates not meeting the requirement.

Train operations can be seen as the most important station characteristic. This is also the easiest applicable because a clear differentiation can be made between operating intercity and sprinter trains, or sprinter trains only. For travellers, this difference is also emphasised by the train frequency and the size of the station and its facilities. The presence of public transport as an access mode is of proven influence on the WTP (Molin & Maat, 2015). However, it is difficult to differentiate the price policy to the public transport connections in the surrounding, as it would be too specific. This also applies to the type of buildings in the surrounding. Based on the findings in previous chapters it is decided to simplify towards the operation status of a station (intercity and sprinter or sprinter only) and the built environment (city centre, suburban and rural). The distance to the surrounding should be considered as well. This is partly captured in the built environment. However, this is also user-specific and is therefore included in the personal characteristics.

Within the parking facility attributes, multiple attributes are correlated. If the security will be taken care of by staff, there is automatically crew available. Also, the presence of a bike repair shop results in available crew, even if they have a different purpose. It is known that the presence already has a positive influence on the experience of the facility users. Therefore, the availability of crew will be left out. The average search time is depending on several factors, as the station layout and sufficient capacity. Capacity itself is dependent on the attractiveness of the facility, along with the pricing policy. As these are arbitrary numbers and are varying over time, a sufficient capacity will be assumed and the average search time will be fixed. Also, the price and the free parking period are linked to each other. However, as they are both the main goal of this research they will be maintained. The type of sheltering and walking distance to the station is easy to imagine by the user and known from literature to be of influence. While the walking time is needed to conduct a better survey, it will

not be applied by NS within one facility. However, it can be used for successive research in case more facilities are present at one station.
By the factor analysis, five factors were obtained which are influencing the experience of the users. These are service, overview, accessibility, appearance and bike safety. Each of these factors is composed of different variables. The main variables are already known from literature. Also, differentiation in levels leaves a lot of room for interpretation by the respondent. Therefore the factors will not be included as attributes but stated in the description of the situation, to limit assumptions.

Table 6.1, Selection of attributes

Attributes	**Expected influence**	**No correlation with other attributes**	**Differentiation by NS**	**Easy to imagine**	**Dependencies**
Station					
Train operation	v	v	v	v	
PT for access	v	v	0	?	
Buildings	v	0	0	0	Related to users
Parking facility					
Security	v	v	v	v	
Crew available	v	?	v	v	Related to security and repair
Bike repair	v	v	v	v	
Opening hours	?	?	v	?	Related to accessibility
Sheltered	v	v	v	v	
Walking time	v	v	?	v	
Average search time	v	0	0	v	Related to capacity and layout
Price	v	?	v	v	Related to free period
Free period	?	?	v	v	Related to price
Capacity	v	0	0	v	Related to price
Service	v	?	?	0	Related to crew available
Overview	v	?	?	0	Related to capacity
Accessibility	v	?	?	0	Related to price
Appearance	v	?	?	0	Related to capacity
Bike safety	v	?	?	0	Related to security

For the evaluation of the survey outcome, also the characteristics of the respondents are required. This entails both personal and travel characteristics. These are assessed in a similar way, see Table 6.2. A v indicates meeting the requirement, ? shows there is doubt about the variable and 0 indicates not meeting the requirement.
Gender is not of proven influence. However, it is kept for analysis purposes. Both bike quality and car ownership are depending on income. As these seem to be of more direct influence, are asked, and income will be left out.
The travel-related characteristics are almost all related. In many cases, the trip purpose is set first, where the others are depending on. As the trip frequency and parking duration are of direct influence on the WTP, they will be maintained. The travel company is mainly present in the case of leisure activities. As this is only a small percentage it will be left out. Also if the bike is parked on the access or egress side will be left out. The scope of this research is aimed at the access mode, and this will be given in the introduction. The impact of departing time is only present in case of capacity shortage. As sufficient capacity is assumed, this is also left out. Cycle distance will be covered in the context description.
Based on additional conversations, more aspects are added. These could explain the preference of the users. The first aspect is the type of bike (regular, electric, scooter, transporter). Outdoor facilities are often not designed for non-regular bikes. Non-regular bikes are in general more expensive as well. Also, the current parking behaviour is asked, even as if they have experienced a damaged or stolen bike while it was parked at the train station. Both might influence their preference for a certain facility.

Table 6.2, Selection of characteristics

Characteristics	Expected influence	No correlation with other attributes	Differentiation by NS	Dependencies
Personal				
Age	v	v	?	
Gender	0	v	0	
Bike	v	?	?	Might depend on income
Car ownership	v	?	0	Depends on income and age
Level of Education	v	?	0	Often related to income
Income	v	v	0	
Travel				
Trip purpose	v	0	v	
Trip frequency before/after COVID	v	0	v	Related to trip purpose
Travel company	?	0	0	Related to trip purpose
Parking duration/period	v	0	v	Related to trip purpose
Departing time/rushhour	?	0	?	Related to trip purpose
Access/egress	?	0	0	Related to trip purpose and parking period
Cycle distance	?	0	?	Related to type of station
Experience				
Current preference	v	0	0	
Damaged/stolen	v	0	0	

All together it results in a list of 6 parking facility attributes that are of interest for the stated choice experiment. The final selection is shown in Table 6.3. The station characteristics will be implemented as context-dependent, based on the current departing station. Therefore they will vary for different users but not within the given scenarios.
As the panel of NS is used, most of the personal and travel characteristics are known. During the survey, only car ownership and bike quality need to be verified of the personal characteristics. Two more questions will be added about their current facility preference and if they experienced a damaged or stolen bike at the station. The trip frequency and trip purpose might be adapted due to COVID-19. Therefore, their expected travel behaviour will be asked as well.
As it is important to give a clear description of the context, attributes that are not considered will be used in the description of the situation. This includes the physical, socio-emotional, and mental setting in which behaviour takes place. This will include the capacity, average search time, opening hours, travel purpose, travel distance to the station, overview, accessibility, appearance and bike safety. The service which is provided in the facility is included in the attributes of security and repair shop.

Table 6.3, Selected attributes

Alternatives	
Station	Operation & Location
Facility	Security Repair shop Shelter Walking time Price Free period

Characteristics	
Personal	Age Gender Bike Car ownership Level of education
Travel	Trip Purpose Trip Frequency Parking Duration Parking Period
Experience	Current preference Damaged/stolen

Context (fixed)	
Travel	Purpose Distance
Parking facility	Capacity Search time Opening hours
Experience	Overview Appearance Accessibility Bike safety

6.1.2. Attribute levels

In the various choice situations, three labelled alternatives are presented: parking your bike at the train station in the guarded facility; parking your bike at the train station in the unguarded facility; or not travelling by bike to the station. In the choice experiment, no further details will be asked when the alternative for not parking your bike is chosen. It is assumed that the alternative mode or trip will be the same in any choice situation, depending on the respondents' context like walking distance or connectivity with local public transport, which is not further specified in the choice model. Further clarification, if the opt-out is selected, is asked during the remainder of the survey.

The value of presented attributes varies in each alternative, see Table 6.4, and are alternative-specific. The level of each attribute needs to be limited between 2 and 4 levels, to limit the size of the design (ChoiceMetrics, 2018). In a guarded facility, always a type of security will be present. This can be by a camera and an entrance gate or by staff. This facility is always indoors. Furthermore, there will be variation in the presence of a bike repair shop. More variation can be found in price and free parking period. For this, equidistance should be preserved. This assures the orthogonality between attributes (ChoiceMetrics, 2018). The price is varied by €0.25, €1.00, €1.75 and €2.50 a day. This range makes it possible to see the impact of lower and higher prices than the current situations (respectively €0.50 and €1.25). Currently, the free period is 0 or 24 hours, depending on the policy. 12 hours is added to the alternatives to see the sensitivity of this attribute and check for linearity. Options for a monthly subscription will be provided in a later stage of the survey. The last attribute is the walking time towards the platform. For the paid facility there is varied between 1, 2 and 3 minutes.
For the unguarded facility, most of the factors are set to current conditions. These are unsecured, outdoor facilities that never ask for a fee. However, coverage might be present to park your bike dry. The walking time will be varying between 2, 3 and 4 minutes. By choosing these values, it is in most cases longer than the paid facility.

Table 6.4, Attributes of two labelled alternatives and their level variations

Attribute	Guarded facility	Unguarded facility	Other
Security	Camera and entrance gate Staff	None (fixed)	-
Repair shop	No Yes	None (fixed)	-
Price	€0.25 per day €1.00 per day €1.75 per day €2.50 per day	€0.00	-
Free period	0 hours 12 hours 24 hours	-	-
Sheltered	Indoors	Outdoors Covered	-
Walking time towards platform	1 min 2 min 3 min	2 min 3 min 4 min	-

6.1.3. Experimental design

In case a full factorial design would be used, the experiment would contain 288 profiles (L^N= 3^2*2^3*4^1). To keep orthogonality, 16 choice situations are required. As this is too high, an efficient design is selected. Priors are obtained from preliminary research and research by La Paix Puello & Geurs (2016), Molin & Maat (2015) Spoorwegen, (2019) and Van Mil et al. (2018). After conducting a pilot survey, the priors are adapted, which is elaborated on in section 6.3. To obtain a more stable design that relies less on the accuracy of the priors, a Bayesian efficient design is used for the final design (ChoiceMetrics, 2018).
As the choice experiment contains 6 attributes with two, three and four levels per attribute, 12 choice situations should be asked to maintain attribute balance. This is a bit high but acceptable, as often 10 is the maximum desired. More choice situations would reduce the focus of the respondents and might result in unrealistic answers. The Ngene syntax for the pilot survey is shown in appendix D. Table D.1 also shows the experimental design used for the pilot and Table D.5 for the final design.

6.2. Constructing questionnaire

The next step is to construct the questionnaire as will be asked to the respondents. The total length should be limited to a maximum of 10 minutes, as a requirement of research agency MWM2. The survey will exist of three parts: the stated choice experiment, questions regarding topics that might influence the WTP, and an adaptive choice experiment to get more insights into subscription fees. The setup of the adaptive choice experiment is explained in section 8.3.1. The online survey tool of MWM2 is used for programming.

6.2.1. Audience

The main target group of this survey are the current users of the facility. However, it is also of interest what the effect of a changed policy will be on attracting new bike-train users. The survey will be distributed amongst members of the NS Panel. The NS Panel is a representation of all train travellers in the Netherlands. Already several personal and travel characteristics are known from this group. Members get an invitation to answer a questionnaire by e-mail if their characteristics match the target group. This panel is a big and diverse group of train travellers who are willing to participate in train-related research. However, this response group does not include travellers of different main modes. So potential new train passengers are excluded. The panel is under control of MWM2. Their role is, next to delivery of the software, sending out the surveys to the target group and collecting the answers.

At the start of the survey, an introduction with the context is given, which can be found in appendix E, page 86. Aspects that could prevent any assumptions are included, as the quality and capacity of the facility. To match the hypothetical situation with respondents current travel behaviour, 3 starting questions are asked. Furthermore, in this research, illegal parking is considered to be unattractive. However, a question is added later on in the survey to get insights into how often it occurs.

6.2.2. Stated choice experiment

In the stated choice experiment, several choice situations are presented. Each situation exists of a guarded paid facility which is indoors and a free unguarded facility which is outdoors, as shown in Figure 6.1. The attributes of the facilities will vary over the situations. To not force people to choose a parking facility, an opt-out is added. As a reminder, the location and operational status of the hypothetical station are also presented during the SC experiment.

To analyse the opt-out, an additional question is added to the survey. First of all, there is asked what the parking facility users would do if they did not park the bike at the station. This might consist of changing the access mode or not performing the train trip anymore. As of second, their choice is asked in case no free facility is present. The impact of a policy can be studied and if a modal shift will occur. It is known that results from a stated preference might vary from the real outcome. This should be considered when interpreting the outcomes.

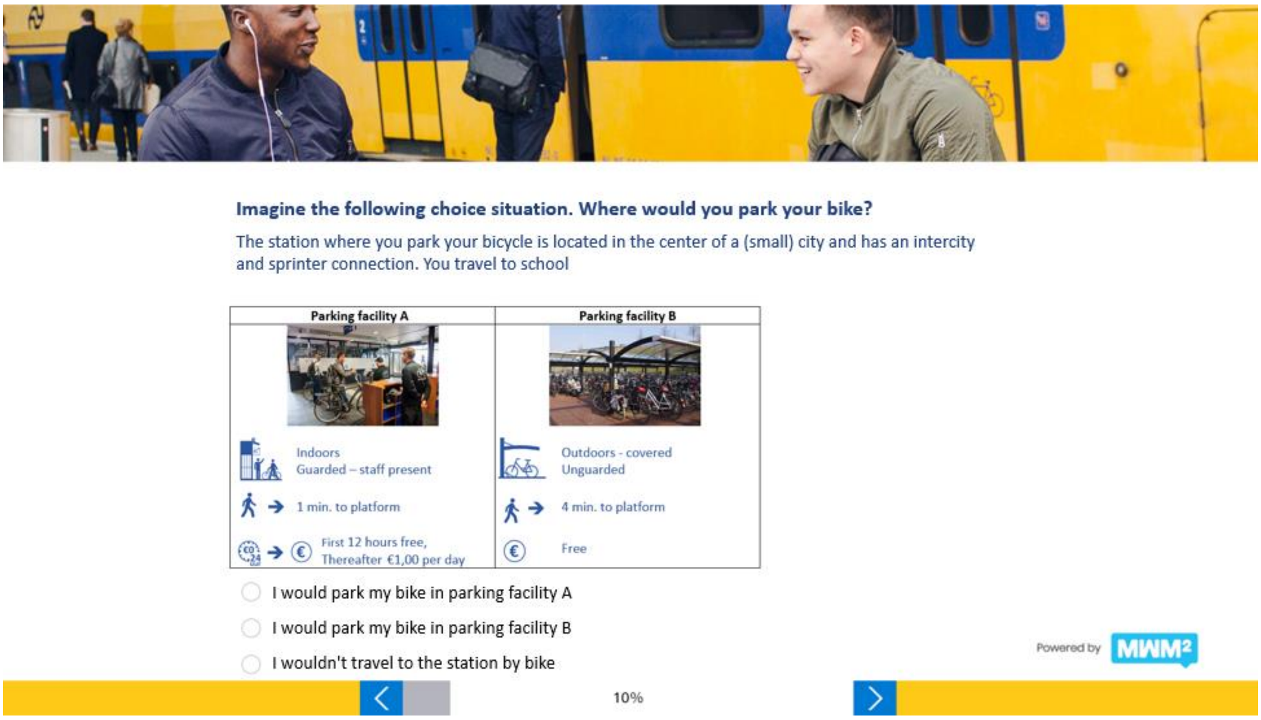

Figure 6.1, Example of a choice set presented

6.2.3. Additional questions

To be able to control for the findings of the stated choice experiment, additional questions are asked to the respondents. First of all, there is asked what the parking facility users would do if they did not park the bike at the station. This might consist of changing the access mode or not performing the train trip anymore. To get more insights into the provided answers, their maximum walking time to the platform, either for the guarded facility or not, is asked. Also, several statements are given which might influence the WTP.

As of last, characteristics that might influence their choice are asked. These consider the parking period, bike quality, possible bad experience and current facility usage. Other personal and travel characteristics are already known from the NS Panel database. To be able to validate the findings for subscriptions, the expected travel frequency after COVID-19 is asked.

6.3. Pilot survey

To test the setup of the experiment and if respondents understand the questionnaire, a pilot survey is conducted. These are distributed amongst 205 bike-train users of the NS-Panel. In the first place, a failure occurred in the survey software which made it impossible to start. 25 respondents tried to load the survey before it was noticed. After fixing the problem, a new email was sent out to the people who tried, stating the survey was functioning now. Eventually, 55 fulfilled the questionnaire of the 64 who started. Descriptive statistics of these respondents can be found in Appendix D.2. Only four quit during the survey. The other five were not able to start the survey initially and never retried. The four people who stopped during the survey, all left before question 4 of the stated choice experiment. Reducing the number of questions would not have influenced the fulfilments. The average completion time turned out to be 10 minutes and 40 seconds.
Besides, a copy of the survey was sent out to several people to get more feedback on the structure and formulation of the survey questions. However, these were not able to provide their answers as not all their personal characteristics are known. This would result in an incomplete data set.

After gathering all the feedback about the survey, several adjustments have been made, which are listed below:

- The introduction text is slightly adjusted to clear out it was a hypothetical situation. If respondents currently not access the station by bike, they are asked to imagine the situation as if they would
- The characteristics of the facilities in the introduction text are emphasized by using italic font.
- The question about whether people sometimes park their bike wrong is adjusted, to less emphasize it to be illegal. This should lower the bar for the respondents to give an honest answer.
- The minimum frequency to enter the adaptive choice experiment was raised from more than 2 days a year to at least once a month. Below, no one considered a subscription which would pollute the results.

To make the design of the survey more robust, new priors are generated for the stated choice experiment. By using the software Biogeme (Bierlaire, 2003) utility functions are estimated. Four models were made: a multinomial logit (MNL), mixed logit (ML) with panel effects, mixed logit with error components, and mixed logit with panel effects and error components. Each of the successive models represented a better fit of the model, as the adjusted likelihood ratio index (ρ^2) increased. However, by implementing an error component, the ability to explain the model was drastically reduced which made it not usable for further analysis in this stage. When analysing the ML model with panel effects, significant values appeared for the sigma component. This indicates the presence of panel effects. However, the values of the various attributes did not strongly deviate from the MNL model.
Designs with priors from MNL and ML model were generated in Ngene (ChoiceMetrics, 2018) to come up with an experimental design. Two different designs were generated based on the priors of the MNL model, one D-efficient and one Bayesian-efficient. For the ML model, only D-efficiency could be applied. The designs of the MNL models showed considerably lower D-errors than of the

ML model (about 0.441 against 1.179). Therefore the outcome of the MNL with Bayesian-efficiency is used for the final experimental design. By the implemented deviation, still, variation between the various answers could be covered. The final design is shown in appendix D.2. No dominant choice situations occur.

6.4. Conclusion

This chapter describes the design process of the final survey that is used to draw conclusions about the WTP for bike parking facilities at train stations. The survey consists of three main parts. The first part is a stated choice experiment of 12 situations, to be able to analyse the impact of various attributes. These are followed by some questions regarding the respondent's preferences and personal characteristics. The last part of the survey is an adaptive choice experiment, to test the maximum monthly subscription price a user is willing to pay. This setup is elaborated on in section 8.3.1.

A pilot survey is performed amongst 55 members of the NS panel to test and improve the setup of the survey. The outcomes of the initial choice experiment were used to adapt the choice situations. The final survey is presented in appendix E.

7. Exploring stated preferences

The data collected via the survey is analysed in this chapter. The first part, section 7.1, consists of descriptive statistics to characterize the sample of the respondents and the choices they made. The respondents are compared to the sample of parking facility users and the travellers of NS. Thereafter, in section 7.2, various models are estimated and interpreted for analysis purpose in section 7.3. This chapter is concluded in section 7.4.

7.1. Descriptive statistics

In total, 624 respondents finished the survey, including the members of the pilot survey. These could be maintained, including their corresponding design, as no major changes to the questions were made. 512 of the respondents are current bike-train travellers while 112 access the station using another mode. Additionally, 115 people started the survey but did not finish. These are left out of the analysis. In total, 7488 choice observations are obtained. First, it is checked whether the sample is representative to draw conclusions regarding bike-train users. Thereafter, the provided answers are considered. This entails amongst others the answers to the stated choice experiment, the adaptive choice experiment and the additional questions.

7.1.1. Personal characteristics and habits

The personal characteristics are mainly obtained via the panel account of the respondents. As a result, not all information is complete. The personal characteristics are compared to the characteristics of the bike-train user, obtained from the KBM 2019 as described in chapter 4 and the general train user of NS. The distribution over the groups can be found in Table 7.1.

More men were willing to answer the survey than women. The average age of the respondents is also higher than the (bike)train users. It is known from previous usage experience of the NS panel that older people in the panel are more likely to fill in the survey. Literature also states that young people are generally less willing to complete questionnaires than the elderly (Jonkeren et al., 2018). Respondents with a social/recreational trip purpose are more likely to start a survey. However, the number of the average train users is not significantly different. Remarkable is the high number of respondents with an (applied) university degree. While this distribution is not known from the KBM results, it is known from the literature that higher educated are more likely to travel to the station by bike (Jonkeren & Kager, 2020; Molin et al., 2016). Considering the frequency, there are fewer. high-frequent travellers and more medium-frequent travellers in the sample.
Deviation in user characteristics can influence the preference for specific attributes. The influence is tested with the model estimation and if needed, a correction is applied to the sample. Furthermore, the sizing of the individual groups should be considered. For example the size of the lowest educated people and the long term parkers. Results can only be interpreted as an indication.

User characteristics are in many cases related as they are depending on the needs of the individual user (Jonkeren et al., 2019). As many characteristics are considered during this analysis, the correlation between them is checked as well. Multiple Chi-square tests are performed in SPSS to find attributes that are strongly related. Results can be found in appendix F.1. In case the Pearson Chi-Square value is <0.05, the result is considered statistically significant. The alternative hypothesis is accepted and correlations are present. If the assumption for Chi-square is violated (e.g. >20%), the Likelihood Ratio test is applied.
Most of the correlations are significant, so various characteristics can be used to describe the same person. Some were already identified in section 4.3. When correlated characteristics describe different aspects, both can be considered despite their relationship. For example, gender and trip purpose appear to be correlated but clearly describe a different phenomenon. However, the effect of these correlations should be considered when implementing interaction effects in the model. Also, correlations occur which do describe the same aspect and therefore should be prevented. A traveller who parks for a full weekend automatically parks during the night as well. They also have a longer parking duration.

Table 7.1, Distribution demographic characteristics of the sample compared to (bike-)train users

	Sample	Bike-train	Train users
Gender			
Male	56%	52%	47%
Female	42%	47%	53%
Other	2%	1%	0%
Age			
12-17	1%	12%	18%
18-24	20%	25%	13%
25-44	20%	26%	30%
45-64	32%	31%	22%
65+	26%	6%	12%
Purpose			
from / to work	44%	53%	46%
business trip	16%	5%	16%
from / to school	11%	32%	14%
social/recreational	28%	10%	24%
Education			
Elementary/high school	1%		4%
VMBO/LBO	1%		18%
HAVO/VWO	10%		16%
MBO	8%		26%
HBO/WO	65%		36%
Frequency			
> 4 x a week	32%	64%	42%
1 - 3 x a week	31%	22%	31%
1 - 3 x a month	22%	7%	10%
6 - 11 x a year	9%	3%	8%
3 - 5 x a year	3%	2%	6%
1 - 2 x a year	0%	1%	2%
< 1 x a year	2%	1%	1%
Parking duration			
0-24	93%		
24-48	3%		
>48	3%		

Current behaviour

Next to the characteristics of the respondents, their current habits are discussed. Corresponding figures can be found in Figure 7.1. The majority of the parking facility users own a normal bike and handle it neatly or really careful. Only 4% indicate to not care about their bike, which are almost all normal bike users. As expected, owners of an electric bike take the best care of it.

60% of parking facility users park their bike in the unguarded facility, in normal conditions, and 40% percent in the guarded facility. Of the people who park guarded, 27% say they take good care of their bike, against 13% for unguarded facilities. In case a user experienced a stolen or heavily damaged bike, they are more likely to park inside. Surprisingly, the majority of the respondents who experience bicycle damage or theft while their bike was parked at the station, are still parking unguarded. This might be due to the absence of guarded facilities. Only 2% of the unguarded facility users state not to care about their bike.

When people are parking their bike, 147 of them or 28% indicate to sometimes park where it is not allowed. This can be next to the parking racks or in the free space. The most important reason is the unavailability of space for 77% of the respondents, followed by being in a hurry for 27%. Only 5 respondents indicate the shorter walking distance. 19% percent are tempted to park their bike wrong if more bikes are already there.

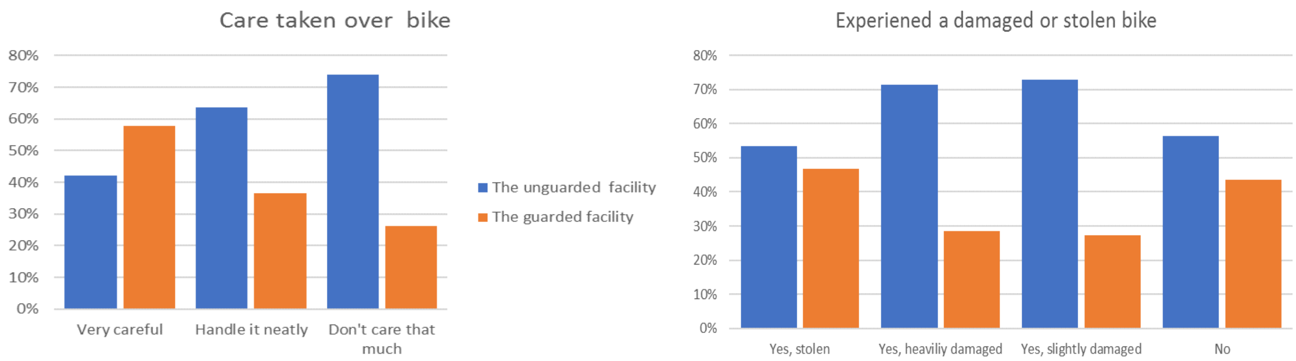

Figure 7.1, Current parking behaviour compared to the quality of the bike

7.1.2. Exploration of given answers

It is also useful to examine the answers provided to the various choice experiments. By doing so, trends might be observed. First, the results of the stated choice experiment will be discussed and thereafter of the adaptive choice experiment, about subscription price.

Stated choice

Table 7.2 provides an overview of the given answers of the stated choice experiment. The guarded facility was in most cases the favourite choice. In 61% of the choice situations, respondents decided to park the bike in this facility. 33% of the time the unguarded facility was chosen and in only 6% of the cases, people would not park their bike at the train station. Of people not parking their bike at one of the facilities, 86% will choose another access mode. 8% of them will park at another location and 6% will cancel their train trip.

80% of the respondents indicated to always go by bike. Of them, 20% always indicated to go for the guarded facility, while 10% of them always chose the unguarded facility. The preference for a guarded facility is considerably higher than shown in current parking behaviour (which is about 40%).

Table 7.2, Distribution of given SC answers

	Guarded	Unguarded	Opt-out
1	59%	35%	6%
2	30%	58%	12%
3	30%	62%	8%
4	66%	29%	5%
5	75%	20%	5%
6	63%	31%	6%
7	73%	22%	5%
8	68%	24%	7%
9	64%	30%	7%
10	59%	35%	6%
11	67%	27%	7%
12	78%	18%	4%
Total	61%	33%	6%

Some clear variations can be found in the choices for the guarded facility. In situation 2 and 3, only 30% would park in the guarded facility. These situations had no free parking period and relative expensive pricing, respectively €2.50 and €1.75. Interesting is to see that 4% is influenced by the shelter of the unguarded facility. In case shelter is present, the outdoor facility has their preference, while otherwise another mode would be considered. This is the strongest variation for not parking the bike at the station. It might be that some of the guarded facility users care too much about their bike to park them unsheltered. When the price without a free parking period drops to €0.25, 63% would consider parking guarded. Obviously, other characteristics of the facilities should be considered as well for full analysis.

7.2. Model estimation

To construct the best model fit for the collected data, some consecutive steps are carried out, as already mentioned in section 2.5 and visualised in Figure 7.2. First, a multinominal logit model (MNL) is estimated to create a base model. This model is extended by the use of interaction effects. Up next the presence of a nested structure is investigated. As of last, a mixed logit model is estimated to both consider the present nest and the panel effects. The significant interactions of the MNL model are implemented again.

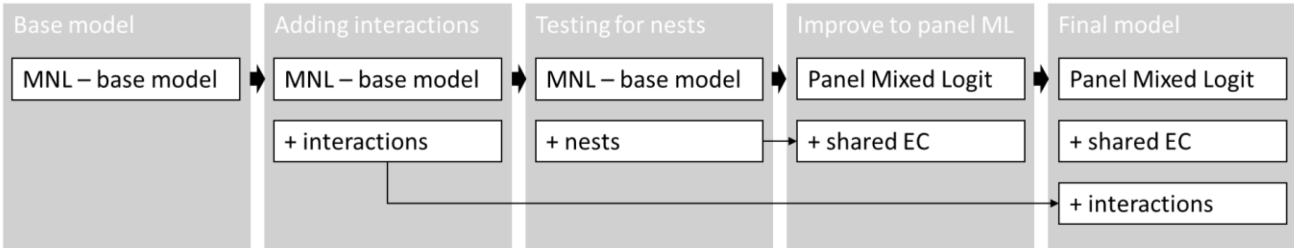

Figure 7.2, Schematic overview of modelling approach

7.2.1. Multinominal logit model

The first model is a basic MNL model. Only attributes that are used in the choice experiment are included. This is seen as the simplest function to express the utility of a choice model. In the first place, only linear attributes are considered. One by one, the significance of quadratic components are tested to see if model improvements occur. This is checked for walking time, free period and costs. Also, the interaction between free period and costs is considered. Models are compared based on the adjusted rho-square value. Both a quadratic component for the free period and an interaction of free period and costs resulted to be significant with a final rho-square-bar of 0,365. Against the findings of Molin & Maat (2015), no quadratic component for the walking time is found. The base function used in the remainder of this research is as follows:

```
V1 = ASC_A + B_SUR * paid_sur + B_REP * paid_repair + B_COST_L * paid_cost +  B_FP_L * paid_fp
        + B_FP_Q * (paid_fp**2) + paid_cost * paid_fp  * B_COST_FP  + B_WT * paid_WTPaid
V2 = ASC_B + B_WT * free_wtfree + B_SHEL * free_shelter
V3 = ASC_C
```

The full Biogeme syntax can be found in appendix G.1, even as the estimation report and estimated parameters. All parameters have the expected signs and values. The presence of a bike repair shop is proven to be significant within a 90% confidence interval. Preliminary research already showed that the impact of this varies widely, depending on the type of traveller. The presence of a shelter is insignificant.

Including interactions
In a simple MNL model, heterogeneity is not considered. So a similarity of preference for each respondent is assumed. By including user characteristics known from the survey, heterogeneity can be partly captured. An improvement of the model fit is expected. Also, the impact of the user characteristics on the various attributes can be estimated. Interactions are incorporated sequentially by the use of dummy variables, as shown in Table G.2. An example of the Biogeme syntax is included in appendix G.2. Table 7.3 shows the impact of the various characteristics.

Testing for nests
Both of the parking facilities have a shared characteristic compared to the opt-out. In both cases, the respondent is travelling to the station by bike instead of another access mode. This is for some travellers a much preferred transport mode because of flexibility. Therefore the presence of a nested structure is investigated, using a nested logit model. The used syntax can be found in appendix G.3. The estimation report and estimated values are also presented. A significant mu-value of 2.67 is found. By the means of a likelihood ratio test, the improvement of the model is verified as well.

7.2.2. Mixed logit model – panel with nest structure

A further improvement to the model can be done by including panel effects. In the MNL model, every choice is considered to be made by a different individual. A Mixed Logit panel model (ML) can correct for the correlations between the choices of one respondent. The uncovered nest structure can also be implemented using error components. The used syntax is presented in appendix G.4. Only small changes occur for the values, in comparison to the MNL model. Only the ASCs and their relative differences change due to the implementation of nests with a mu value of 2.42. The sigma for panel effects has a value of 1.66. The rho-square-bar increased to 0.387.

The model is extended by implementing the interactions found in the MNL-model. All interactions remain significant and a rho-square-bar of 0.463 is reached. Table G.7 presents the estimated parameters.

7.2.3. Future bike-train travellers

The estimated panel ML model can also be used to see the differences between current and future facility users. The first remarkable thing is the insignificance of the bike-nest, with a p-value of 0.776. While current bike parking users see a link between the use of both facilities, this nest is not present for future users. They experience separate alternatives so the nest is removed from the final model of future bike-train travellers. The final Biogeme syntax can be found in appendix G.5. The estimation of the parameters is presented as well. It can be concluded that a difference in utility exists for (non-)bike-train users. The preference for either guarded or unguarded is depending on the included attributes.

7.3. Relations between attributes

Based on the estimated models it can be concluded that various attributes hold a relation both to other attributes as to user characteristics. These relationships and their interpretation of them are described below.

7.3.1. Cost and free period combination

The values, as presented in the top row of Table 7.3, show the impact of the various attributes on the utility of both facilities. It can be found that the alternative specific constant (ASC) for the guarded facility is higher than for the free facility. Asking a fee to park your bike reduces this utility. The value of -0.781 needs to be multiplied by the price. The impact is visualised in grey in Figure 7.3. The linear component of the free period shows a positive effect while the quadratic component has a negative impact. Therefore, the impact of a 24-hours free policy is lower than that of a 12-hours free policy (the orange lines). However, this effect is partly compensated by the interaction effect between costs and free period, as is shown in yellow. The overall effect of both cost and free period can be found in blue. In the 0-hours free policy, this matches the grey line.
As expected, the walking time negatively affects the utility and the presence of staff for surveillance purpose has a positive impact. No significant difference could be found between the walking time of the guarded and unguarded facilities. Also no significant impact of the presence of shelter can be found (p=0.33). It might be that some of the respondents did not consider the attributes when answering the questions.

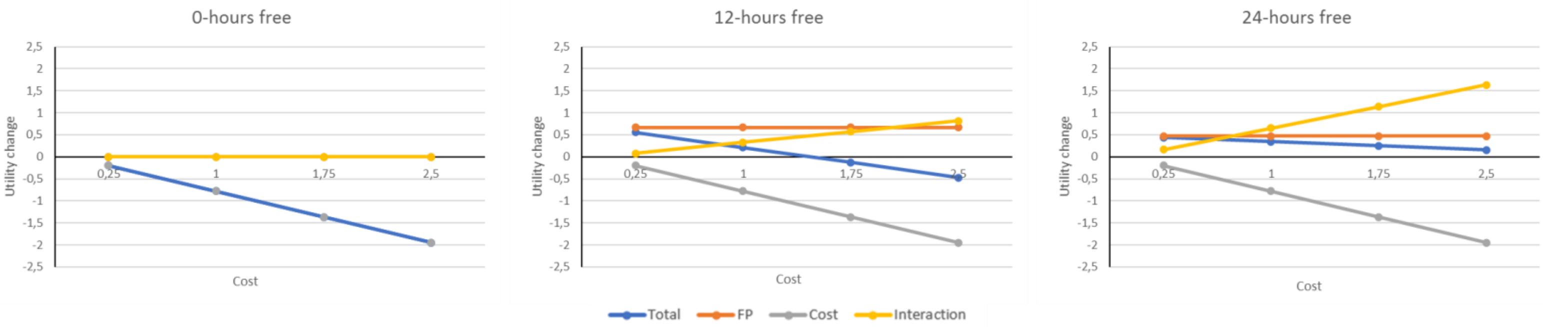

Figure 7.3, Impact of attributes costs and free period on utility

7.3.2. Impact personal characteristics

Of each characteristic, the lowest row represents the base case. In the case of car availability, “no car” is the basis (=0). It can be found that someone without a car has strong adversity against cost, -0.913. Bike-train users with the opportunity to use a car are less sensitive to cost, with a cost parameter estimate of -0.751. Furthermore, the interaction with the B-value needs to be discussed. This is the preference of the group for the paid facility, in comparison to the preference of the control group. So the ASC of car owners for the guarded facility is 0.348 higher than for non-car owners.
All values marked in green are labelled as significant, within a 95% confidence interval. These interactions are labelled as relevant. Notable effects are mentioned below. As interactions are added one by one, only comparisons within the attribute can be made.

- **Gender:** None of the interactions related to gender is relevant.
- **Age:** Especially young people (<25 years old) have a significantly different preference than retired people. They are in general less attracted by the guarded facility and are sensitive to costs. Also, their aversion to the presence of a repair shop and staff is remarkable. Only 65+ are positively influenced by these services. The group between 45 and 64 years old could be considered to be similarly opinionated as 65+.
- **Education:** The impact of education on the various utility functions is small and can be disregarded.
- **Car:** As stated in the explanation of the model results, the availability of a car has a significant impact on the user's preferences. Car owners are positive towards the guarded facility and more influenced by costs. Increasing the free period has a positive effect. The values for surveillance and walking time are not significant and can therefore not be further interpreted.
- **Purpose:** As found in literature, travellers with a mandatory trip purpose are more likely to park their bike guarded and are less influenced by costs. However, they are less sensitive to walking time, while literature stated that mandatory travellers are in general more in a hurry to catch a train and therefore not willing to walk longer distances.
- **Frequency:** Surprisingly, the frequency does not show many significant values. Low frequent travellers (less than once a month) are more affected by costs than high frequent travellers (more than once a week). Remarkable is the impact of walking time, for low frequent travellers, this increases the utility.
- **Parking duration:** Long term parkers are more in favour of the guarded facility, as expected. The presence of surveillance and a repair shop has a positive effect. A higher cost and lower free period result in a lower utility than for short term parkers.
- **Type of bike:** It can be found that mainly electric bike users differ from regular bike users. They have a strong preference for indoor parking.
- **Weekend:** weekend parkers show a similar effect as young people. They are less likely to park guarded and sensitive for any price policy. A longer free period has a positive effect.
- **Night:** Matching to the findings found in literature, people who park during the night prefer the guarded facility. They are less influenced by higher costs. However, they have a stronger preference for a longer free period than daytime parkers. Surprising is the negative effect of the repair shop and surveillance by travellers who never park during the night.
- **Current behaviour:** Travellers who currently park their bike in a guarded facility are more positive regarding it. As expected, the impact of costs and free period is bigger on people who park outdoors.
- **Location:** It can be found that the effects at the city centre and suburban stations are quite similar. At rural stations, users are less in favour of guarded facilities but seem more positive towards a shelter. They are also more sensitive to costs.
- **Operation:** Users of intercity stations prefer a guarded facility and are less influenced by higher costs. The presence of a shelter has more effect at sprinter stations.

Table 7.3, MNL model – values and interaction effects

	B	Cost	FreePeriod_L	FreePeriod_Q	Cost/FP	Repair	Shelter	Surveillance	WalkingTime
Average user	0.55	-0.781	0.0915	-0.00299	0.0272	0.145	0.0679	0.159	-0.143

Interactions:

	B	Cost	FreePeriod_L	FreePeriod_Q	Cost/FP	Repair	Shelter	Surveillance	WalkingTime
Gender									
Male	-0.0637	-0.0515	-0.0038	-0.0038	-0.0031	-0.0439	-0.00332	-0.0495	-0.0265
Female		-0.706	0.0971	-0.00298	0.0317	0.209	0.0728	0.232	-0.104
Age									
<25	-0.875	-0.52	-0.0294	-0.00124	-0.0189	-1.07	0.896	-0.935	0.188
25-44	-0.294	-0.221	-0.00375	-0.000205	-0.00492	-0.47	0.262	-0.373	0.0138
45-64	0.0339	-0.00526	0.00481	0.000157	0.000921	-0.125	-0.00655	-0.042	-0.0114
65+		-0.644	0.096	-0.00268	0.0324	0.508	-0.185	.465	-0.184
Education									
HBO/WO	0.193	0.0873	0.00894	0.000405	0.0052	0.315	-0.246	0.226	-0.0909
MBO	0.267	0.0983	0.0143	0.00055	0.00787	0.297	-0.287	0.273	-0.129
Primary/high school		-0.863	0.0266	-0.00338	0.0212	-0.081	0.295	-0.0587	-0.0432
Car									
Yes	0.348	-0.168	0.0196	0.00078	0.00888	0.2	-0.341	0.249	-0.135
No		-0.913	0.0758	-0.00358	0.0204	-0.0132	0.331	-0.0326	-0.0383
Purpose									
Mandatory	0.285	0.186	0.024	0.000878	0.0123	-0.0612	-0.115	0.234	0.103
Recreational		-0.919	0.0741	-0.00357	0.0187	0.189	0.15	-0.00737	-0.231
Frequency									
Low	-0.229	-0.0811	-0.0162	-0.0006	-0.00728	-0.0928	-0.268	-0.0398	0.208
Medium	0.204	0.0851	0.0037	0.000144	0.00225	0.328	-0.177	0.265	-0.015
High		-0.803	0.0913	-0.00299	0.0269	0.0651	0.13	0.0867	-0.129
Parkingduration									
12-24	-0.185	-0.138	-0.0109	-0.000245	-0.138	0.0347	-0.0124	-0.108	-0.00151
24-48	1.53	-1.34	-0.103	-0.00425	-1.34	1.13	1.51	1.38	0.031
>48	1.32	-1.02	-0.0934	-0.00399	-1.02	1.08	1.52	1.15	0.0303
0-12		-0.736	0.0979	-0.00255	0.0288	0.217	-0.0372	0.262	-0.165
Bike									
Electric	1.63	0.862	0.0839	0.00369	0.0452	0.164	-1.76	1.71	-0.276
Other	0.0713	0.0174	0.00911	0.000417	0.00461	0.0817	-0.23	0.0458	0.0559
Regular		-0.881	0.0806	-0.00313	0.0243	-0.00252	0.238	0.0261	-0.109
Weekend									
Yes	-0.435	-0.304	0.0268	-0.00104	-0.0151	-0.202	0.328	-0.364	0.117
No		-0.754	0.0938	-0.00287	0.0288	0.164	0.0342	0.198	-0.154
Night									
Yes	1.53	0.809	0.0738	0.00322	0.0408	1.84	-1.8	1.77	-0.293
No		-1.2	0.0555	-0.00371	0.0149	-0.575	0.739	-0.481	-0.0254
Current									
Unguarded	-0.809	-0.809	-0.0408	-0.0738	-0.0408	-1.84	1.8	-1.77	0.293
Guarded		-0.393	0.0795	-0.0025	0.0558	1.27	-1.06	1.29	-0.319
Location									
Rural	-0.194	-0.127	-0.0114	-0.000445	-0.127	-0.102	0.244	-0.204	0.0585
Suburban	-0.209	-0.0287	-0.00928	-0.000398	-0.0287	-0.314	0.258	-0.231	0.0466
CityCentre		-0.722	0.0981	-0.00268	0.0274	0.256	-0.0962	0.3	-0.178
Operation									
Intercity	0.21	0.0948	0.00442	0.000161	0.00223	.286	-0.201	0.248	0.0473
Sprinter		-0.84	0.0887	-0.00309	0.0258	-0.0341	0.191	0.00994	-0.172

Quite some interaction effects can be marked as significant. When constructing a final MNL model, including correlated characteristics should be prevented, as discussed in 7.1. Therefore the interaction of the weekend is excluded. The sensitivity of night is checked during modelling, as parking duration is more important for this research. Also, the interaction effects between current behaviour and the type of bike are closely checked.

All significant interaction effects are added to one model. Correlations are taken into account. The final model is the result of an iterative process where interactions that were no longer significant are removed one by one, based on the robust p-value. Significant effects can be found for age, type of bike, availability of a car, current behaviour, travel frequency, parking duration, purpose and weekend trips. Values are presented in Table G.4. The interpretation of it will be discussed in 7.2.2, after optimising the model by implementing nest and panel effects.

Before, the individual contribution of the attributes and interactions will be viewed. In section 8.2, personal profiles are considered for better interpretation. Not all identified interactions are directly applicable for steering but they might be for promotional purposes, among other things.
Figure 7.4 is a representation of the values. The yellow bar represents the value for an attribute by one unit increase in case none of the characteristics applies. The blue bar below the attribute is the value in case that condition is true for the traveller. So in general, the alternative specific constant (ASC) for the guarded facility is set at 7.10. However, if someone is below 25 and none of the other characteristics apply, the utility should be lowered to 6.30. The other characteristics being invalid indicate that this user is currently parking indoors, has a regular bike but no car available and travels at least once a month. For a car owner without the other characteristics, the ASC should be 7.63. Furthermore, it can be seen that a traveller who currently parks outdoors has a decreased preference for the guarded facility. Travellers with an electric bike have a stronger preference for the guarded facility.
It should be noted that this figure represents the number of utils lost or gained by one unit increase of the attribute. The attributes marked by * needs to be multiplied by their attribute level for interpretation. The utility contribution is shown in Figure G.1 The deviation in utility further expands with an increasing value of the attribute.

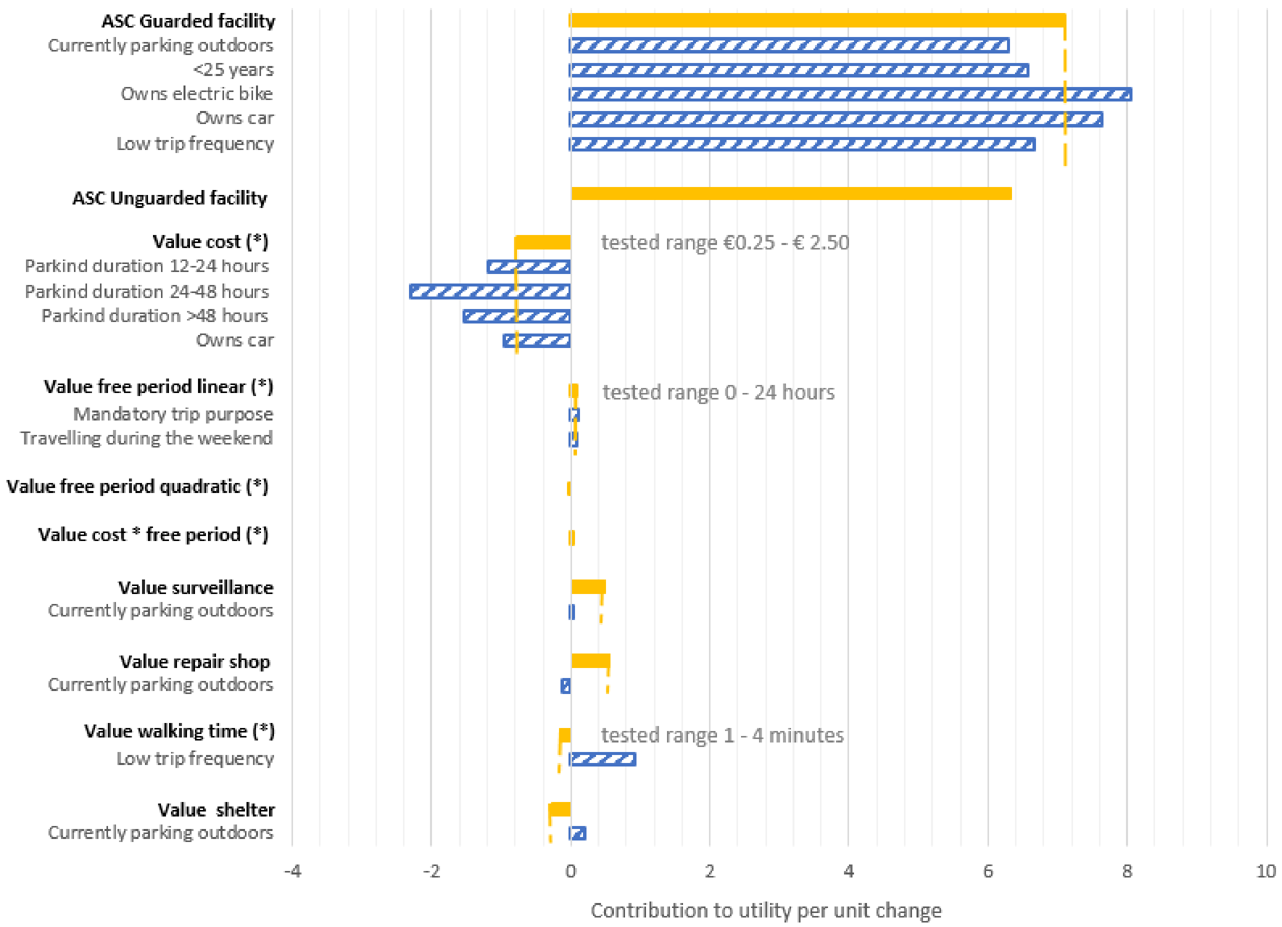

Figure 7.4, Utility contribution per unit change of individual attributes

The main characteristic impacting the utility of cost is the parking duration. Especially people parking between 24 and 48 hours are massively influenced by the costs, as the value still needs to be multiplied by the price. Surprisingly, long term parkers (>48) experience less impact of costs. This might be related to expectations or the ownership of a subscription. This group knows they are parking for a longer period and therefore are making use of the facility, so they accept the costs. In line with Puello & Geurs (2015), car owners are more influenced by costs than non-car owners.
For the free period, the utility increases more in case someone is performing a mandatory trip and/or travelling during the weekend. More characteristics of influence on the free period were expected, such as frequency and parking duration. These interactions appear to be less strong than trip purpose and weekend travellers.
Current behaviour appears to have a strong influence on the view of the respondents as interactions with surveillance, presence of a repair shop and shelter can be identified. People who currently park outdoors are much more positive regarding the shelters, while they do not see the need for surveillance or a repair shop.
As of last, the interaction between travel frequency and walking time can be identified. Low frequent travellers (less than once a month) experience a positive contribution of walking time. Both literature (Monsuur et al., 2017) and research regarding user experience indicate the appreciation of secured facilities by low frequent travellers. For travellers with a preference for security, the walking distance to the station entrance can be larger without reducing the utility (Arbis et al., 2016; Molin & Maat, 2015). However, an increase in utility is against expectations.

7.3.3. Future-users

A model of future bike-train users is estimated as well. These are current train travellers who access the station via another mode. The results are presented in Table 7.4. The difference in ASC's between the guarded and unguarded facility is bigger for non-bike users. This indicates a stronger preference for the guarded facility. Future users also seem to be less influenced by a certain pricing policy. While the negative impact of cost is weaker, also the free period has a less positive impact. The quadratic part of the free period is not significant, so only a linear relationship can be found. The presence of a repair shop is also insignificant, which is not surprising. Both the presence of shelter and surveillance has a greater positive contribution.

Table 7.4, Estimated parameters ML-model for non-bike-train users

Name	Value	Rob, Std err	Rob, t-test	Rob, p-value
ASC guarded facility	6,14	0,804	7,64	2,20E-14
ASC unguarded facility	4,93	0,819	6,02	1,72E-09
Cost	0,0241	0,00661	3,65	0,00026
Free period linear	-0,733	0,0971	-7,55	4,53E-14
Free period quadratic	0,0572	0,0262	2,18	0,0293
Interaction cost and free period	-0,0000219	0,00109	-0,0202	0,984
Surveillance presence	-0,143	0,135	-1,06	0,289
Repair shop presence	0,233	0,0944	2,47	0,0136
Shelter	0,279	0,098	2,84	0,00446
Walking time	-0,123	0,0318	-3,87	0,000108
Sigma_panel	-3,32	0,412	-8,07	6,66E-16

The way of approaching future bicycle-train users is different from the current ones. Travellers who currently park unguarded have to experience the convenience of guarded parking, and that it outweighs the costs. Non-bike-train travellers have to experience the convenience of the bike-train combination a few times and show that it is safe, as the fear of damaging their bicycle is the biggest dissatisfier. They are less sensitive to the cost of the parking service.

7.4. Conclusion

In total, 624 respondents completed the survey conducted for this research. 512 of them are current bike-train travellers and the rest access the station using another mode. The two groups are studied separately. The group is not fully representative. The respondents are older and have more often a social recreational trip purpose. In addition, fewer high frequent travellers and more medium frequent travellers are present in the sample. The influence of the various characteristics is tested during the model estimation. Where needed, a correction is applied to the sample.

To study the impact of the various attributes as considered during the questionnaire, a discrete choice model is used. Various models are used. Using a multinominal logit model, the interaction between the free parking period and parking costs can be identified. Additionally, a quadratic component for a free parking period appears to be significant. Because of the negative value, the additional benefits of a longer free period are lower. Furthermore, this model is used to identify characteristics with significant influence on the utility of attributes. Characteristics of influence are age, type of bike, car ownership, travel frequency, parking duration, trip purpose, week or weekend travel, and current parking behaviour.

A nested logit model is used to identify the presence of nests. It can be concluded that the alternatives for the two parking facilities are correlated. As this type of model cannot account for panel effects, a mixed logit model is estimated. The base model, a panel mixed logit model with a nested structure represents the average of all facility users. This model is extended with previously uncovered interactions to determine the preferences of each individual. The base model is also applied to the data of possible future bike-train travellers. By doing so, the difference in utility can be viewed. It appears that for these respondents, no nest structure occurs. Furthermore, future users seem to be less sensitive to a pricing policy. As of last, the repair shop does not have a significant impact while the presence of staff has a bigger impact.

III.
The users' willingness to pay and market shares

The last part of this research aims to elaborate on the willingness to pay of various facility users. The findings are based on the model as composed in section II. The various values which are added to an attribute are computed to the willingness to pay in chapter 8. As a result, the marginal willingness to pay for each identified attribute can be calculated. Herewith, an answer is provided to sub-question 5: *To what extent is the willingness to pay of a parking facility affected by its characteristics and the station where it is situated?* This chapter also provides an answer to sub-question 6: *To what extent is the willingness to pay expressed in a subscription price?*
The last sub-question as formulated during this research is answered in chapter 9. The question is: *What potential changes will facility users make in their trip if a proposed pricing scheme is considered to be too expensive?* Based on the earlier defined logit model, the choices of individual bike-train users can be viewed. In combination with the known facility users, the effect of an adapted pricing policy is studied.

8. Willingness to pay

Until now, all attributes and interactions are assessed as individual numbers. This chapter discussed the interpretation and application of the results. First, the average willingness to pay of all facility users is discussed in section 8.1. The impact of various user characteristics is discussed in 8.2. To see how this influences the choice of an individual, traveller profiles are constructed as well. The impact of a monthly subscription is discussed in section 8.3. Lastly, this chapter is concluded in section 8.4.

8.1. Average user

For the various attributes of the guarded facility, the willingness to pay (WTP) can be calculated. This indicates the price a user is willing to pay for a unit improvement of the attribute. First, the average WTP for walking time, repair shop and staff are calculated for both current and future facility users, using the mixed logit model without interactions. Results are shown in Table 8.1. The influence of the free period is left out (e.g. set to 0) to show what the consumer is directly willing to pay. The WTP of future users for the repair shop is not shown as this value is not significant. On the other hand, future users are willing to pay a significantly higher price for the presence of staff in the facility. This is in line with the findings of prior research (Monsuur et al., 2017). Users who are unfamiliar with the facilities have a significantly better experience with staff being present. The WTP for reducing walking time are slightly higher than found by Van Mil et al. (2018), where the WTP is €0,11 for a minute less time to park. This includes both walking to the platform and average search time. Variation might be caused by a difference in user characteristics of the used sample.

Table 8.1, Marginal WTP for staff, repair shop and walking time

Attribute	Current users	Future users
Staff	€0.20	€0.38
Repair shop	€0.18	-
Walking time	€0.18 / min	€0.16 / min

In addition, the values of the mixed logit model can be used to calculate the average WTP for the various facilities, as are in use by NS. In these calculations, the free parking period is taken into account. Both for current and future users, nine possible scenarios are calculated. They are presented in Table 8.2. The walking time is set to 3 minutes in each of the situations. As a result of the insignificant value for the repair shop by future users, the WTP is expected to be similar as without a repair shop. Also, the impact of the free period is different for future users, as the quadratic component had no significant value in the model.

Table 8.2, Average willingness to pay at various parking facilities of NS, depending on free parking period

	Current users			**Future users**		
	0 hours	**12 hours**	**24 hours**	**0 hours**	**12 hours**	**24 hours**
Self-service bicycle parking	€0.55	€0.79	€1.22	€0.50	€0.82	€1.14
Staffed	€0.75	€0.99	€1.42	€0.88	€1.21	€1.53
Staffed + repair shop	€0.93	€1.17	€1.60	€0.88	€1.21	€1.53

According to the various statements included in the survey, the WTP can be mostly increased by guaranteeing people a free parking spot, see Figure 8.1. 47% agree and 26% strongly agree to the statement: “Paying for guarded parking for my bicycle becomes more attractive when I am sure of a bicycle parking space”. Thereafter reducing the walking distance seems to be the best way, where 28% agree and 10% strongly agree. Mainly frequent travellers tend to be sensitive for the guarantee of space and the walking time. A private parking spot is not required by most of the users. The opinion regarding attractiveness of the facility when charging your electric bike is strongly varied. 38% of the owners of an electric bike does not agree, 24 % is neutral and 39 % agrees.

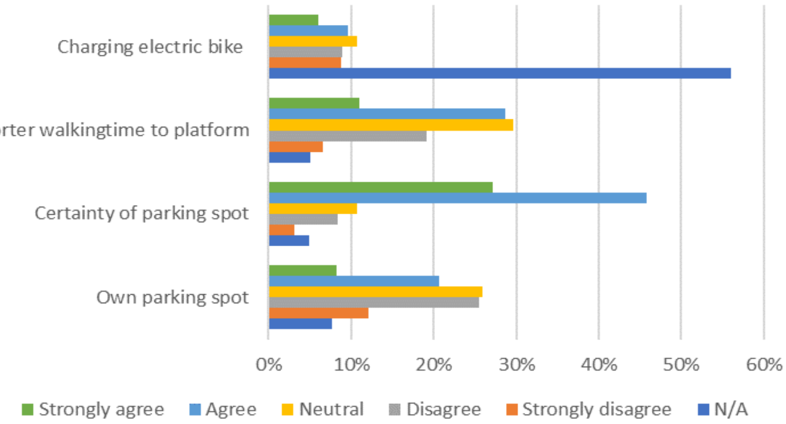

Figure 8.1, Opinion regarding statements to increase willingness to pay

8.2. Depending on user characteristics

The impact of various user characteristics on the WTP can be viewed as well. To do so, the panel ML model with nest and interaction effects is used. In Table 8.3 the relative effect of the various characteristics is shown. Similar to the utility functions, the impact is calculated in comparison to the base version where none of the characteristics apply. So the reference is a frequent traveller of above 25 years who owns a regular bike and parks currently in the guarded facility between 0 and 12 hours but does not own a car. These travellers have a WTP of €0.64 for staff, €0.74 for the presence of a repair shop and €0.22 for a minute less walking time to the platform.
The parking duration has an impact on the utility of the cost. Therefore the WTP of each attribute decreases if the parking duration is more than 12 hours. The values are the lowest for a parking duration between 24 and 28 hours, similar to the utility functions. The WTP is also lower if facility users own a car, due to different sensitivity to cost. Whether someone is currently parking guarded or not has an impact on the utility for repair shop and surveillance. These are lower for people who park unguarded and therefore also have a lower WTP. A low travel frequency only influences the WTP for walking time. As explained in the utility values in section 7.2.2, low frequent travellers are less affected by the walking time. However, a negative value for walking time can not be further explained.
More characteristics are identified to be of significant influence on the utility. These are linked to the ASC and therefore do not influence the willingness to pay. Their impact is shown in the chance to choose a certain option

Table 8.3, Marginal WTP depending on user's characteristics

Attribute	reference	Parking duration 12-24	Parking duration 24-48	Parking duration 48+	Car	Unguarded	Low frequency
Staff	€0.64	- €0.26	- €0.43	- €0.33	- €0.13	- €0.60	
Repair shop	€0.74	- €0.22	- €0.49	- €0.37	- €0.15	- €0.90	
Walking time	€0.22 / min	- €0.07 / min	- €0.14 / min	- €0.11 / min	- €0.04 / min		- €1.42 / min

To get more insights into the interpretation of the relative values, of both the utility and WTP, traveller profiles are generated based on typical users, as described in 4.3. The utilities of an individual can be estimated. The values for each attribute applying to a person's profile are shown in Table 8.4. When this value varies from the base value, it is shown in bold. In this situation, a free period of 24 hours is assumed. All dummy variables of the facility are assumed to be true (e.g. repair shop, staff and shelter present) and the walking time for both facilities is set at 3 minutes. As a reference, currently, €1.25 is asked at most of the facilities which are guarded with staff.

The first profile is of an adult who travels for work purposes. They currently park indoors for about 8 hours every weekday, owns a regular bike and has a car available. This influences many of the values. In general, the utility for the guarded facility increases while the one for the unguarded facility remained the same. This indicates a stronger preference for the guarded facility in comparison to

the reference model. The WTP can be up to €1.68. When a similar travel pattern is assumed, only conducted by a teenager to go to school, the WTP is €0.63 and therewith below the asked price. However, some of the teenagers with the same travel profile will still park indoors due to deviations. Due to the longer parking duration the willingness to pay of a student who mainly travels during the weekends, in profile 3, even dropped to €0.28 for 24 hours of parking.
In profile 4 & 5, adults who mainly travel for social or recreational purposes are considered. Profile 4 shows a traveller who regularly accesses the station by an electric bike. Profile 5 is similar, only travels on a less frequent basis. The less frequent traveller has a lower ASC for the guarded facility because of the frequency, which lowers the choice probability for the guarded facility. On the other hand, it resulted in a positive effect on the walking time which results in a high WTP.

Table 8.4, Willingness to pay for various travellers profiles

	Reference of model	Profile 1 (41%)	Profile 2 (24%)	Profile 3 (6%)	Profile 4 (8%)	Profile 5 (5%)
Age	Adult	Adult	Teenager	Teenager	Adult	Adult
Trip purpose	Leisure	Work	School	Leisure	Leisure	Leisure
Current facility	Guarded	Guarded	Unguarded	Unguarded	Guarded	Guarded
Parking duration	0-12 hours					
Day of the week	Weekday	Weekday	Weekday	Weekend	Weekend	Weekend
Travel frequency	Medium or high	high	high	Medium	Medium	Low
Car availability	No car	Car	No	No	Car	Car
Type of bike	Regular bike	Regular bike	Regular bike	Regular bike	Electric bike	Electric bike
ASC guarded facility	7.1	**7.628**	**5.774**	**5.774**	**8.575**	**8.144**
ASC unguarded facility	6.33	6.33	6.33	6.33	6.33	6.33
Cost	-0.763	**-0.961**	**-0.961**	**-1.545**	**-1.378**	**-1.378**
Free period linear	0.0825	**0.1028**	**0.1028**	**0.1171**	**0.0968**	**0.0968**
Free period quadratic	-0.00318	-0.00318	-0.00318	-0.00318	-0.00318	-0.00318
Interaction cost and free period	0.0375	0.0375	0.0375	0.0375	0.0375	0.0375
Surveillance presence	0.49	0.49	**0.03**	**0.03**	0.49	0.49
Repair shop presence	0.562	0.562	**-0.126**	**-0.126**	0.562	0.562
Shelter	-0.279	-0.279	**0.198**	**0.198**	-0.279	-0.279
Walking time	-0.166	-0.166	-0.166	-0.166	-0.166	**0.924**
Willingness to pay						
	€1.96	€1.68	€0.63	€0.28	€1.44	€2.20

8.3. Impact of subscription

To study the full package of the pricing policy as is provided at guarded parking facilities at NS stations, also the opportunity to purchase a subscription should be studied. To be able to, an adaptive choice experiment is included in the survey set up for this research. The setup is discussed in 8.3.1. Up next, section 8.3.2 discussed the provided answers. Section 8.3.3 the findings are compared to the previous identified willingness to pay for single usage.

8.3.1. Adaptive choice experiment

The adaptive choice experiment aims to get more insight into the maximum amount a user is willing to pay for a monthly subscription. In a later stage, this is linked to the expected travel frequency. The highest interest for NS is in the ZSF facilities because more and more facilities at medium-sized stations are switching to this system. Hence, this situation is presented to the respondents. The need for a subscription is depending on the period a user can park for free and the price which is asked thereafter. The free period needs to be shorter than the average current parking duration as otherwise no fee has to be paid and the need for a subscription disappears. The parking price is too uncertain in future scenarios and therefore it is decided to leave this to the imagination of the facility user. This also makes it impossible for the respondent to calculate the benefits of purchasing a subscription. It gives a better representation of the maximum WTP of the user. Only respondents who expect to travel at least once a month after COVID-19 are considered during this question.

The ranges are based on discussions with various experts of NS. In Figure 8.2, three possible scenario's (trees) are presented, depending on the free parking period. Which tree a respondent enters is depending on their current average parking duration. The free parking period will always be lower. First, the top price is asked. The follow-up question is depending on the answer given in the previous question(s). If the respondent indicates to be willing to pay the price for a monthly subscription, the second question will be higher. When the previous answer is no, the question will be lower. In total, three questions need to be answered. The question will be presented as shown in Figure 8.3. Thereafter the price will adapt according to Figure 8.2.

It is known from experience that purchasing a subscription is influenced by a lot of factors. Users in general make a quick calculation if it saves money to purchase a subscription. This is based on parking duration and trip frequency. Furthermore, in some facilities, subscription holders may skip the line for paying, which saves time. A last known motive to purchase a subscription is the guaranty for a parking spot in a dedicated area. These additional aspects will not be taken into consideration in this question design.

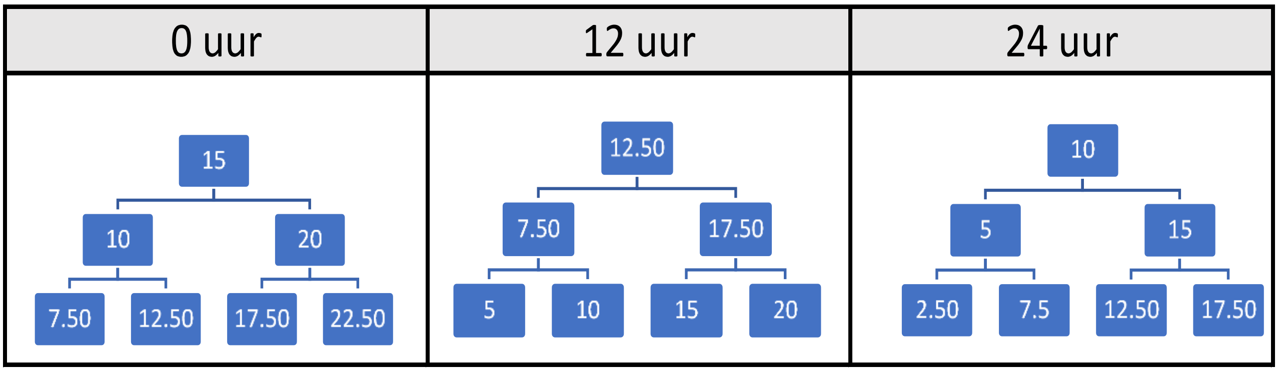

Figure 8.2, Adaptive choice experiment trees, depending on the free parking period (0, 12 or 24 hours)

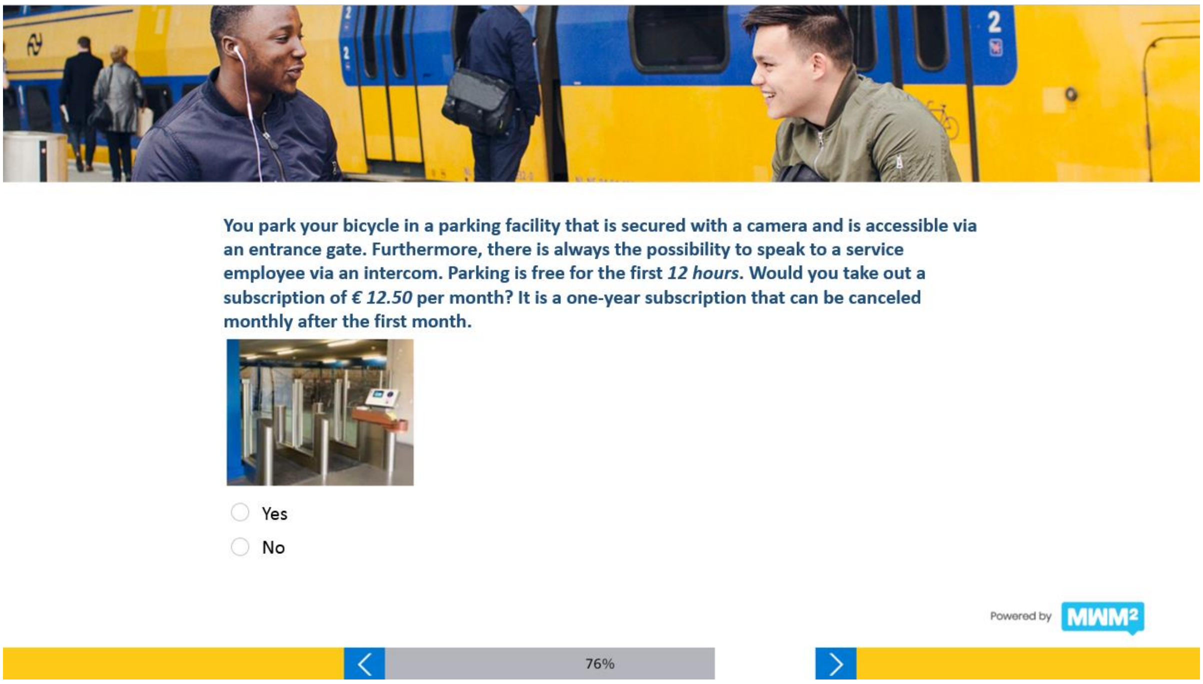

Figure 8.3, Example of adaptive choice experiment

8.3.2. Provided answers

The percentage of the respondents who are willing to get a subscription for a ZSF at a certain monthly price is shown in both Figure 8.4 and Table F.2. The presented free scenario, regarding the free parking periods, is depending on their current parking behaviour as discussed before. To someone who currently parks 8 hours, the scenario of 0 hours free is presented and the asked price ranged between €7.50 and €22.50. Travellers with a low trip frequency (less than once a month), were not considered.
The majority of the respondents did not experience a free period. For this last group, it can be found that 36% are considering a subscription for €7.50 a month. In case €10,- is asked, this already dropped by 11 percent points. This is also the cutoff point for most of the respondents who did not experience a free parking period. On average respondents of this group, when considering a subscription, are willing to pay €4.65 for a subscription. Of the group who needs to pay after 12-hours of parking, the biggest dropout occurs between €5.00 and €7.50.
Currently, at most parking facilities, a 24-hours free policy is applied. In the case of a subscription, a price of €7.50 a month is asked. In this survey, only 16% indicate taking a subscription. This is higher than the current number of subscriptions, which is on average 10% of the guarded facility users. However, as stated before, 60% of the respondents currently park unguarded. None of the respondents in this category is willing to pay €12.50 for a monthly subscription.

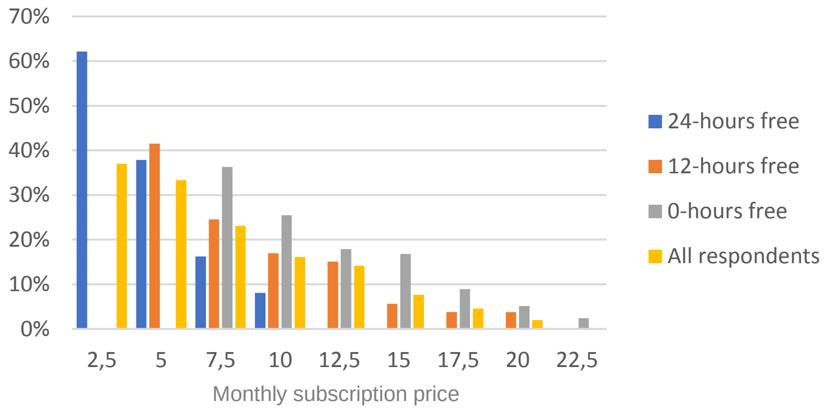

Figure 8.4, Percentage of respondents willing to take subscriptions at a certain price, depending on provided free period

When considering the characteristics of the people willing to take a subscription, only the group without a free parking period is considered because of a representative sample size. Values are presented in appendix F.2. Respondents parking during weekdays are more likely to take a subscription than weekend users. Important to note is the small sample size of the group travelling during the weekend. Travellers on workdays are often the ones with a necessary trip purpose as well, which shows similar values. Also, people who already use the guarded facility or have a high trip frequency are more likely to take a subscription. Both characteristics also increase the average willingness to pay. Gender does not show a significant effect. As of last, the impact of age on subscriptions is unclear. Pensioners are less attracted to a subscription, which might be related to their trip frequency. Furthermore, adults tend to have a higher willingness to pay than younger travellers.

8.3.3. Relation to the willingness to pay

As the last part of this research, the relationship between the WTP and a subscription price is evaluated. The situation of a ZSF is used and considering the expected travel frequency after releasing travel restrictions due to COVID-19. By dividing this price by the range of frequency, a minimum and maximum price for each individual visit can be calculated. This can be compared to the individual's WTP resulting from the model. As expected, frequent travellers are willing to accept a higher subscription price (€13,06 against €10,87). Older people are willing to pay more for a subscription than younger travellers (€12.84 against €9.69). Travellers with a mandatory trip purpose are more likely to take a subscription (43% against 29%).

Especially in case no free parking period is provided, a good subscription price can have some benefits. 69% of the respondents who had this situation indicated to be willing to take a higher subscription price than their WTP indicates. This is mainly the case for medium frequent travellers. The 22% whose WTP is matching their subscription price mainly consists of frequent travellers. 9% indicate a lower monthly subscription price. Travellers with a longer parking duration, between 12 and 24 hours are more in line with the subscription price. The WTP is within the range of the subscription for 55 % of the respondents.
From practice, various reasons are known why users are willing to pay more for a subscription than they would spend if they paid for every single use. First of all, is set monthly costs. Some people do not like the insecurity of receiving a bill after a month. Furthermore, in some parking, subscription holders have a dedicated parking area that might be closer to the platform. This was not stated in the context, but current users might know this. More certainty for a spot is also mentioned. As of last, which is not applicable in this situation but should be considered when determining subscription prices, is the possibility for quicker checkout. At staffed facilities, subscription holders do not have to check out at the staff member, but can just skip the line.

Lastly, the data reveals that the possibility to take a subscription does not attract more bike-train travellers to the guarded facility. The majority of the people considering a subscription indicated at least 7 times to park in the guarded facility during the stated choice experiment.

8.4.Conclusion

Based on the results of the panel mixed logit model with nest structure, the WTP for the various attributes can be determined. On average, current facility users are willing to pay €0.20 extra for the presence of staff, €0.18 for the presence of a repair shop, and €0.18 for a minute less walking time to the platform. Future bike-train users indicate to be willing to pay €0.38 extra for the presence of staff and €0.16 for a minute less walking time. The WTP for the repair shop is not significant.
By specifying the facilities as currently present at train stations, the average WTP for 24 hours of parking can be determined, depending on the free parking period. The WTP is the highest if the free period is set to 24 hours. For current bike-train travellers, the WTP of a ZSF ranges from €0.55 to €1.22 for 24 hours of parking. In case the facility is staffed, the WTP varies between €0.75 to €1.42. The highest WTP appears for facilities with both staff and a repair shop, ranging from €0.93 to €1.60. Potential bike-train travellers show a slightly different pattern. In general, their WTP is higher. The numbers for the WTP vary depending on the parking duration, car ownership, current parking location and trip frequency. The probability for parking in the guarded facility is also depending on current parking location, trip frequency and car ownership, but also age and type of bike. Several profiles can be generated to indicate the impact of user characteristics.
Explorative research indicated that the option for a monthly subscription does not attract new users to the guarded facility. Only users who often indicated to park in the guarded facility are willing to take a subscription. The price they are willing to pay for the subscription is higher than expected from their daily WTP and travel frequency. Possible other benefits of having a subscription are taken into consideration.

9. Effects of price policy changes

The effects of pricing policies on the user experience and utilisation at various facilities are of great interest to NS (Dutch Railways). This can be studied based on previously determined utility functions. Section 9.1 discussed the distribution of the current bike-train travellers over the facilities, depending on the situation. These findings are further specified, based on the generated traveller profiles. The findings of the model are validated by comparisons to literature and real-time situations in section 9.2. As of last, an in-depth analysis is performed in section 9.3 to get more insights into the consequences. This chapter is concluded in section 9.4.

9.1. Distribution over the facilities

The profiles as described above are examples of parking facility users. Based on the information know of current bike-train users, a prediction can be made about how these users distribute themselves across the provided options at a station (guarded parking facility, unguarded parking facility, no bike as access mode). The three existing facility situations at NS stations are considered, e.g. ZSF, staffed and staffed with a repair shop. Both the effects of cost and free period on patronage are studied and shown in Figure 9.1. It is acknowledged that people do not always do what they state they would do. Therefore, the predicted rates should be viewed with caution.
As shown before, guarded facilities have a higher WTP than ZSF's. The percentage that will park inside in case of an equal price is up to 10% if a repair shop is present. As revealed by the utility functions, enlarging the free parking period does not contribute to more guarded facility users. This is also visible in the graphs. For a certain facility, the gradient of each price line drops and the line moves to an equilibrium. Also at these equilibrium points, the staffed facility is about 6% more attractive than the ZSF and adding the repair shop attracts another 4% of the users.
For the costs, it can be found that the reduction of facility usage is larger by a price increase from €0.25 to €0.75 in comparison to €1.75 to €2.25. This matches previous findings where the sensitivity of price decreases at higher costs. Also during the survey, 25% indicated to always park indoors. This is higher than revealed by the model, where the most unfavourable situation shows patronage of about 10%. On the other hand, 11% indicated to always park outdoors. In the model, at least 16% will always park outdoors. These differences are caused by modelling the entire sample. The model fit is up to 0.5 which makes there are some factors left.

Next to the cost and free period, also the walking time has an impact on the distribution over the parking facilities. Both increasing the walking time of the free facility as decreasing the walking time of the guarded facility results in an increase of patronage of the guarded facility by 4 precent-points. Adding shelters outdoors also slightly affects the facility usage. In each of the situations, the unguarded facility attracts 4 precent-points. of the guarded facility users and 0.2 precent-points. of the opt-out travellers.

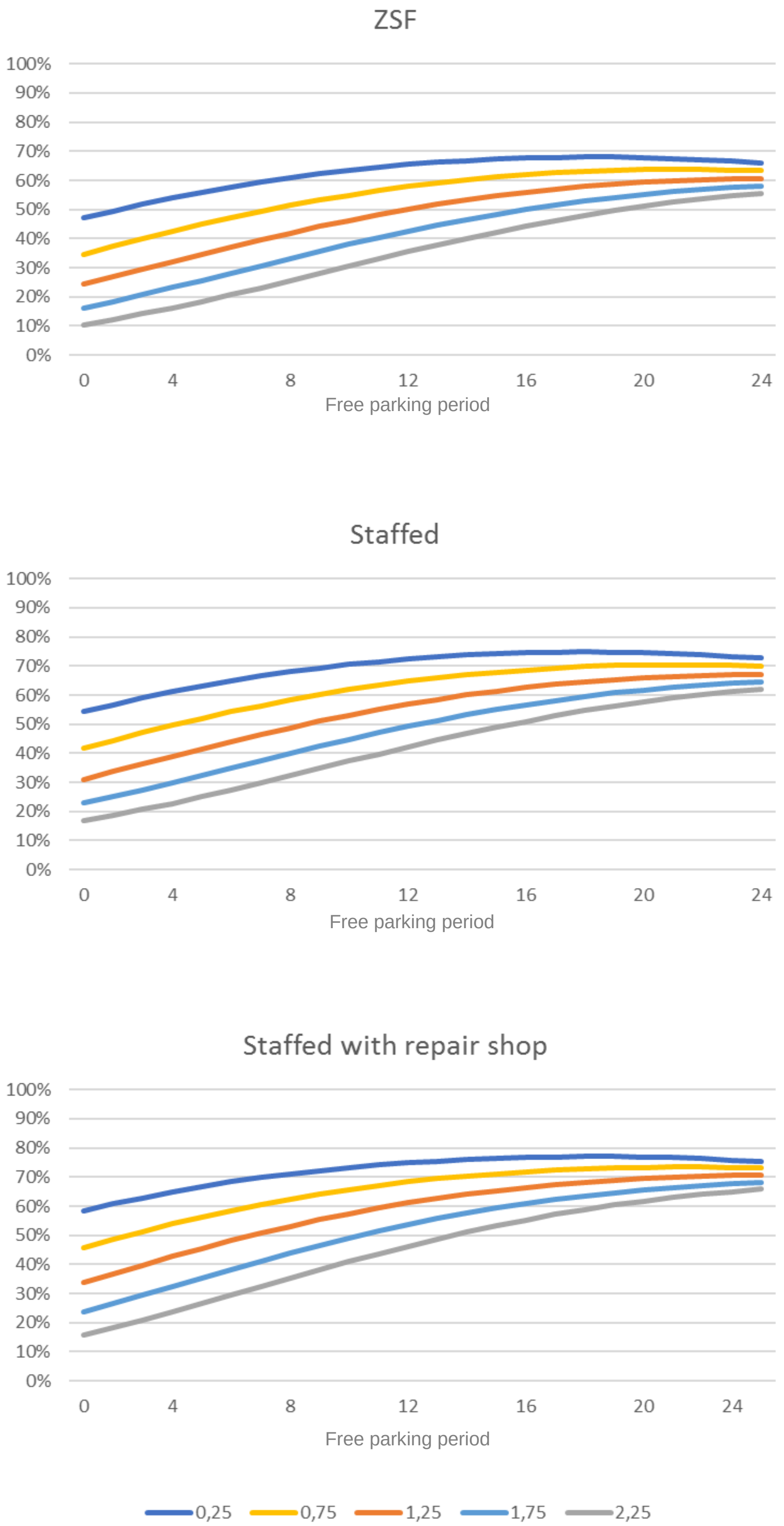

Figure 9.1, Impact cost and free parking period on patronage guarded facility

These distributions can be further specified by looking into the various traveller profiles, as shown in Table 9.1. A free period of 24 hours is assumed whereafter €1.25 is asked, as is the case in most facilities nowadays. Staff and a repair shop are present at the guarded facility and shelter at the unguarded facility. The walking time for both facilities is set at 3 minutes.
The willingness to pay of commuters to work is higher than asked. As a result, 60% indicates parking at the guarded facility. People below 25 have a relatively low willingness to pay. The probability that they will park at the guarded facility is 41% in case of travelling to school and 24% when travelling for leisure activities. Adults travelling with a leisure-related purpose and owning an electric bike have the highest probability of parking guarded. The WTP for travellers with a medium travel frequency is lower than that of the commuters or social/recreational travellers with a low trip frequency. However, in general, they have a higher preference for the guarded facility as can be found in Table 8.4.

Table 9.1, Distribution over parking facilities for various travellers profiles

	Reference of model	Profile 1 (41%)	Profile 2 (24%)	Profile 3 (6%)	Profile 4 (5%)	Profile 5 (5%)
Age	Adult	Adult	Teenager	Teenager	Adult	Adult
Trip purpose	Leisure	Work	School	Leisure	Leisure	Leisure
Current facility	Guarded	Guarded	Unguarded	Unguarded	Guarded	Guarded
Parking duration	0-12 hours					
Day of the week	Weekday	Weekday	Weekday	Weekend	Weekend	Weekend
Travel frequency	Medium or high	high	high	Medium	Medium	Low
Car availability	No car	Car	No	No	Car	Car
Type of bike	Regular bike	Regular bike	Regular bike	Regular bike	Electric bike	Electric bike
Choice probability						
Guarded	53%	60%	41%	24%	75%	65%
Unguarded	43%	35%	53%	72%	23%	32%
Opt-out	4%	5%	6%	4%	2%	3%

9.2. Validation

To check the validity of the model, a comparison can be made to the research of Molin & Maat (2015). They investigated the price-walking trade-off at Delft station by the means of a Latent Class model. Their first scenario represented the situation at that time: the guarded facility is staffed with a pricing of €1.20 without free parking. Both the walking time for the free and paid facilities is set at 1 minute. Results indicate that 17% of the cyclists will choose for the guarded facility, 81 % for the unguarded facility and 3% will not park a bike at the station. This corresponded very well to the usage back then were 16% parked guarded. When the same scenario is used for this model, 26% will park guarded, 69% unguarded and 5 % will go for the alternative option. However, Delft is a university city so the average age of the travellers is in general lower than that of the entire bike-train population. Therefore, the sample of only respondents in Delft of the KBM 2019 are used as well. Results indicate that 19% of the cyclist would use the guarded facility and 77% the unguarded facility. This is only a small deviation from the model of Molin & Maat (2015).
The models have a bigger deviation at the lower boundary for a price of €0.30 (65% vs 58%) and the upper boundary for walking time of 5 minutes for the free facility (24% vs 30%). This can be explained by the quadratic component for walking time in the model of Molin & Maat (2015), which was not significant in this model. The interaction of cost and free period is not of impact in this situation, as the free period is set to 0. The impact of the free period in the model can not be validated as this is not investigated before.

A change in the walking time of the free facility, from 1 to 5 minutes, increases the number of users that is willing to pay for the paid facility (€1,20) from 17% to 24%. When the price is raised to €1,50, only an increase of 1% occurred. A walking time of 5 minutes for the free facility and a price of €0,30 for the paid facility, results in 65% of the respondents choosing the paid facility. According to Van

Mil et al. (2018), consumers are willing to pay €0.11 for a minute less time to park, which includes walking to the platform and average search time. Dijk (2014) performed a study at various stations in the Netherlands. It provides a rough indication of the willingness to pay of travellers. It is also the only known research that included the WTP for a subscription. During this research, no attributes of the facility were specified. Therefore, scientific support is missing.

9.3. Analysis of alternatives

Of the respondents who indicate to choose not to park at one of the dedicated facilities, only 6% to stop performing the train trip. This entails both switching to another main mode as not performing the trip at all. The rest keeps travelling by train. 87% of the total indicated to choose another access mode and 8% to park the bike somewhere else, which might be a violation of local rules. These findings are again matching with the findings of Molin & Maat (2015) where 90% chooses to walk or use public transport for access. It can be concluded that the findings of that study, which was conducted in Delft, match the rest of the bike-train travellers in the Netherlands.
When no unguarded facility is available at a train station, most of the users, 81% will park at the guarded facility. Only 2% indicated they would no longer perform their train trip. The impact on the WTP is not known.

9.4. Conclusion

With the known information of current bike-train users. The effect of the pricing policy, existing of a combination of price and free parking period, can be studied. This is done for the three parking situations at NS stations. Up to 10% more bike-train travellers will park guarded in case staff and a repair shop is present. The increase in costs is not linear related to the loss of users. An increase from €0.25 to €0.75 has more impact on patronage than from €1.75 to €2.25. Also increasing the free parking period has a limited effect.
The results are also depending on the types of users in a facility. Of commuters to work, 60% will park at the guarded facility. People below 25 have a relatively low willingness to pay. Therewith, the probability that they will park at the guarded facility is 41% in case of travelling to school and 24% when travelling for leisure activities. Adults travelling with a leisure-related purpose and owning an electric bike have the highest probability of parking guarded.

10. Conclusion, discussion and recommendations

This research investigated the willingness to pay of various types of bike parking-users at train stations for different types of facilities and at different types of stations. First, the conclusion of this research is provided in section 10.1, by answering the sub research questions and main research question. In section 10.2, the process and results of the research are discussed. As of last, the chapter is finalised with the recommendations for policymaking and future research in section 10.3.

10.1. Conclusion

Various studies investigated the bike-train combination, due to its (societal) benefits such as improved accessibility and sustainability. Most studies focused on the entire multimodal trip, from door to door. The parking facility at train stations is mainly seen as an attribute of this trip. Hence, previous research has not identified all elements influencing the experience of parking facility users. Furthermore, a full understanding of the impact of these different elements on the user's preferences and the willingness to pay (WTP) is lacking. Additionally, none of the known research is a true resemblance of the current situation at stations. Among others, the impact of the free parking period has not been considered before. This research increases the understanding of which attributes influence facility usage. The effects of pricing policies on the users' experience and utilisation at various facilities are of great interest to NS (Dutch Railways). In this research, an answer to the main question is formulated:

What is the willingness to pay of various types of bike parking-users at train stations for different types of facilities and at different types of stations?

Bike parking users and their experience

To gain more insight into the willingness to pay of parking facility users, a more thorough understanding of the users and their experience is required. To start with, more information is collected regarding the current facility users based on an ongoing data collection effort (Keten Belevings Monitor or KBM). Five traveller profiles can be identified which each consist of at least 5% of the current bike-train users. The two largest groups are high-frequency travellers (at least once a week) who respectively commute for business and to school. The smaller groups consist of leisure travellers. The distinction between those three groups lies in their age, travel frequency and parking duration. The younger travellers are high-frequency travellers but tend to park longer. Almost half of the older travellers is a medium frequency traveller(1 to 3 times a month), which entails 8% of the total bike-train travellers. In 5% it entails low frequent travellers (less than once a month).

Distribution of users towards different types of stations can be made as well. Suburban stations tend to be more used by commuters to work. This also results in more frequent travellers at suburban stations. Social and recreational travellers tend to be more attracted to intercity stations. Also, long-term parking occurs more often at intercity stations.

From literature it is known that the users' experience differs among the population, depending on the provided services, such as the presence of staff, the presence of a repair shop and the pricing policy. This study into the data of the ongoing KBM confirms these findings. Furthermore, the overall user experience differs among facilities, hence in-depth research is performed to identify which elements influence the overall user experience. Five elements of the facility can be identified:

1. Service: the presence and attitude of the staff and the feeling of safety
2. Overview: effort to search for a parking spot, clarity of parking and where to find information
3. Appearance: the care and cleaning of parking facilities
4. Accessibility: accessibility of facility in terms of time, price and easiness
5. Bike security: risk of theft or damage of bicycle when stored

The service-related attributes are of impact on the valuation of the five elements of experience. Together these attributes can explain up to 69.4% of the overall user experience.

The valuation for service is higher for women, elderly, travellers with a lower frequency and a social recreational trip purpose. This is similar for overview and appearance, with exception of the gender. Men rate overview higher than women. Due to the price aspect, accessibility is valued lower by younger travellers and travellers with a longer parking duration. For infrequent travellers, the entrance system influences the experience of accessibility of the parking. They prefer staffed parking. The last factor influencing the experience is bike safety. This is highest appreciated for travellers with a low frequency, social recreational trip purpose, and a longer parking duration.

In general, service is valued lower at bike parking’s at intercity stations compared to sprinter stations in a suburban area. Overview and appearance are lower rated at rural stations, as half of the dedicated locations struggle with capacity problems. Accessibility has the highest score on suburban intercity station. The asked price is lower at suburban stations, €0.50 after 24-hours free parking versus €1.25 after 24-hours free parking at intercity stations. Additionally, intercity stations are more likely to be staffed. However, self-service bike parking is not less valued than staffed facilities by frequent users. The score of bike security is higher when staff is present and at station types with higher train frequencies.

Stated preferences for bike parking

All in all, the service-related elements seem to have a large influence on user experience and therefore on both the preference and the willingness to pay. The experience is also depending on the type of station. Literature indicated the influence of the walking time and the shelter for unguarded facilities on the preference of facility users. To be able to find the impact of these attributes, data is collected using a survey, including a stated choice experiment. Twelve situations are presented to the respondents, with the option for a guarded facility, unguarded facility or another (access) mode. The considered aspects are shown in Table 10.1.

Table 10.1, Aspects considered during survey

Alternatives	
Station	Operation & Location
Facility	Security Repair shop Shelter Walking time (1 - 4 min) Price (€0.25 - €2.50) Free period (0 – 24 h.)

Characteristics	
Personal	Age Gender Bike Car ownership Level of education
Travel	Trip Purpose Trip Frequency Parking Duration Parking Period
Experience	Current preference Damaged/stolen

Context (fixed)	
Travel	Purpose Distance
Parking facility	Capacity Search time Opening hours
Experience	Overview Appearance Accessibility Bike safety

In total, 624 members of the NS-panel completed the survey. 512 of them are current bike-train travellers while 112 access the station via another mode. Of respondents who currently go to the station by bike, 80% considered this mode in all choice situations. 20% of this group always indicated to go for the guarded facility, while 10% of them always chose the unguarded facility. The travellers parking in the guarded facility are in general handling their bike more careful. Other characteristics with a significant impact on the preference for the guarded facility are age, type of bike, current usage, trip frequency, and car ownership. Both younger people and bike-train travellers who currently park unguarded have a lower preference for the unguarded facility. Owners of an electric bike and/or a car do have a higher preference for the guarded facility.

In case the parking fee is considered too high for a bike-train traveller, they mainly shift to the unguarded facility. In general, between 4 and 6% of the travellers consider not parking their bike at one of the dedicated facilities. The numbers for the opt-out drop by 2 percentage points if a shelter is added to the unguarded facility. Of the respondents who choose the opt-out in one of the choice situations, only 6% chooses not to travel by train anymore. This entails both switching to another (main) mode and not performing the trip at all. The others choose to continue travelling by train. 87% of the respondents will choose another access mode and 8% will park the bike somewhere else, which might be a violation of local rules.

Willingness to pay

A panel mixed logit model with nesting structure is estimated. From the model, the willingness to pay (WTP) of various types of facilities can be calculated and is shown in Table 10.2. The WTP depends on the free parking period and the presence of staff and a repair shop. The WTP is highest if the free period is set to 24 hours. For current bike-train travellers, the WTP of a ZSF ranges from €0.55 with no free parking period to €1.22 with 24 hours of free parking. In case the facility is staffed, the WTP varies between €0.75 to €1.42. The highest WTP appears for facilities with both staff and a repair shop, ranging from €0.93 to €1.60. The type of station a facility is located has no impact on the WTP. Potential bike-train travellers show a slightly different pattern with, in general, a higher WTP. Only the willingness to pay for the facility with a repair shop is lower than that of current users due to no significant impact of the repair shop.

Table 10.2, Average willingness to pay at various parking facilities of NS, depending on free parking period

	0 hours free	**12 hours free**	**24 hours free**
Self-service bicycle parking	€0.55	€0.79	€1.22
Staffed	€0.75	€0.99	€1.42
Staffed + repair shop	€0.93	€1.17	€1.60

The WTP for current bike-train travellers can be further specified based on personal and travel characteristics. Travellers who own a car, who have a parking duration longer than 12 hours, or who currently park unguarded, have a lower WTP. This is also represented in the travellers' profiles. Teenagers travelling for leisure-related activities have the lowest willingness to pay, followed by bike-train users going to school. In the case of a guarded facility where staff and a repair shop are present with a 24-hours free policy, the WTP is respectively €0.28 and €0.63. Adults with a mandatory trip purpose, who are the main users of the facility, have a willingness to pay of €1.68 in the same situation.

Finally, bike-train travellers have the option to purchase a monthly subscription instead of paying for single usage. Explorative research indicates that a subscription does not necessarily attract travellers from the unguarded to the guarded facility. It should mainly be seen as an addition for people who already park at the guarded facility. The majority of the respondents even indicated to pay more for the subscription than would be expected based on their willingness to pay and expected parking frequency. This might be due to the possible advantages of having a subscription, while this was not mentioned during the research. From current membership holders, advantages as set monthly costs and quick checkout are known.

In sum, this research contributed to a better understanding of the WTP for parking facility usage in the Netherlands. A differentiation should be made in the type of facility, based on the type of security and the presence of a bike repair shop. In general, staff and a repair shop present in the facilities result in a higher WTP. As expected, but never researched before, also the free parking period is of impact on the willingness to pay for the guarded parking facility. The willingness to pay varies for each person, depending on characteristics like car ownership, trip frequency, and parking duration. Other characteristics like age, type of bike, frequency, and current usage only impact the preference for a certain facility. These characteristics slightly differ from the characteristics influencing the user experience. Against all expectations, the type of station does not influence the WTP but should be considered as it will reflect in the user experience.

10.2. Discussion

In this study, more insights have been obtained regarding bike parking facilities at train stations concerning both user experience and the WTP. To be able to perform the research, various assumptions and decisions had to be made. The impact of the research design and its limitations will be further elaborated on below.

While performing this research, the COVID-19 pandemic was happening. Therefore, actual train trips were limited and the demand at bike parking facilities lowered. This resulted in a better overview of the facilities and a lower walking time as it is more likely a spot at the exit is available. To limit the impact of this during the survey, a situation as before the pandemic was described in the context of the choice experiment. As the survey was spread online, still everyone was able to respond to the survey. Therefore, no major impact of the pandemic is expected on the results.

User experience

For the analysis of the user experience, the results of the KBM 2019 are used. The use of this dataset has a few drawbacks. First of all, as the data was explored and applied to the sample collected, the principal component analysis is chosen. By doing so, the conclusions are limited to the collected sample. Generalization of the results can only be achieved if analysis with different samples reveals the same factor structure. It might be of interest to check if the results hold for other years as well. Adaptations might be needed as the statements used in the survey are slightly modified each year.
Secondly, this survey only entails users of the guarded parking facilities. Train travellers who park their bike in the unguarded facilities are left out. In addition, the KBM survey is also answered by non-bike-train travellers who use the guarded facility. As their presence is known, their results could partly be filtered. However, the question regarding public transport use was only added in 2020. Furthermore, the KBM survey is limited in personal characteristics. Information such as income, car ownership, and bike quality is not known. Likewise, the survey is only held on weekdays. So it is not known whether weekend travellers have a different opinion. Literature indicated significant impacts of these characteristics on facility usage (e.g. Molin & Maat, 2015; Puello & Geurs, 2015; Van der Spek & Scheltema, 2015). As a result, characteristics that might influence the user experience could not be studied to their fullest. During the stated choice survey, to determine the willingness to pay, these characteristics are included.

To prevent complexity, the various facility characteristics which influence the user experience, obtained by the factor analysis, were not included in the survey as attributes. Instead, they were given in the situation description of the survey to prevent assumptions regarding the appearance of the hypothetical facility. In the various choice situations, the focus was on attributes that could be easily differentiated.
Additionally, by focussing on rational elements, like walking time and costs, no further impact of the environmental factors on the WTP has been studied. The surroundings of the station influence the attractiveness of the options in terms of travel distance and social safety. As a result, these attributes might influence the choice of a traveller (Maat & Louw, 2012; Van Mil et al., 2020). Attractive alternatives might have enlarged the number of respondents who would consider another way of travelling to the station. The availability and competition with regional transport has a negative influence on the willingness to pay according to Molin & Maat (2015) and Van Mil et al. (2018). The built environment also affects the type of user who is attracted to the station in terms of trip purpose and trip frequency (Puello & Geurs, 2015; Shelat et al., 2018). By not including the surroundings of the station in the study, the results will not represent the true effect of implementation in a real case. However, NS aims for a uniform pricing policy that cannot be adapted to each detail of the surrounding. The simplification of location as used before (city centre, suburban and rural area) might be considered.

Assumed situations in the context of the survey

As previously stated, the context plays an important role in a decision parking facility users make. During the survey, parking your bike outside the station area was assumed to be unfeasible. However, in reality, strict supervision is needed by the municipality, which is not always the case.

Including this option might have influenced the choice of some of the respondents, as 5% of the respondents indicated to regularly park their bike where this is not allowed and 23% occasionally. Another limitation is that all choice situations included both a guarded and unguarded facility. This makes it hard to conclude what happens if only guarded facilities are present, which is the case at some stations. Opponents of providing only paid parking facilities argue that this policy may reduce the use of the bicycle as an access and/or egress mode and consequently may result in a decrease in train travel (Molin & Maat, 2015). In an additional question of this survey, 81% of respondents indicated they would park in the guarded facility if an unguarded facility is not present. If this would also influence the WTP is not known. Only 2% indicated they would no longer perform their train trip.

Research method
In previous researches, a variety of methods have been used, including interviews, focus groups, preference surveys, and some intervention studies (Heinen & Buehler, 2019). Longitudinal studies, such as studies on panel data or intervention studies are very limited. Most commonly used is a stated preference survey. The dominance of one type of study results in a limited understanding of the topic (Puello & Geurs, 2015). Their study reveals that a stated preference approach shows a higher share in guarded facility users than observed in reality. During this study, the preference for a guarded facility is also considerably higher than shown in the current parking behaviour of the respondents (60% against 40%). However, when the utility function describes the former situation of Delft station in 2014 a similar patronage is predicted (Molin & Maat, 2015), This indicates the accuracy of the model in real-time situations without extreme pricing policies.

The main survey of this research, to get more insights into the WTP of bike-train travellers, is performed online, amongst the respondents of the NS-panel. A setup like this is required to get a big data set. It would be interesting to see if the values of the utility function strongly deviate when the same questions are asked in the parking facility itself. People will consider their current experiences. This might also reveal the impact of earlier determined attributes as appearance and overview of the parking facility. As the impact of the determined factors (service, overview, accessibility, appearance, and bike security) is not considered before, it might be a valuable contribution to science. Other factors which are left out to prevent complexity might also be of interest like opening hours and search time.

Analysis method
When analysing the outcome of the survey, first a multinominal logit model is used. This is sequentially improved towards a mixed logit model (ML) where panel effects and nest structure are taken into account. To further improve the ML model, a normal distribution to the parameter values is added. By doing so, heterogeneity in taste can be explained. A disadvantage might be that it results in a model which is hard to explain. A latent class model can be a good alternative as it identifies the traveller profiles based on their preferences (e.g. Molin & Maat, 2015; Muñoz, B., Monzon, A., & Daziano, n.d.). As this was too challenging in the given time frame, it is decided to partly capture the heterogeneity by including interactions based on user characteristics. Only the heterogeneity related to the significant characteristics is taken into account, which is lower than on an individual level.

The included interactions are all assumed to be on a personal level while some of them are trip-related, like travel purpose and parking duration. These might be different each time an individual is performing a trip. Even though the purpose was stated in the description of the situation, it is not certain respondents considered this. Parking duration is not necessarily the same for every trip, so the influence on the WTP should be further investigated.

To include the interaction effects, dummy coding is used. However, using effect coding would have been better as it improves interpretation (ChoiceMetrics, 2018). By doing so, the attribute parameter shows the utility deviations from the average. Also, the alternative specific constant will show the average utility, while the ASC of the dummy coded utility presents the value if all attributes are set to the reference level.

Station typology
Since the start of this research, a simplification regarding station type is used, based on solely micro and macro-accessibility. The existing categorization of the NS Operator department appeared not practical for in-field application. Presenting a hypothetical station during the survey would become too complex as well. As a result, only the connection and location of the hypothetical train station were presented. According to the findings of the stated choice experiment, the used typology is not related to the willingness to pay of facility users. However, a relation to the user experience is identified at the beginning of this research. A different categorisation might show a significant impact on the WTP. Unfortunately, the effect of different categorizations could not be tested due to the data collection method during the survey. In the original survey, the departing station of the respondent is asked. The presented environment during the questions is then automatically adapted to it. However, due to a technical failure of the questionnaire software, the location and connection of the most frequent departing station had to be asked to the respondents directly. This made the analysis of other categorizations no longer possible. Therefore, in further research, it is recommended to ask a respondent's departing station as well, so an extended investigation is feasible if desired. If a pricing policy is designed based on different typologies, also the effects can be better predicted. For example, the focus of NS is currently shifting towards mobility hubs. The implications of this are still under development. As a result, the used simplification might not be in line with future NS policies.

The system of hubs in the prospect of NS might be suitable to deviate travellers over various stations, in case multiple are present in an area. By doing so, better utilisation can be generated and capacity shortage limited. Both Molin & Maat (2015) and Van Mil et al. (2018) investigated the impact of nearby stations on the WTP. Bike-train users are willing to pay €0.60 per avoided transfer and €0.11 for a minute less cycling time. This is especially applicable for bigger cities, where both intercity and suburban stations are present.

Generalisability
During this research, the focus was on the Dutch bike-train system. However, issues with bicycle parking are not only occurring at train stations. (Arbis et al., 2016; Fietsersbond, n.d.; Molin & Maat, 2015). Municipalities are also wondering how best to operate the bicycle parking facilities in city centres. Aspects like the need for supervision and pricing policies are relevant for other parking facilities as well. Also, the experience might show similar factors of influence. The users' trade-offs may be similar. Mainly the trip purpose and parking duration will be important characteristics of influence on willingness to pay. Therefore, to calculate the average WTP, the variation in user population should be considered.
To be able to use the findings in other countries, the model should be extended. Previous research indicated that the success of the bike-train combination is dependent on both the environment of the facility and the familiarity with biking as a transportation mode (Shelat et al., 2018). Considering these aspects improves the representation of reality and therefore might help to use the findings in other countries as well. Both existing literature (Monsuur et al., 2017) and this research indicate a higher WTP for people who are unfamiliar with the parking facility. However, it is expected that the WTP will be lower as the margin to use the bike as access mode is smaller.

10.3. Recommendations
This section is subdivided into two parts, recommendations for policy and future research. The policy recommendations include aspects which NS should consider based on the findings of this research. To get a full overview, some more research is required. To broaden the knowledge regarding guarded parking facilities and their users further, recommendations for future research are provided.

Policy
Given the findings of the studies, a couple of recommendations for practice can be made. Several aspects are identified who impact the experience of facility users. As the opinion of the travellers is important to NS, the quality of the facility must be closely monitored. With various surveys, they are doing this very well. Their policy contributes to the increasing quality of the facilities. As a result, more travellers are getting attracted to the bike-train mode combination. To offer a complete system, it is advisable to offer guarded parking at every station. Currently, at stations with a demand below

200 guarded facility users, only lockers with a subscription are present. These are not accessible for travellers with a low travel frequency, who are the ones with a strong preference for bike safety. The option to make them available for daily usage is recommended and is currently investigated by NS. This lower the threshold for train travellers who don't access the station by bike because of the fear of bicycle theft (Rietveld, 2000).

Elderly are feeling less attracted to self-service bike parking's and prefer staff being present to be able to ask for help. However, at self-service parking facilities, this is also possible, as there is an intercom with a direct connection to a help desk. Improving the communication regarding the entrance system and the intercom system might lower the boundaries for older travellers. Promoting the self-service bike parking facility well will result in more users.
Getting people familiar with the guarded facility will have a positive impact as well. A big difference is found in the opinion of current bike-train users between the ones who park unguarded against the ones who park guarded. The guarded ones are much more positive regarding the various benefits and services. A free trial of a month can show those benefits to people who currently park unguarded. The limited additional effort might surprise some bike-train users, especially in comparison to the added comfort. However, some of them will still stick to their old habits.

The willingness to pay for the guarded facility is depending on the type of security. Most of the users are willing to pay more when staff is present. However, this does not apply to all bike-train travellers. The additional price must be explainable to the customer. This is also the case if an additional price is considered when a bike repair shop is present. Some travellers indicated to see the added value of this service. However, it is not justifiable to settle these costs with people who only park their bicycle. Therefore the implementation of this service in the pricing policy should be a well-considered decision.
The various opinions are also presented in the general WTP. Especially younger travellers have a low willingness to pay, as highlighted by Molin & Maat (2015) as well. Integration of facility usage with their free travel card, paid by the government, could be considered. This keeps the bike-train combination accessible for students. However, the usage of the facility as a bike graveyard should be prevented as they do not experience any costs in this case. A reduction via the travel card might be a good compromise, as their willingness to pay is not set to zero. Also, the inclusion of other bike-train usages could be considered, as with a business card or a day trip ticket for recreational travellers.

With an increasing amount of bike-train users, the capacity must continue to meet the demand. A lack of it is a dissatisfier (Molin & Maat, 2015) and of impact on various factors determining the experience. The price policy is of impact on this demand. Currently, NS maintains a 24-hours free policy at guarded facilities. As a result, the majority of the users do not have to pay. An advantage of this system is the accessibility for day users, while long term parkers are discouraged. By only increasing the price, without adjusting the free period, long term parking is further discouraged. However, it might also scare short term users when they once in a while park for more than 24 hours, while additional revenue is limited. Therefore, adjusting the free period to 12-hours free might be considered. Day trips without additional costs are still possible for the customer. In order not to further discourage users who park for longer periods, the prices should be adapted as well. By lowering the price from €1.25 to €0.75, for a staffed facility, still, 60% of the users will choose for the guarded facility, but the utilisation might improve. The use of an increasing fee over time might also discourage long term parking.
Furthermore, differentiation of price over various facilities at one station of over various nearby stations might be considered to improve utilisation. Also within one facility, there can be differentiated based on walking time. The stated preference indicated the positive impact of a shorter walking time on the willingness to pay. This is also in line with the statements included in the survey. However, it also shows that not all users agree with price differentiation based on walking distance. Another way of improving utilisation is promoting shared bike usage.

Adjusting the pricing policy will also result in resistance. Communication about an adapted price policy to the customer will have a big influence on this. Other stakeholders should be taken into account when determining the final pricing policy. This entails the Ministry of Infrastructure and Water Management, Prorail, and municipalities, and as consumer representatives the Fietsersbond and Rover. The use of a pilot study is recommended before finalizing the policy.

Future research

This research extends the knowledge of elements influencing the experience of parking facility users. With a rho-square of 0.694 for the regression line to explain the experience, more aspects of influence are existing. One of the options is to include the personal characteristics and type of station into the regression line, as statistical analyses indicated a variation in experience over these aspects. But also more, unknown, factors might have an impact, as the size of the facility and types of racks used. In addition, this study focused on travellers on the access side. Hence, the variation in experience on the egress side is unidentified, even as when no train trip is performed at all. Additional research can be carried out to keep expanding the knowledge regarding parking facilities. This will improve the generalisability of this study as well. It is also of great interest to elaborate on how the experience of the bike-parking facility influences the experience of the entire train travel. The overall train-trip experience is currently measured with another ongoing data collection at the stations. However, the potential of these two data set is not fully utilised yet.

Next to the attributes regarding experience, not all attributes regarding the WTP are identified. The applied model, panel mixed logit model with nesting structure, has a rho-square of 0.387. A first improvement can be the use of a latent class model, where heterogeneity of the users is considered based on the findings of the data. Additionally, the factors influencing the experience (service, overview, appearance, accessibility, and bike security) are all set to a moderate level during this research. They might impact the WTP for a certain facility, as they also strongly vary over the various facilities. The impact should be further investigated. Additional research can be done on the impact of the environment, such as the accessibility of the station by bike and other local transport, the travel distance to the station and the types of buildings in the environment. But also the train connectivity and frequency should be investigated in more detail. This again contributes to an improved generalisability of this study. The aspects taken into account by other countries to determine the price of parking facilities near train stations might provide new insights as well. Also, lessons might be learned of how other public transport operators define the prices for their services. To what level do others take into account the willingness to pay of the different travellers and do they take the user experience into account.

Another interesting aspect to test is the impact of a non-linear pricing policy. Asking a higher fee over time might discourage long term parking. It is hard to conclude the effectiveness based on this research as the direct relationship of the pricing policy on the user experience is still unknown. As the feeling of accessibility is important to NS, this should be further investigated. It will result in a more detailed answer on the relationship with the demand as well. A certain price policy will influence the traveller's mode choice and therewith the utilization.

In the stated choice experiment, parking your bike in the public space was strongly discouraged because of strict control. However, this is not always the case, as current bike-train travellers will know. The level of supervision might also be of impact on the willingness to pay and can be further researched. As of last, the choice situations included both guarded and unguarded facilities. Additional research should reveal the change of the WTP in case only a guarded facility is present, which is already the case at some train stations. Also, other services which will increase the preference and willingness to pay for the guarded facility might exist. An option is the availability to reserve a parking spot. This can be just before you leave your home or, if you have a set weekly schedule, for more days in advance. The possibility of a private parking spot seemed to be less needed from the results of the survey. But maybe more elements exist.

The explorative research regarding the subscriptions showed that users are willing to accept a higher price than their WTP. This might indicate that respondents considered other aspects. It is known that users consider a subscription to be able to skip the check-out line at staffed facilities. In other facilities, a subscription is linked to a dedicated parking area, which is closer to the platform. Some users also like to have certainty about their monthly spending on parking. A subscription takes away any uncertainties. A more detailed investigation regarding subscription pricing is needed. This can start by investigating the current users and asking about their experiences. This might result in a better understanding of the motivation for taking a subscription. When determining new policies regarding subscription, the uncertainty of travel frequency after COVID-19 should be considered as well.

During this study, no significant influence of the type of station on the WTP is found, even though this was expected. On one hand, the availability and the competition with regional transport are of influence on the WTP. On the other hand, city centres are more attractive for cycling in comparison to suburbs. Asking for a high contribution at a rural sprinter station might have a bigger impact on the customer experience than at an intercity station in a city centre. The effects can be tested by either the use of a pilot study or the use of a simulation model. Puello & Geurs (2015) examined the impact of bicycle-train integration policies on train ridership and job accessibility for public transport users by extending the Dutch National Transport Model (NVM) for the Randstad South area. By doing this, a detailed bicycle network linked to the public transport network, access/egress mode combinations and station-specific access and egress penalties by mode can be considered. However, extending this model to the national level is extremely time-consuming, so it should only be considered on a regional level, to study local effects. Such a study also provides more insight into the shift of access/egress mode when the bike is no longer considered by a user.

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Appendix

A. Station typologies

Table A.1, Assignment of stations to category

CITY CENTRE INTERCITY (47)	SUBURBAN INTERCITY (5)	CITY CENTRE SPRINTER (19)	SUBURBAN SPRINTER (7)	RURAL SPRINTER (5)
Alkmaar	Alkmaar Noord	Baarn	Amsterdam Muiderpoort	Barendrecht
Almelo	Amsterdam Amstel	Beverwijk *	Hoofddorp	Heerhugowaard
Alphen aan den Rijn	Amsterdam Bijlmer ArenA	Bilthoven	Houten Castellum	Hoogeveen
Amersfoort	Amsterdam Sloterdijk	Castricum	Utrecht Overvecht	Steenwijk
Amsterdam Centraal	Amsterdam Zuid *	Culemborg	Utrecht Vaartsche Rijn	Zaltbommel
Apeldoorn		Emmen	Voorburg	
Arnhem Centraal *		Harderwijk	Wormerveer	
Assen		Hoorn		
Bergen op Zoom		Houten		
Breda		Kampen		
Delft		Maarssen *		
Hertogenbosch ('s)		Meppel		
Den Haag Centraal *		Naarden-Bussum		
Den Haag HS		Rijswijk		
Den Helder		Tiel		
Deventer		Weert		
Dordrecht		Weesp		
Ede-Wageningen		Zaandam *		
Eindhoven		Zwijndrecht		
Enschede				
Goes				
Gouda				
Groningen *				
Haarlem				
Heemstede-Aerdenhout				
Heerenveen *				
Heerlen				
Helmond				
Hengelo				
Hilversum				
Leeuwarden				
Leiden Centraal				
Lelystad Centrum				
Maastricht *				
Middelburg				
Nijmegen				
Oss				
Roermond				
Roosendaal				
Rotterdam Centraal *				
Schiedam Centrum				
Sittard				
Tilburg				
Utrecht Centraal *				
Venlo				
Vlissingen				
Woerden				
Zutphen				
Zwolle				

Stations marked with * experience high numbers of parking facility users who are not performing a train trip. However, it should be noted that the survey was distributed in September 2020, with COVID-19 restrictions were in place

B. Factor analysis

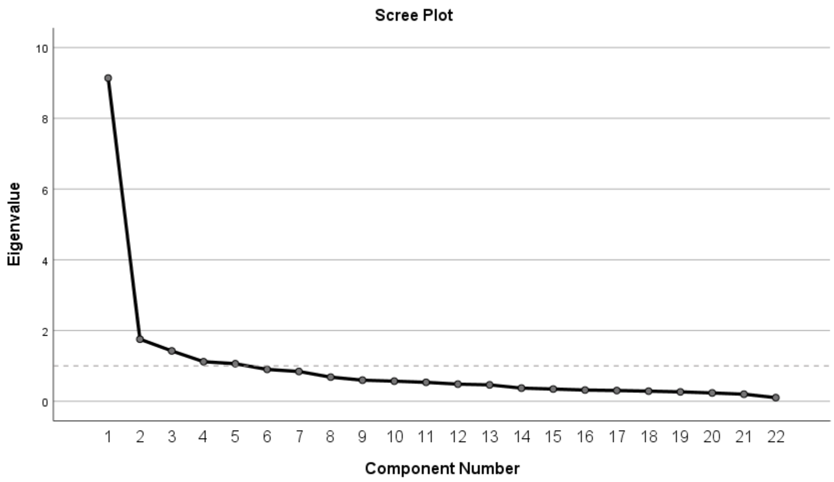

Figure B.1, Scree plot factor analysis

Table B.1, Structure matrix factor analysis

	Service	Overview	Appearance	Accessibility	Bike safety
Ik vind het personeel in deze fietsenstalling klantvriendelijk	,861		-,482		
Ik vind dat er voldoende personeel in deze fietsenstalling aanwezig is	,859		-,444		
Ik stel de aanwezigheid van personeel in deze fietsenstalling op prijs	,854		-,435	,448	
Ik voel me veilig in deze fietsenstalling	,793	,428	-,647	,468	
Ik kan gemakkelijk een plek vinden om mijn fiets te stallen		,864			
Ik heb een goed overzicht in deze fietsenstalling	,429	,830	-,502		
Ik ervaar het aantal beschikbare stallingsplekken in deze fietsenstalling als voldoende		,815			
Ik kan gemakkelijk mijn fiets terugvinden in deze fietsenstalling	,443	,709		,449	
Ik vind de borden die de weg aangeven in deze fietsenstalling duidelijk	,451	,660	-,496	,412	
Ik weet waar ik informatie kan inwinnen over deze fietsenstalling	,435	,552			
Ik vind dat deze fietsenstalling er verzorgd uitziet	,489	,434	-,941		
Ik ervaar deze fietsenstalling als schoon	,497		-,915		
Ik vind de uitstraling van deze fietsenstalling aantrekkelijk	,403	,463	-,877		
Ik ervaar de verlichting in deze fietsenstalling als prettig	,627	,407	-,747	,508	
Ik ervaar een goede prijs kwaliteit verhouding in deze fietsenstalling	,537	,427	-,412	,753	
Ik vind het stallen van mijn fiets in deze fietsenstalling goedkoop				,752	
Ik kan op ieder gewenst tijdstip deze fietsenstalling in				,667	
Ik ervaar de ingang van deze fietsenstalling als goed toegankelijk			-,464	,655	
Ik ervaar de huidige wijze van betalen voor deze fietsenstalling als gemakkelijk	,532			,639	
Ik ervaar de route van deze fietsenstalling naar de trein als prettig	,424	,435	-,488	,556	
Ik ben niet bang dat mijn fiets beschadigd raakt in deze fietsenstalling		,546	-,453		,613
Ik ben niet bang dat mijn fiets gestolen wordt in deze fietsenstalling	,489	,424	-,408		,594

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Table B.2, Correlation matrix factor analysis

	Service	Overview	Appearance	Accessibility	Bike safety
Service	1,000	,424	-,513	,466	,051
Overview	,424	1,000	-,469	,335	,060
Appearance	-,513	-,469	1,000	-,389	-,062
Accessiblity	,466	,335	-,389	1,000	,041
Bike Safety	,051	,060	-,062	,041	1,000

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Table B.3, Score coefficient matrix factor analysis

	Service	Overview	Appearance	Accessibility	Bike safety
Ik kan op ieder gewenst tijdstip deze fietsenstalling in	-,051	-,032	,012	**,327**	-,087
Ik ervaar de ingang van deze fietsenstalling als goed toegankelijk	-,028	-,001	-,064	**,249**	-,187
Ik kan gemakkelijk een plek vinden om mijn fiets te stallen	-,039	**,290**	,026	-,053	,068
Ik heb een goed overzicht in deze fietsenstalling	-,008	**,238**	-,018	,002	-,089
Ik vind de borden die de weg aangeven in deze fietsenstalling duidelijk	,028	**,166**	-,043	,042	-,281
Ik weet waar ik informatie kan inwinnen over deze fietsenstalling	,120	**,170**	,008	-,063	-,353
Ik kan gemakkelijk mijn fiets terugvinden in deze fietsenstalling	,023	**,192**	,037	,067	-,077
Ik ervaar de route van deze fietsenstalling naar de trein als prettig	-,002	,045	-,066	,166	-,205
Ik ervaar de huidige wijze van betalen voor deze fietsenstalling als gemakkelijk	,087	,006	,050	**,213**	-,084
Ik ervaar het aantal beschikbare stallingsplekken in deze fietsenstalling als voldoende	-,049	**,265**	,010	-,058	,142
Ik ben niet bang dat mijn fiets gestolen wordt in deze fietsenstalling	,065	,029	-,002	-,016	**,473**
Ik ben niet bang dat mijn fiets beschadigd raakt in deze fietsenstalling	-,018	,090	-,033	-,026	**,489**
Ik ervaar een goede prijs kwaliteit verhouding in deze fietsenstalling	,014	-,002	,034	**,257**	,243
Ik vind het stallen van mijn fiets in deze fietsenstalling goedkoop	-,054	-,053	,034	**,350**	,166
Ik stel de aanwezigheid van personeel in deze fietsenstalling op prijs	**,300**	-,034	,036	-,009	-,036
Ik vind dat er voldoende personeel in deze fietsenstalling aanwezig is	**,306**	-,006	,038	-,049	-,027
Ik vind het personeel in deze fietsenstalling klantvriendelijk	**,303**	-,009	,015	-,063	-,045
Ik voel me veilig in deze fietsenstalling	**,190**	-,025	-,071	-,016	,098
Ik ervaar de verlichting in deze fietsenstalling als prettig	,066	-,034	**-,167**	,052	-,022
Ik ervaar deze fietsenstalling als schoon	-,021	-,047	**-,304**	-,030	,024
Ik vind dat deze fietsenstalling er verzorgd uitziet	-,034	-,028	**-,314**	-,038	,006
Ik vind de uitstraling van deze fietsenstalling aantrekkelijk	-,065	,009	**-,297**	-,030	-,043

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Table B.4, Score Covariance matrix factor analysis

	Service	Overview	Appearance	Accessibility	Bike safety
Service	1,171	,804	1,060	,000	,616
Overview	,804	1,376	-,330	-,329	1,862
Appearance	1,060	-,330	2,937	-,223	,094
Accessiblity	,000	-,329	-,223	,970	-,495
Bike Safety	,616	1,862	,094	-,495	4,157

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

C. Score for factors at various types of stations by user characteristics

C.1. Mean scores of factors

Table C.1, Mean scores for factors to age categories

		<18	18-25	26-45	46-65	65+	Total
Service	City centre with IC	8,59	8,66	8,75	8,93	8,91	**8,77**
	Suburban with IC	8,91	8,59	8,66	8,93	8,81	**8,76**
	City centre with SP	8,77	8,95	8,72	9,11	9,09	**8,93**
	Suburban with SP	8,62	8,93	8,93	9,11	8,70	**8,93**
	Rural with SP	.	.	.	.	.	**.**
	Total	**8,63**	**8,69**	**8,75**	**8,95**	**8,91**	**8,79**
Overview	City centre with IC	7,16	7,20	7,25	7,39	7,33	**7,27**
	Suburban with IC	7,68	7,88	7,73	7,77	7,55	**7,76**
	City centre with SP	7,39	7,45	7,40	7,74	7,64	**7,54**
	Suburban with SP	7,34	7,47	7,88	7,37	7,57	**7,56**
	Rural with SP	7,07	6,60	6,57	6,91	6,26	**6,76**
	Total	**7,22**	**7,26**	**7,34**	**7,47**	**7,37**	**7,34**
Appearance	City centre with IC	7,79	7,97	7,80	7,83	7,96	**7,86**
	Suburban with IC	8,20	8,34	8,22	8,23	8,46	**8,25**
	City centre with SP	7,81	8,00	7,58	7,68	8,05	**7,77**
	Suburban with SP	7,76	7,82	7,77	7,63	8,25	**7,76**
	Rural with SP	8,06	7,82	7,47	7,38	7,47	**7,65**
	Total	**7,82**	**7,98**	**7,80**	**7,80**	**8,00**	**7,86**
Accessiblity	City centre with IC	8,40	8,41	8,23	8,29	8,21	**8,31**
	Suburban with IC	8,69	8,47	8,27	8,36	8,25	**8,35**
	City centre with SP	8,39	8,65	8,52	8,63	8,71	**8,58**
	Suburban with SP	8,61	8,78	8,48	8,46	9,16	**8,57**
	Rural with SP	8,70	8,34	8,31	8,55	8,48	**8,47**
	Total	**8,42**	**8,46**	**8,29**	**8,37**	**8,33**	**8,37**
Bike_security	City centre with IC	7,99	8,02	7,92	7,80	7,88	**7,92**
	Suburban with IC	8,75	8,47	8,34	8,09	7,98	**8,27**
	City centre with SP	8,12	8,17	7,81	7,89	7,97	**7,97**
	Suburban with SP	8,08	8,26	8,18	7,69	8,22	**8,04**
	Rural with SP	8,09	7,71	7,38	7,09	6,53	**7,48**
	Total	**8,05**	**8,07**	**7,95**	**7,81**	**7,87**	**7,94**

Table C.2, Mean scores for factors to gender

		man	woman	other	Total
Service	City centre with IC	8,71	8,83	9,01	**8,77**
	Suburban with IC	8,66	8,85	.	**8,76**
	City centre with SP	8,90	8,96	.	**8,93**
	Suburban with SP	8,91	8,92	.	**8,92**
	Rural with SP	.	.	.	**.**
	Total	**8,73**	**8,84**	**9,01**	**8,79**
Overview	City centre with IC	7,46	7,11	6,12	**7,27**
	Suburban with IC	7,87	7,68	3,60	**7,76**
	City centre with SP	7,71	7,39	7,03	**7,54**
	Suburban with SP	7,80	7,38	9,20	**7,57**
	Rural with SP	6,89	6,62	7,44	**6,76**
	Total	**7,52**	**7,19**	**6,27**	**7,34**
Appearance	City centre with IC	7,85	7,88	7,36	**7,86**
	Suburban with IC	8,24	8,26	.	**8,25**
	City centre with SP	7,82	7,73	8,13	**7,77**
	Suburban with SP	7,92	7,64	8,00	**7,76**
	Rural with SP	7,69	7,63	5,31	**7,65**
	Total	**7,87**	**7,85**	**7,38**	**7,86**
Accessiblity	City centre with IC	8,31	8,32	8,11	**8,31**
	Suburban with IC	8,37	8,34	.	**8,35**
	City centre with SP	8,67	8,49	9,59	**8,58**
	Suburban with SP	8,66	8,51	9,25	**8,57**
	Rural with SP	8,49	8,43	.	**8,46**
	Total	**8,39**	**8,36**	**8,29**	**8,38**
Bike_security	City centre with IC	8,01	7,84	6,81	**7,92**
	Suburban with IC	8,27	8,27	1,00	**8,26**
	City centre with SP	8,11	7,86	8,23	**7,98**
	Suburban with SP	8,33	7,81	9,16	**8,03**
	Rural with SP	7,69	7,24	7,49	**7,47**
	Total	**8,05**	**7,85**	**7,03**	**7,94**

Table C.3, Mean scores for factors to trip frequency

		4 days a week or more	1 to 3 days a week	1 to 3 days a month	6 to 11 days a year	3 to 5 days a year	1 to 2 days a year	less than 1 day a year	Total
Service	City centre with IC	8,74	8,81	8,82	8,86	8,58	8,89	9,10	**8,77**
	Suburban with IC	8,74	8,78	8,93	8,57	8,99	8,51	7,99	**8,76**
	City centre with SP	9,00	8,76	8,86	9,12	8,50	10,00	8,39	**8,94**
	Suburban with SP	8,92	8,88	8,71	9,34	9,01.	10,00	.	**8,92**
	Rural with SP	.	.	.	.	.	.	.	**.**
	Total	**8,77**	**8,81**	**8,83**	**8,87**	**8,61**	**8,84**	**8,99**	**8,79**
Overview	City centre with IC	7,27	7,24	7,26	7,26	7,26	7,57	7,54	**7,27**
	Suburban with IC	7,74	7,69	8,01	8,06	7,31	7,95	7,52	**7,76**
	City centre with SP	7,59	7,52	7,28	7,15	7,40	7,27	7,91	**7,55**
	Suburban with SP	7,37	7,84	8,02	8,18	8,25	7,07	9,00	**7,56**
	Rural with SP	6,81	6,58	7,23	5,77	7,69	3,34	9,18	**6,77**
	Total	**7,34**	**7,33**	**7,36**	**7,30**	**7,34**	**7,47**	**7,66**	**7,34**
Appearance	City centre with IC	7,77	7,90	8,11	8,29	7,98	8,35	8,79	**7,86**
	Suburban with IC	8,11	8,39	8,66	8,51	8,35	8,37	8,59	**8,25**
	City centre with SP	7,75	7,79	7,89	7,91	7,69	8,32	7,82	**7,77**
	Suburban with SP	7,58	7,94	8,35	8,43	8,57	7,76	8,14	**7,75**
	Rural with SP	7,69	7,62	7,53	7,36	8,11	3,86	8,23	**7,65**
	Total	**7,77**	**7,91**	**8,13**	**8,23**	**8,00**	**8,22**	**8,60**	**7,86**
Accessiblity	City centre with IC	8,30	8,36	8,32	8,26	8,05	8,11	8,50	**8,30**
	Suburban with IC	8,24	8,42	8,69	8,81	8,71	8,66	8,06	**8,35**
	City centre with SP	8,60	8,59	8,45	8,26	8,37	8,41	8,06	**8,59**
	Suburban with SP	8,41	8,79	9,26	8,99	8,76	7,84	7,35	**8,56**
	Rural with SP	8,53	8,54	8,18	7,97	8,86	4,57	7,90	**8,46**
	Total	**8,36**	**8,43**	**8,40**	**8,33**	**8,17**	**8,08**	**8,33**	**8,37**
Bike_security	City centre with IC	7,84	8,01	8,10	8,16	7,95	8,03	8,41	**7,92**
	Suburban with IC	8,21	8,23	8,68	8,23	7,72	9,00	8,74	**8,27**
	City centre with SP	7,97	7,99	7,82	8,29	7,98	8,88	8,00	**7,98**
	Suburban with SP	7,88	8,28	8,21	8,58	8,62	8,30	7,67	**8,03**
	Rural with SP	7,71	7,00	6,78	7,15	7,12	5,23	8,73	**7,49**
	Total	**7,89**	**8,01**	**8,08**	**8,16**	**7,92**	**8,23**	**8,38**	**7,94**

Table C.4, Mean scores for factors to trip purpose

		from / to work	business trip	from / to school, study or cursus	visits to relatives / acquaintances	shopping	other	Total
Service	City centre with IC	8,81	8,79	8,63	9,02	9,06	8,89	**8,77**
	Suburban with IC	8,70	9,02	8,61	9,06	9,40	8,83	**8,75**
	City centre with SP	8,96	8,89	8,89	9,12	9,69	8,72	**8,93**
	Suburban with SP	9,05	8,33	8,74	9,19	8,52	8,19	**8,91**
	Rural with SP	.	.	.	.	.	.	**.**
	Total	**8,82**	**8,81**	**8,66**	**9,04**	**9,11**	**8,86**	**8,78**
Overview	City centre with IC	7,33	7,15	7,17	7,30	7,59	7,47	**7,27**
	Suburban with IC	7,68	8,09	7,78	8,05	9,01	8,27	**7,78**
	City centre with SP	7,61	7,27	7,47	7,46	8,09	7,65	**7,55**
	Suburban with SP	7,67	7,61	7,28	7,98	7,67	7,54	**7,57**
	Rural with SP	6,98	5,69	6,67	6,66	7,60	5,47	**6,77**
	Total	**7,42**	**7,25**	**7,21**	**7,38**	**7,74**	**7,53**	**7,35**
Appearance	City centre with IC	7,74	8,04	7,91	8,09	8,24	8,25	**7,86**
	Suburban with IC	8,13	8,89	8,17	8,51	9,31	8,63	**8,24**
	City centre with SP	7,63	7,82	7,94	7,76	8,68	8,00	**7,77**
	Suburban with SP	7,62	8,37	7,85	8,71	7,94	7,83	**7,75**
	Rural with SP	7,55	6,07	7,90	7,98	8,00	7,43	**7,68**
	Total	**7,74**	**8,07**	**7,92**	**8,10**	**8,35**	**8,21**	**7,86**
Accessiblity	City centre with IC	8,24	8,29	8,39	8,36	8,42	8,47	**8,31**
	Suburban with IC	8,23	8,99	8,38	8,58	9,56	8,64	**8,35**
	City centre with SP	8,56	8,66	8,60	8,61	9,22	8,54	**8,58**
	Suburban with SP	8,48	8,79	8,71	9,07	8,90	8,77	**8,58**
	Rural with SP	8,51	5,54	8,47	8,60	8,53	8,78	**8,45**
	Total	**8,31**	**8,38**	**8,44**	**8,44**	**8,60**	**8,51**	**8,37**
Bike_security	City centre with IC	7,81	8,12	8,00	8,15	7,99	7,99	**7,92**
	Suburban with IC	8,11	8,92	8,57	8,37	8,45	8,47	**8,26**
	City centre with SP	7,88	8,00	8,14	7,97	8,53	7,86	**7,98**
	Suburban with SP	7,96	8,37	8,12	8,78	8,22	7,66	**8,04**
	Rural with SP	7,48	4,69	7,73	7,31	7,50	6,54	**7,51**
	Total	**7,85**	**8,13**	**8,04**	**8,15**	**8,10**	**7,97**	**7,94**

Table C.5, Mean scores for factors to parking duration

		0 to 24 hours	24 to 48 hours	langer dan 48 uur	Total
Service	City centre with IC	8,79	8,64	8,70	**8,77**
	Suburban with IC	8,73	8,72	9,05	**8,76**
	City centre with SP	8,95	8,82	9,10	**8,96**
	Suburban with SP	8,91	9,14	8,95	**8,92**
	Rural with SP	.	.	.	**.**
	Total	**8,80**	**8,68**	**8,77**	**8,79**
Overview	City centre with IC	7,25	7,22	7,46	**7,27**
	Suburban with IC	7,72	7,64	8,13	**7,76**
	City centre with SP	7,53	7,68	7,67	**7,55**
	Suburban with SP	7,64	7,33	6,93	**7,58**
	Rural with SP	6,76	6,21	7,57	**6,78**
	Total	**7,33**	**7,28**	**7,52**	**7,34**
Appearance	City centre with IC	7,84	7,90	7,95	**7,86**
	Suburban with IC	8,23	8,15	8,44	**8,25**
	City centre with SP	7,78	7,72	7,72	**7,78**
	Suburban with SP	7,78	7,84	7,52	**7,76**
	Rural with SP	7,68	6,19	8,41	**7,66**
	Total	**7,85**	**7,85**	**7,94**	**7,86**
Accessiblity	City centre with IC	8,32	8,24	8,23	**8,31**
	Suburban with IC	8,41	8,13	8,12	**8,35**
	City centre with SP	8,61	8,36	8,33	**8,58**
	Suburban with SP	8,61	8,62	8,23	**8,58**
	Rural with SP	8,45	8,31	8,71	**8,46**
	Total	**8,39**	**8,27**	**8,24**	**8,37**
Bike_security	City centre with IC	7,89	7,89	8,14	**7,92**
	Suburban with IC	8,28	7,96	8,27	**8,26**
	City centre with SP	7,97	8,01	8,18	**7,98**
	Suburban with SP	8,07	8,32	7,42	**8,04**
	Rural with SP	7,46	7,39	8,06	**7,48**
	Total	**7,93**	**7,92**	**8,11**	**7,94**

C.2. Deepening of the findings

User characteristics

In the KBM, age and gender are the only known demographics of the users. Regarding their travel behavior, the trip purpose, travel frequency and parking duration are known. The distribution of these characteristics is already elaborated in chapter 4**Error! Reference source not found.**. Relations between several characteristics were revealed as well. These will also be discussed in this analysis, even as some findings from literature.

Parking Service

The first factor to consider is regarding the parking service. In general, this is higher appreciated by women than men. The difference in mean is 0.11, and is significant. Furthermore, an variation in service appreciation can be found for the age of the users. Older users have a higher appreciation for the parking service. This is as expected because in general older people are more demanding for assistance. However, the category of 65+ has a little lower score than the category of 46-65. This is surprising and can not be further explained.

For the trip purpose, a higher mean score can be found for people travelling with a leisure purpose. Unfortunately, no significant relationship can be found for the parking duration and trip frequency. Especially the last one is against expectations. By comparing the means, an increase can be found while the trip frequency decreases. Only a clear drop is visible for the respondents who travel between 3 to 5 days a year. Another reason for the lack of significance might be the low number of respondents for infrequent travellers.

Parking Overview

The second factor to discuss is the overview. Similar as found in literature, women do have a lower appreciation for the overview. Regarding age, the same pattern as for service appears. Against expectations, the score for overview increases with the age, with an exception of 65+. From literature it became clear that in general younger people and frequent travellers are more likely to be in a hurry to catch a train. The time taken by older people to park their bike, and therefore being less bothered by fewer available places, might be related to this score. This also applies to people who tend to park for a longer period or to perform a leisure related trip. Unfortunately, no significant findings appear for the score of overview regarding the travel frequency. The scores for high and medium frequent travellers is about the same (7.34). Only infrequent travellers score higher with an average of 7.51. However, this group of respondents is too small to draw conclusions.

Parking Appearance
No significant difference can be found in the score for appearance between men and women, even though a lower score for women was expected from literature. Also the average score for appearance within each age category is against expectations. The average of all groups is 7.86. Travellers below 18 or between 26-65 score slightly lower. However 18-25 and 65+ score significant higher with respectively 7.98 and 8.00. No direct explanation can be found.
The variation in the score for appearance at age also appears in the means of the trip purpose. School commuters scores higher than work commuters. However, it still can be concluded that leisure-related trips score in general higher than obligatory trips. The trip frequency substantiates this finding. Travellers with a high trip frequency have on average a lower score for appearance. As of last, no significant findings for parking duration are present.

Parking Accessibility
Similar to the mean score of overview, it is hard to draw conclusions for the mean score of accessibility by comparing age categories. It becomes clear that young travellers (below 25) have a higher grading than older people (8.45 against 8.32). But no clear line becomes visible. However, a significant difference can be found between each group. There against, no significant difference can be found in the score for accessibility between men and women (8.39 to 8.36).
Luckily some conclusions can be drawn from the trip related characteristics. The score for accessibility decreases when the trip frequency reduces (from 8.43 to 8.08), as expected. Infrequent users might be less familiar with the systems, for example for paying. However, because of the low respondents of people using the facility less than 2 days a year, the value for significance is 0.079. As expected, the score for accessibility also decreases when the facility is used for a longer period of time (8.39 when parking less than 24 hours and 8.24 when more than 48 hours). This is caused by the price that needs to be paid for parking, sometimes after 24 hours. A significant negative correlation can be found for the pricing attributes by performing a t-test between the statements of this factor. So an increase in parking duration results in a lower score for the pricing and therefore accessibility.

Parking Bike security
The scoring for bike security is matching the findings from the literature. First of all, older people have a lower grading than younger people. Again elderly (65+) are a bit off. Also, women score lower than men. The travel related attributes are as expected but need some further explanation. When comparing the trip frequency, similar findings can be done compared to the overview. A decrease in trip frequency results in a higher mean score, with an exception to parking your bike between 3 to 5 days a year. However, now the differences can be marked as significant. Furthermore, people who park their bike less than 24 hours are almost equal to people parking their bike between 24 and 48 hours (7.92). A big difference is shown whit users who park their bike for more than 48 hours. They value the bike security with an average score of 8.1, which is a significant difference. The difference might be explained by the reversed reasoning. Because people have a high appreciation for the security of their bike, they are willing to park their bike for more than 48 hours, otherwise they would have chosen another mode to access the station. In the user analysis, it was already shown that mainly users going to work or school are the ones who park their bike more than 48 hours, so probably owners of a second bike on the activity end.
The trip purpose tends to e a combination of trip frequency and age. Frequent trip purposes as commuting score lower than low frequent purposes as visits. The score for young people, who go to school, is slightly higher than for work commuters (7.85 against 8.03).

Station typology
The distribution of the typologies is aimed at the function of the station in its surrounding. On the other hand, the factors tell something about the experience inside the station. This analysis aims to find relations between the two. When performing the analysis, it has to be kept in mind that suburban

and rural stations only consists of a few stations, and are therefore sensitive for outliers. If situations occur, it is discussed in the text.

Parking Service
Again, the first factor to access is the service. Clearly, a higher mean score for service is provided for sprinter stations (8.93 against 8.76 for IC). When staff is present, they are mainly located at the entrance. When the facility becomes bigger, not necessarily more staff is needed for operational reasons and therefore the ratio of staff per spots decreases.

Parking Overview
The factor overview is harder to discuss as strong deviations in the outcomes occur. Overview is mainly depending on the capacity of a facility and if it is sufficient. For example, Amsterdam Muiderpoort (suburban with sprinter) and Steenwijk (rural with sprinter) are known for their capacity problems. As rural stations with sprinter connection (6.76) only includes five stations, the impact is significant. Remarkable is also the lower score for intercity stations located in city centres (7.27). Again several stations with capacity problems have a low score (< 7.0). The sizing of the facilities is here of influence as well.

Parking Appearance
For the appearance, similar outliers occur as in the scoring of overview. This is caused by the earlier proven correlation of available spots. Facilities at intercity stations in suburban areas score relatively high (8.25), which might be caused by relatively new parking facilities. Furthermore, sprinter stations tend to score lower (7.77) than intercity stations in city centres (7.86).

Parking Accessibility
For accessibility, a clear difference can be found in the mean scores. Stations in city centres in general ask a higher price (after 24 hours of parking), which results in a lower grade (8.30 for city centre and 8.40 for suburban stations). Sprinter stations score the highest (8.58 for city centre and 8.57 for suburban). These are in general the facilities who are located in small cities but use the same pricing policy as rural stations. Therefore rural stations might have a slightly lower score (8.47). The score also increases towards smaller stations, at these locations more often ZSF facilities occur. It suggests that accessibility is not strongly influenced by the entrance system. This was already imposed by employees of NS stations. An independent t-test confirms these findings.

Parking Bike Security
The last factor to check is the bike security. No significant difference can be found for four out of five station types, with a score around 7.94. It is already shown before that the deviations in bike security are small because it only considers two variables. Stations located in rural areas have the lowest score (7.49). This can be explained by the fact that they are all ZSF parking facilities and in general have capacity problems, which result in densely parked bikes. Also train frequency was suggested in literature to be of influence.

Overall variation
The first characteristic is age. For parking services, a higher variation occurs at stations located in city centres. When the score for appearance was accessed, a drop was shown for travellers between 26 and 65 years. This occurs for every type of station and can not be further explained.
Remarkable is the variation for accessibility in both types of station and age. It appears that for younger people the price might be more important when grading the accessibility, while for older people, the entrance seems to be of more influence. When looking into the scores of bike security, it appears that older people do have a stronger preference for staffed facilities and a higher dislike for camera protected facilities than younger people do.

Women tend to be more constant about the grading of parking service at the different type of stations than men. Furthermore, the experience of security of a parked bike seems for women to be more depending on the presence of staff. For overview, appearance and accessibility no clear variation is found.

Up next are the travel characteristics. First, we consider the trip frequency. Before it was reported that the score for service dropped when travellers travelled between 3 to 5 days a year. This mainly occurs at stations located in city centres. The response rate of infrequent travellers at sprinter stations is too low for further conclusions. Previously, trip frequency did suggest that the score for accessibility is both influenced by the price and the familiarity with the entrance. Combining the analysis shows more complex cohesion. A deviation can be made between the pricing, where intercity stations are more expensive than sprinter and the paying system. Frequent travellers tend to be more influenced by the pricing policy, and infrequent travellers by the way of entering the facility. Also in case of the bike security, staffed facilities score higher in the case of infrequent trips. This is as expected because travellers would otherwise consider an alternative access mode. For the factors overview and appearance, no further conclusions can be drawn.

Often related to the trip frequency is the trip purpose. For service, it was already known that leisure activities score higher, even at smaller stations. This also becomes clear at this analysis. Remarkable is the high score for people going to or from their work at suburban sprinter stations, the main users. On each type of station, the leisure activities score higher for overview and appearance. When looking at the accessibility, especially smaller stations used for leisure activities are highly appreciated, although this has a relatively low number of respondents. However, also sprinters stations receive a good score by commuters. The rural stations by business users, which scores 5.54, is graded by only nine people so hard to draw strong conclusions.

As of last we are looking into the variation in case of parking duration. Only a few people have parked their bike on suburban and rural sprinter stations for more than 24 hours. Therefore they can not be evaluated. No other conclusions than before can be drawn regarding the factors related to parking duration and station type.

D. Experimental design

D.1. Input pilot survey

The Ngene syntax used for the pilot survey is presented:

```
design
; alts = paid, free, other
; rows=12
; eff = (mnl,d)
; con
; model:
U(paid)=b0[5.4]+ sur.dummy[0.6]*sur[1,0] +rep.dummy[0.1]*repair[0,1] +
     price.dummy[-1.8|-1.5|-1.0] * price[2.5,1.75,1.00,0.25] +
     fp.dummy[-1.1|-0.5] *fp[0,12,24]  +b6[-0.2]*WTPaid[1,2,3] /
U(free)=b7[5.0]+b6*WTfree[2,3,4]+ shelter.dummy[0.3]*shelter[1,0]
$
```

Table D.1, Coding experimental design pilot survey

Choice situation	Paid facility					Free facility	
	Guarded	Repair shop	Price	Free Period	Walking Time	Walking Time	Shelter
1	1	1	2.5	24	1	4	0
2	0	0	1.75	0	2	3	0
3	0	0	0.25	24	3	2	0
4	1	0	1.75	24	1	4	1
5	1	1	0.25	0	3	2	1
6	1	0	2.5	0	2	3	1
7	0	1	0.25	12	1	4	1
8	1	0	1	12	2	3	0
9	0	1	1	24	3	2	1
10	0	1	1	0	1	4	0
11	0	0	2.5	12	2	3	1
12	1	1	1.75	12	3	2	0

D.2. Input final survey

To compose the experimental design of the final survey, the data of the pilot survey is used. In total, 55 respondents filled it out. Table D.2 shows the characteristics of the respondents. Remarkable is the high age of the respondents. Also a higher share than usual is performing leisure related trips. It is known from the NS Panel that members with these characteristics are more willing to fill in questionnaires. This will be taken into account when requesting the final group of respondents.

Table D.2, Descriptive statistics of respondents pilot survey

Number of respondents	55
Age	<25: 13% 25-44: 2% 45-64: 57% 65+ : 25%
Gender	Male: 46% Female:54%
Train travel frequency	Heavy: 64% Medium: 20% Low: 16%
Trip purpose	Work: 36% School: 13% Business: 16% Leisure: 35%

Based on the responses of the pilot survey, an initial model for the utility is estimated. The MNL model is eventually used to compose the final experimental design. The following utility functions are used:

$$V_{PAID} = \beta_{0\_PAID} + \beta_{SS} * SUR_{STAFF} + \beta_r * Repair + \beta_{PP} * PP + \beta_{FP} * FP + \beta_{WT} * WT_{Paid}$$
$$V_{FREE} = \beta_{0\_FREE} + \beta_{cov} * COVERED + \beta_{WT} * WT_{Free}$$
$$V_{OTHER} = 0$$

In which:

β_i = The parameters of the attributes
SUR_{STAFF} = Dummy variable for the surveillance by staff (1) or camera (0)
$Repair$ = Dummy variable for the presence of a bike repair shop (1) or not(0)
PP = parameter for parking price
WT_{Paid} = parameter for walking time in Paid facility
WT_{Free} = parameter for walking time in Free facility
$COVERED$ = Dummy variable for covered parking facility (1) or not (0)

The estimation report resulting from Biogeme are presented in Table D.3. The estimated values are presented in Table D.4. All parameters could be estimated with a values direction (positive or negative) as expected. Some attributes were of slight less impact as estimated in the initial model. The presence of a repair shop, shelter for the outdoor facilities, presence of staff and the walking time all resulted in insignificant results. This is no further reason for concern as only 55 people filled in the pilot. In the final experimental design Bayesian coefficient will be used, which cover these uncertainties.

Table D.3, Estimation report MNL

Number of estimated parameters:	8
Sample size:	672
Excluded observations:	0
Init log likelihood:	-738.267
Final log likelihood:	-551.990
Likelihood ratio test for the init. model:	372.556
Rho-square for the init. model:	0.252
Rho-square-bar for the init. model:	0.241
Akaike Information Criterion:	1.119.979
Bayesian Information Criterion:	1.156.061

Table D.4, Values MNL model pilot

Name	Value	Std err	t-test	p-value
ASC_A	2.395	0.285	2.26	0.02
ASC_B	1.75	0.250	-7.01	0.00
B_COST	-0.255	0.0843	-3.02	0.00
B_FP	0.0392	0.00837	4.68	0.00
B_REP	0.130	0.175	0.74	0.46*
B_SHELTER	0.0893	0.169	0.53	0.60*
B_SUR	0.173	0.170	1.01	0.31*
B_WT	-0.0855	0.0564	-1.52	0.13*

The Ngene syntax used for the final survey is as follows:

```
design
; alts = paid, free, other
; rows=12
; eff = (mnl,d,mean)
; con
; model:
U(paid)= b0[(n,2.40,0.285)]+ sur.dummy[(n,0.17,0.17)]*sur[1,0]
                            + rep.dummy[(n,0.13,0.17)]*repair[0,1]
                            + b1[(n,-0.26,0.08)] * price[0.25,1.00,1.75,2.5]
                            + b2[(n,0.039,0.01)] *fp[0,12,24]
                            + b3[(n,-0.09,0.06)]*WTPaid[1,2,3] /
U(free)= b4[(n,1.75,0.25)] + b3*WTfree[2,3,4]
                            + shelter.dummy[(n,0.09,0.17)]*shelter[1,0]
$
```

Table D.5, Coding experimental design final survey

Choice situation	**Paid facility**					**Free facility**	
	Guarded	Repair shop	Price	Free Period	Walking Time	Walking Time	Shelter
1	1	0	2.5	12	2	3	1
2	1	1	2.5	0	1	4	0
3	0	0	1.75	0	3	2	1
4	1	1	1.75	24	3	2	1
5	1	0	0.25	12	2	3	0
6	0	1	0.25	0	1	4	1
7	0	1	1	24	2	3	1
8	0	0	1.75	12	1	4	0
9	0	1	2.5	24	3	2	0
10	1	1	0.25	0	3	2	0
11	0	0	1	12	2	3	0
12	1	0	1	24	1	4	1

Table D.6, MNL probabilities

Choice situation	**Paid facility**	**Free facility**	**Opt out**
1	0.64	0.30	0.06
2	0.55	0.36	0.09
3	0.49	0.43	0.08
4	0.72	0.23	0.04
5	0.77	0.18	0.04
6	0.64	0.30	0.07
7	0.76	0.20	0.04
8	0.70	0.24	0.06
9	0.66	0.28	0.06
10	0.62	0.32	0.07
11	0.71	0.24	0.05
12	0.83	0.14	0.03

E. Final Survey

This appendix only shows the text and the figure of the questions asked during the survey. The online survey was presented according to the template of NS-panel. Question 6 till 17 are the same questions, only a different picture is shown. Question 36-56 also represents similar questions. The free period and price differs, as presented in Figure 8.2, Adaptive choice experiment.

1	Met welk doel heeft u (in het jaar voor COVID-19) binnen Nederland het vaakst met de trein gereisd?

- ○ Van en naar mijn werk / vrijwilligerswerk
- ○ Zakenreis / dienstreis
- ○ Van en naar school, studie, opleiding, stage
- ○ Bezoek aan familie / kennissen
- ○ Voor hobby, sport, verenigingsbezoek
- ○ Dagje uit, winkelen
- ○ Anders

2	Het vertrekstation indien ik met de fiets naar het station zou gaan (in het jaar voor COVID-19), heeft een ... verbinding

- ○ Sprinter
- ○ Intercity en sprinter

3	Het vertrekstation indien ik met de fiets naar het station zou gaan (in het jaar voor COVID-19), ligt ...

- ○ In het centrum van een (kleine) stad
- ○ In de buitenwijk van een stad of aan de rand van een stad
- ○ In een dorpse omgeving of het buitengebied

4	De komende 12 vragen gaan over het stallen van uw fiets bij een niet-bestaand station. We vragen u voor te stellen dat u met de fiets naar het station gaat. U kunt kiezen tussen twee fietsenstallingen, ieder met andere kenmerken (die per vraag worden gevarieerd). Indien beide opties voor het parkeren van uw fiets niet naar tevredenheid zijn, kunt u kiezen om niet met de fiets naar het station te reizen maar met een ander alternatief. Het station ligt op fietsbare afstand in [{Locatie}] en heeft een [{Verbinding}] verbinding. U reist [{Motief}].

5	De drie mogelijke opties waartussen u moet kiezen zien er als volgt uit: A) Dit is een fietsenstalling die bewaakt en betaald is. De genoemde prijs betaalt u per dag (24 uur). De stalling is binnen en voorzien van digitale informatie over beschikbare plekken, waardoor u snel een beschikbare plek kunt vinden. Verder is er altijd de mogelijkheid om via een intercom te spreken met een service medewerker, wanneer deze niet in de stalling aanwezig is. Deze stalling heeft daarnaast een nette uitstraling en is overzichtelijk.

B) Dit is een gratis buiten fietsenstalling. Deze stalling wordt veel gebruikt en is vaak voller. Hier is geen informatie beschikbaar over beschikbare plekken, dus u zult zelf moeten zoeken naar een plekje. Door de drukte kan dit wat langer duren.

C) De twee fietsenstallingopties zijn niet naar uw wens en u zal in deze situatie niet met de fiets naar het station reizen.

6

Stelt u zich de volgende keuze situatie voor. Waar zou u uw fiets parkeren?
Het station waar u uw fiets parkeert ligt in [{Locatie}] en heeft een [{Verbinding}] verbinding. U reist [{Motief}].

- ◯ Ik zou in fietsenstalling A parkeren
- ◯ Ik zou in fietsenstalling B parkeren
- ◯ Ik zou niet met de fiets naar het station reizen

7

8

Fietsenstalling A	Fietsenstalling B
	
Binnen Bewaakt - camera en toegangspoort	Buiten - overdekt Onbewaakt
3 min. naar perron	2 min. naar perron
0 uur gratis, €1,75 per dag	Gratis

9

Fietsenstalling A	Fietsenstalling B
	
Binnen Bewaakt - personeel aanwezig	Buiten - overdekt Onbewaakt
Reparatie punt aanwezig	
3 min. naar perron	2 min. naar perron
Eerste 24 uur gratis, daarna €1,75 per dag	Gratis

10

Fietsenstalling A	Fietsenstalling B
	
Binnen Bewaakt - personeel aanwezig	Buiten Onbewaakt
2 min. naar perron	3 min. naar perron
Eerste 12 uur gratis, daarna €0,25 per dag	Gratis

11

Fietsenstalling A	Fietsenstalling B
	
Binnen Bewaakt - camera en toegangspoort	Buiten - overdekt Onbewaakt
Reparatie punt aanwezig	
1 min. naar perron	4 min. naar perron
0 uur gratis, €0,25 per dag	Gratis

12

Fietsenstalling A	Fietsenstalling B
	
Binnen Bewaakt - camera en toegangspoort	Buiten - overdekt Onbewaakt
Reparatie punt aanwezig	
2 min. naar perron	3 min. naar perron
Eerste 24 uur gratis, daarna €1,00 per dag	Gratis

13

Fietsenstalling A	Fietsenstalling B
	
Binnen Bewaakt - camera en toegangspoort	Buiten Onbewaakt
1 min. naar perron	4 min. naar perron
Eerste 12 uur gratis, daarna €1,75 per dag	Gratis

14

Fietsenstalling A	Fietsenstalling B
	
Binnen Bewaakt - camera en toegangspoort	Buiten Onbewaakt
Reparatie punt aanwezig	
3 min. naar perron	2 min. naar perron
Eerste 24 uur gratis, daarna €2,50 per dag	Gratis

15

Fietsenstalling A	Fietsenstalling B
	
Binnen Bewaakt - personeel aanwezig	Buiten Onbewaakt
Reparatie punt aanwezig	
3 min. naar perron	2 min. naar perron
0 uur gratis, €0,25 per dag	Gratis

16

Fietsenstalling A	Fietsenstalling B
	
Binnen Bewaakt - camera en toegangspoort	Buiten Onbewaakt
2 min. naar perron	3 min. naar perron
Eerste 12 uur gratis, daarna €1,00 per dag	Gratis

17

Fietsenstalling A	Fietsenstalling B
	
Binnen Bewaakt - personeel aanwezig	Buiten - overdekt Onbewaakt
1 min. naar perron	4 min. naar perron
Eerste 24 uur gratis, daarna €1,00 per dag	Gratis

18 U heeft aangegeven niet met de fiets naar het station te reizen. Wat voor alternatief zou u hebben gekozen?

- ◯ Ik zou op een andere manier naar het station komen
- ◯ Ik zou de fiets op een andere plek in de buurt van het station parkeren, met het risico dat mijn fiets wordt verwijderd door de gemeente
- ◯ Ik zou de treinreis niet maken

19 Wat zou u doen als er alleen een fietsenstalling is die bewaakt is en waarvoor u moet betalen (na de 1e 24u gratis te kunnen stallen)?

- ◯ Ik zou mijn fiets in de bewaakte stalling parkeren
- ◯ Ik zou mijn fiets op een andere plek in de buurt van het station parkeren, met het risico dat mijn fiets wordt verwijderd door de gemeente
- ◯ Ik zou op een andere manier naar het station komen
- ◯ Ik zou de treinreis niet maken

20 Geef aan in hoeverre u het eens bent met de volgende stellingen:

Het betalen voor bewaakt stallen van mijn fiets wordt aantrekkelijker wanneer...

	Zeer oneens	Oneens	Niet eens, niet oneens	Eens	Zeer eens	N.V.T	
Ik een eigen, vaste fietsparkeerplek heb	○	○	○	○	○	○	
Ik zeker ben van een fietsparkeerplek	○	○	○	○	○	○	
De looptijd naar het perron korter is dan vanaf de andere fietsparkeerplekken	○	○	○	○	○	○	
Ik mijn elektrische fiets kan opladen	○	○	○	○	○	○	

21 Dit was het eerste deel van het onderzoek. Nu volgen enkele vragen over uw fietsgebruik

22 Waar parkeert u meestal uw fiets bij het station waar u doorgaans op de trein stapt?

Mocht u door COVID-19 niet meer met de trein reizen, baseer uw antwoord dan op wanneer u nog wel met de trein reisde

- ○ In de bewaakte binnen stalling
- ○ In de onbewaakte buiten stalling
- ○ Ik kom niet met de fiets naar het station [>> Vraag 27.]

23 Hoe lang staat uw fiets meestal bij het station geparkeerd?

- ○ 0-12 uur
- ○ 12-24 uur
- ○ 24-48 uur
- ○ langer dan 48 uur

24 Staat uw fiets regelmatig gedurende (een deel van) de nacht bij het station geparkeerd?

- ○ Ja
- ○ Nee
- ○ Wisselend

25 Heeft u uw fiets wel eens naast de rekken of in de openbare ruimte geparkeerd?

- ○ Ja, regelmatig
- ○ Ja, soms
- ○ Nee [>> Vraag 27.]

26 Waarom parkeert u uw fiets soms buiten de rekken?

- ☐ Als ik geen plek kan vinden
- ☐ Als ik haast heb
- ☐ Als er al meer fietsen fietsen buiten de rekken geparkeerd staan
- ☐ De loopafstand tot het perron is korter
- ☐ Ik heb een fiets die niet in de rekken past
- ☐ Anders, namelijk...

27 Kunt u aangeven wat uw maximale gewenste looptijd is van uw fiets naar het perron, indien u in de onbewaakte fietsenstalling parkeert? ... minuten.

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7
- ☐ 8

28 Kunt u aangeven wat uw maximale gewenste looptijd is van uw fiets naar het perron, indien u in de bewaakte fietsenstalling parkeert? ... minuten.

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7
- ☐ 8

29 Is uw fiets wel eens beschadigd of gestolen terwijl deze in een fietsenstalling (binnen en/of buiten) bij het station geparkeerd stond?

- ○ Ja, gestolen
- ○ Ja, zwaar beschadigd
- ○ Ja, licht beschadigd
- ○ Nee

30 Wat voor soort fiets bezit u?

- ○ Elektrische fiets
- ○ Fiets met kinderzitje
- ○ Fiets met krat/rekje/mand/extra breed stuur
- ○ Ligfiets/bakfiets/tandem
- ○ Normale fiets
- ○ Anders

31 Hoe zuinig bent u op uw fiets?

- Heel erg zuinig
- Ik ga er netjes mee om
- Ik geef niet veel om mijn fiets

32 Hoe vaak verwacht u, na COVID-19, met de trein te reizen?

- 4 dagen per week of vaker
- 1 - 3 dagen per week
- 1 - 3 dagen per maand
- 6 - 11 dagen per jaar [>> Vraag 57.]
- 3 - 5 dagen per jaar [>> Vraag 57.]
- 1 of 2 dagen per jaar [>> Vraag 57.]
- Nooit [>> Vraag 57.]

33 Hoe vaak verwacht u, na COVID-19, met de fiets naar het station te komen

- 4 dagen per week of vaker
- 1 - 3 dagen per week
- 1 - 3 dagen per maand
- 6 - 11 dagen per jaar [>> Vraag 57.]
- 3 - 5 dagen per jaar [>> Vraag 57.]
- 1 of 2 dagen per jaar [>> Vraag 57.]
- Nooit [>> Vraag 57.]

34 Hoe lang verwacht u uw fiets meestal bij het station te parkeren?

- 0-12 uur
- 12-24 uur
- 24-48 uur
- langer dan 48 uur

35 Nu volgt het laatste onderdeel van deze enquête. Het gaat over het eventueel afsluiten van een fiets-parkeerabonnement. Dit betekent dat u zo lang kan parkeren als u wilt. De prijs van het abonnement varieert. Het gaat hierbij om een jaarabonnement dat u maandelijks kunt opzeggen. Lees de situatie goed door.

36 - 56 **U parkeert uw fiets in een stalling die met een camera is beveiligd en bereikbaar is via een toegangspoort. Verder is er altijd de mogelijkheid om via een intercom te spreken met een service medewerker. Parkeren is de eerste 24 uur gratis. Zou u een abonnement van €10,- per maand af sluiten? Het is een jaar abonnement dat al na de eerste maand, maandelijks opzegbaar is.**

- Ja [>> Vraag 37.]
- Nee [>> Vraag 38.]

57 **Dit is het einde van de enquête. Heeft u nog eventuele vragen of opmerkingen?** *Open vraag (groot)*

F. Exploration of provided answers

F.1. Personal characteristics - correlated attributes

The top row of each cell indicates the Pearson Chi-Square or Likelihood Ratio value, if the assumption for Chi-square is violated (e.g. >20%). The bottom row indicates the significance by showing the p-value. Correlation is emphasised by a green cell.

Table F.1, Correlation between user characteristics

	Gender	Education	Car	Type of bike	Frequency	Trip purpose	Parking duration	Weekend	Night	Careful	Current	Operation	Location
Age	16,991 0,009	61,784 0	15,093 0,002	68,697 0	66,164 0	20,971 0	56,249 0	40,161 0	68,694 0	2,931 0,817	28,429 0	7,343 0,062	4,25 0,643
Gender		9,047 0,171	1,331 0,514	20,028 0,029	4,273 0,64	6,788 0,034	3,646 0,888	0,228 0,892	10,046 0,04	3,872 0,424	4,11 0,128	1,032 0,597	5,059 2,81
Education			16,702 0,001	31,247 0,008	263,445 0	6,726 0,081	21,269 0,128	10,799 0,013	11,689 0,069	3,52 0,741	4,776 0,189	10,891 0,092	10,738 0,294
Car				14,169 0,015	18,568 0	7,636 0,006	38,962 0	16,277 0	26,256 0	0,216 0,898	2,826 0,093	3,311 0,191	11,454 0,01
Type of bike					28,781 0,017	5,599 0,347	49,418 0	4,884 0,43	35,281 0	18,296 0,05	57,618 0	3,134 0,679	9,735 0,464
Frequency						110,535 0	42,086 0	61,537 0	35,06 0	6,376 0,382	13,523 0,004	20,537 0	13,481 0,142
Trip purpose							71,828 0	94,506 0	39,354 0	0,805 0,669	5,146 0,023	5,174 0,075	2,775 0,428
Parking duration								46,102 0	616,89 0	3,997 0,947	100,198 0	27,699 0,002	39,252 0,001
Weekend									8,441 0,015	0,164 0,921	0,111 0,739	2,659 0,265	0,272 0,965
Night										0,719 0,949	98,146 0	7,876 0,096	13,16 0,041
Carefull											0,417 0,812	4,084 0,395	3,874 0,694
Current												35,519 0	42,353 0
Operation													778,651 0
Location													

F.2. Subscription results

Table F.2, Percentage of respondents willing to take subscriptions at a certain price, depending of provided free period

	24-hours free	12-hours free	0-hours free	Total
no subscription	38%	58%	64%	61%
2,5	62%	-	-	39%
5	38%	42%	-	37%
7,5	16%	25%	36%	33%
10	8%	17%	25%	23%
12,5	0%	15%	18%	16%
15	0%	6%	17%	14%
17,5	0%	4%	9%	8%
20	-	4%	5%	5%
22,5	-	-	2%	2%

Table F.3, Maximum accepted subscription price compared to user characteristics

	Gender			**Weekend**		**Current**		**Mandatory**		**Frequecy**		**Age**			
	Male	**Female**	**Other**	**Yes**	**No**	**Unguarded**	**Guarded**	**Yes**	**No**	**High**	**Medium**	**<25**	**25-45**	**45-65**	**65+**
None	62%	67%	33%	79%	63%	69%	55%	62%	69%	63%	63%	63%	63%	63%	63%
7,5	11%	10%	17%	5%	11%	11%	11%	11%	10%	15%	15%	15%	15%	15%	15%
10	7%	8%	17%	0%	8%	6%	9%	9%	3%	6%	6%	6%	6%	6%	6%
12,5	1%	1%	0%	0%	1%	2%	0%	1%	0%	0%	0%	0%	0%	0%	0%
15	7%	9%	0%	5%	8%	4%	14%	8%	8%	5%	5%	5%	5%	5%	5%
17,5	2%	4%	33%	5%	4%	3%	5%	4%	3%	5%	5%	5%	5%	5%	5%
20	4%	1%	0%	0%	3%	2%	3%	3%	0%	1%	1%	1%	1%	1%	1%
22,5	4%	0%	0%	5%	2%	3%	2%	1%	7%	5%	5%	5%	5%	5%	5%

G. Model results

G.1. Final Multinominal Logit

Biogeme syntax

```
import pandas as pd
import biogeme.database as db
import biogeme.biogeme as bio
import biogeme.models as models
from biogeme.expressions import Beta
from biogeme import *

# Read the data
df = pd.read_csv('Data_16_3_1.txt', '\t')
database = db.Database('pilot', df)

# allows to use the names of the variable as Python variable.
globals().update(database.variables)

# Removing non bike-train users
exclude = (Bike_AV ==0)
database.remove(exclude)

#[Beta] - Parameters to be estimated:
ASC_A           = Beta('ASC_A',0,-3000,3000,0)
ASC_B           = Beta('ASC_B',0,-30,30,0)
ASC_C           = Beta('ASC_C',0,-3000,3000,1)
B_SUR           = Beta('B_SUR',0,-1000,1000,0)
B_REP           = Beta('B_REP',0,-1000,1000,0)
B_COST_L        = Beta('B_COST_L',0,-1000,1000,0)
B_WT            = Beta('B_WT',0,-1000,1000,0)
B_SHEL          = Beta('B_SHEL',0,-1000,1000,0)
B_COST_FP       = Beta('B_COST_FP',0,-1000,1000,0)
B_FP_L          = Beta('B_FP_L',0,-1000,1000,0)
B_FP_Q          = Beta('B_FP_Q',0,-1000,1000,0)


#[Utilities]
Alt1 = ASC_A + B_SUR * paid_sur + B_REP * paid_repair + B_COST_L * paid_cost + B_FP_L * paid_fp
        + B_FP_Q * (paid_fp**2) + paid_cost * paid_fp  * B_COST_FP  + B_WT * paid_WTPaid
Alt2 = ASC_B + B_WT * free_wtfree + B_SHEL * free_shelter
Alt3 = ASC_C

#[Choice set and availability]
choiceset = {1: Alt1,2: Alt2,3: Alt3}
#availability = {1: availability1,2: availability2,3: availability3}

#[Model] -  MNL  // Logit Model
logprob = models.loglogit(choiceset,None,Choice)

# Create the Biogeme object
biogeme = bio.BIOGEME(database, logprob)
biogeme.modelName = 'MNL_Basis_Final'

# Estimate the parameters
results = biogeme.estimate()

# Get the results in a pandas table
pandasResults = results.getEstimatedParameters()
print(pandasResults)
pandasCorrelations = results.getCorrelationResults()
pandasCorrelations
pandasGeneralStat = results.getGeneralStatistics()
pandasGeneralStat
```

Estimation report

Number of estimated parameters: 10
Sample size: 6144
Excluded observations: 1344
Init log likelihood: -6749.874
Final log likelihood: -4278.333
Likelihood ratio test for the init. model: 4943.083
Rho-square for the init. model: 0.366
Rho-square-bar for the init. model: 0.365
Akaike Information Criterion: 8576.665
Bayesian Information Criterion: 8643.897
Final gradient norm: 2.2347E-02
Nbr of threads: 8
Algorithm: BFGS with trust region for simple bound constraints
Proportion analytical hessian: 0.0%
Relative projected gradient: 4.412955e-06
Number of iterations: 55
Number of function evaluations: 142
Number of gradient evaluations: 44
Number of hessian evaluations: 0
Cause of termination: Relative gradient = 4.4e-06 <= 6.1e-06
Optimization time: 0:00:01.212857

Estimated parameters

Table G.1, Estimated parameters MNL-model

Name	Value	Std err	t-test	p-value	Rob. Std err	Rob. t-test	Rob. p-value
ASC_A	3.57	0.146	24.5	0	0.145	24.6	0
ASC_B	3.02	0.104	29	0	0.104	29	0
B_COST_FP	0.0272	0.00426	6.38	1.8e-10	0.00424	6.4	1.51e-10
B_COST_L	-0.781	0.0514	-15.2	0	0.0512	-15.3	0
B_FP_L	0.0915	0.0169	5.42	5.86e-08	0.0171	5.36	8.31e-08
B_FP_Q	-0.00299	0.000605	-4.93	8.05e-07	0.000611	-4.88	1.04e-06
B_REP	0.145	0.085	1.71	0.088	0.0855	1.7	0.0896
B_SHEL	0.0679	0.061	1.11	0.266	0.0612	1.11	0.267
B_SUR	0.159	0.0571	2.79	0.00526	0.0572	2.79	0.00528
B_WT	-0.143	0.0193	-7.39	1.51e-13	0.0193	-7.38	1.57e-13

G.2. Multinominal logit with interaction

Table G.2, Dummy coding scheme for interaction effects

Attribute	Level indication		
Gender	Gender		
Male	1		
Female	0		
Age	Age1	Age2	Age3
<25	1	0	0
25-44	0	1	0
45-64	0	0	1
65+	**0**	0	0
Education	Education1	Education2	
HBO/WO	0	1	
MBO	1	0	
Primary/high school	0	0	
Car	Car		
Yes	1		
No	**0**		
Purpose	Purpose		
Mandatory	1		
Recreational	**0**		
Frequency	Frequency1	Frequency2	
Low	0	1	
Medium	1	0	
High	0	0	
Parking duration	Park_duration1	Park_duration2	Park_duration3
12-24	1	0	0
24-48	0	1	0
>48	0	0	1
0-12	**0**	0	0
Bike	Bike1	Bike2	
Electric	1	0	
Other	0	1	
Regular	0	0	
Weekend	Weekend		
Yes	1		
No	**0**		
Night	Night		
Yes	1		
No	**0**		
Current	Current		
Unguarded	1		
Guarded	0		
Location	Loc1	Loc2	
Rural	0	1	
Suburban	1	0	
CityCentre	**0**	0	
Operation	Oper		
Intercity	1		
Sprinter	**0**		

Biogeme syntax

```
import pandas as pd
import biogeme.database as db
import biogeme.biogeme as bio
import biogeme.models as models
from biogeme.expressions import Beta
from biogeme import *

# Read the data
df = pd.read_csv('Data_16_3_1.txt', '\t')
database = db.Database('pilot', df)

# allows to use the names of the variable as Python variable.
globals().update(database.variables)

# Removing some observations
exclude = (Bike_AV ==0)
database.remove(exclude)

#[Beta] - Parameters to be estimated
ASC_A          = Beta('ASC_A',0,-3000,3000,0)
ASC_B          = Beta('ASC_B',0,-30,30,0)
ASC_C          = Beta('ASC_C',0,-3000,3000,1)
B_SUR          = Beta('B_SUR',0,-1000,1000,0)
B_REP          = Beta('B_REP',0,-1000,1000,0)
B_COST_L       = Beta('B_COST_L',0,-1000,1000,0)
B_WT           = Beta('B_WT',0,-1000,1000,0)
B_SHEL         = Beta('B_SHEL',0,-1000,1000,0)
B_COST_FP      = Beta('B_COST_FP',0,-1000,1000,0)
B_FP_L         = Beta('B_FP_L',0,-1000,1000,0)
B_FP_Q         = Beta('B_FP_Q',0,-1000,1000,0)

B_CAR          = Beta('B_CAR',0,-1000,1000,0)
B_CAR_SUR      = Beta('B_CAR_SUR',0,-1000,1000,0)
B_CAR_REP      = Beta('B_CAR_REP',0,-1000,1000,0)
B_CAR_COST     = Beta('B_CAR_COST',0,-1000,1000,0)
B_CAR_FP_L     = Beta('B_CAR_FP_L',0,-1000,1000,0)
B_CAR_FP_Q     = Beta('B_CAR_FP_Q',0,-1000,1000,0)
B_CAR_COST_FP = Beta('B_CAR_COST_FP',0,-1000,1000,0)
B_CAR_WT       = Beta('B_CAR_WT',0,-1000,1000,0)
B_CAR_SHEL     = Beta('B_CAR_SHEL',0,-1000,1000,0)

#[Utilities]
Alt1 = ASC_A + B_SUR * paid_sur + B_REP * paid_repair + B_COST_L * paid_cost +  B_FP_L * paid_fp \
       + B_FP_Q * (paid_fp**2) + paid_cost * paid_fp  * B_COST_FP  + B_WT * paid_WTPaid \
       + B_CAR_WT * paid_WTPaid * Car
Alt2 = ASC_B + B_WT * free_wtfree + B_SHEL * free_shelter \
       + B_CAR_WT * free_wtfree * Car
Alt3 = ASC_C

#[Choice set and availability]
choiceset = {1: Alt1,2: Alt2,3: Alt3}
#availability = {1: availability1,2: availability2,3: availability3}

#[Model]
# MNL  // Logit Model
# The choice model is a logit, with availability conditions
logprob = models.loglogit(choiceset,None,Choice)

# Create the Biogeme object
biogeme = bio.BIOGEME(database, logprob)
biogeme.modelName = 'MNL_Base_16_inter_car'

# Estimate the parameters
results = biogeme.estimate()

# Get the results in a pandas table
pandasResults = results.getEstimatedParameters()
print(pandasResults)
pandasCorrelations = results.getCorrelationResults()
pandasCorrelations
pandasGeneralStat = results.getGeneralStatistics()
pandasGeneralStat
```

Individual interactions

Table G.3, Individual interaction effects of various characteristics

	B				Cost				FP_L			
	Value	Std. Error	t-test	p-value	Value	Std. Error	t-test	p-value	Value	Std. Error	t-test	p-value
Age												
<25	-0.875	0.0822	-10.6	0	-0.52	0.0517	-10.1	0	-0.0294	0.00526	-5.59	2.23e-08
25-44	-0.294	0.0843	-3.49	0.000482	-0.221	0.051	-4.32	1.53e-05	-0.00375	0.00556	-0.675	0.5
45-64	0.0339	0.077	0.44	0.66	-0.00526	0.0462	-0.114	0.909	0.00481	0.00508	0.946	0.344
65+					-0.644	0.0592	-10.9	0	0.096	0.0173	5.54	2.96e-08
Gender												
Male	-0.0637	0.0526	-1.21	0.226	-0.0515	0.032	-1.61	0.107	-0.0038	0.00345	-1.1	0.271
Female					-0.706	0.0692	-10.2	0	0.0971	0.0176	5.51	3.55e-08
Education												
HBO/WO	0.193	0.121	1.59	0.111	0.0873	0.0742	1.18	0.24	0.00894	0.00788	1.14	0.256
MBO	0.267	0.0721	3.71	0.00021	0.0983	0.0447	2.2	0.0277	0.0143	0.00467	3.05	0.00225
Primary/high school					-0.863	0.0637	-13.5	0	0.0266	0.00425	6.27	3.67e-10
Car												
Yes	0.348	0.0661	5.26	1.42e-07	-0.168	0.0407	-4.11	3.87e-05	0.0196	0.00425	4.61	4.07e-06
No					-0.913	0.061	-15	0	0.0758	0.0173	4.38	1.18e-05
Purpose												
Mandatory	0.285	0.0617	4.61	3.94e-06	0.186	0.038	4.89	1,00E-06	0.024	0.00397	6.05	1.42e-09
Recreational					-0.919	0.0591	-15.5	0	0.0741	0.0172	4.31	1.62e-05
Frequency												
Low	0.204	0.0633	3.23	0.00125	0.0851	0.0381	2.24	0.0254	0.0037	0.00416	0.891	0.373
Medium	-0.229	0.128	-1.79	0.074	-0.0811	0.0793	-1.02	0.306	-0.0162	0.00816	-1.98	0.0472
High					-0.803	0.0531	-15.1	0	0.0913	0.0169	5.39	6.97e-08
Parking duration												
>48	-0.185	0.0963	-1.92	0.0548	-0.138	0.0587	-2.36	0.0185	-0.0109	0.00632	-1.72	0.0857
24-48	-1.53	0.16	-9.55	0	-1.34	0.147	-9.11	0	-0.103	0.0108	-9.54	0
12-24	-1.32	0.155	-8.48	0	-1.02	0.124	-8.22	2.22e-16	-0.0934	0.0103	-9.04	0
0-12					-0.736	0.0523	-14.1	0	0.0979	0.0173	5.66	1.54e-08
Bike												
Electric	1.63	0.128	12.7	0	0.862	0.0755	11.4	0	0.0839	0.0102	8.24	2.22e-16
Other	0.0713	0.0773	0.922	0.356	0.0174	0.0472	0.368	0.713	0.00911	0.00513	1.78	0.0757
Regular					-0.881	0.0539	-16.3	0	0.0806	0.0171	4.71	2.45e-06
Weekend												
Yes	-0.435	0.0902	-4.83	1.39e-06	-0.304	0.0569	-5.34	9.06e-08	0.0268	0.00569	4.72	2.41e-06
No					-0.754	0.0518	-14.6	0	0.0938	0.017	5.53	3.17e-08
Night												
Yes	1.53	0.0652	23.5	0	0.809	0.0397	20.4	0	0.0738	0.00449	16.4	0
No					-1.2	0.0596	-20.2	0	0.0555	0.0177	3.14	0.00169
Current												
Unguarded	-0.809	0.0397	-20.4	0	-0.809	0.0397	-20.4	0	-0.0408	0.00269	-15.2	0
Guarded					-0.393	0.0564	-6.96	3.49e-12	0.0795	0.0174	4.57	4.91e-06
Location												
Rural	-0.194	0.0696	-2.8	0.00518	-0.127	0.0422	-3.01	0.00262	-0.0114	0.00456	-2.5	0.0126
Suburban	-0.209	0.0837	-2.5	0.0123	-0.0287	0.0515	-0.558	0.577	-0.00928	0.0054	-1.72	0.0856
CityCentre					-0.722	0.0534	-13.5	0	0.0981	0.017	5.78	7.67e-09
Operation												
Intercity	0.21	0.0573	3.66	0.000251	0.0948	0.0349	2.71	0.00664	0.00442	0.00377	1.17	0.241
Sprinter					-0.84	0.056	-15	0	0.0887	0.0171	5.2	2.01e-07

	FP_Q				Interaction Cost/FP				Rep			
	Value	Std. Error	t-test	p-value	Value	Std. Error	t-test	p-value	Value	Std. Error	t-test	p-value
Age												
<25	-0.00124	0.000239	-5.2	1.98e-07	-0.0189	0.00312	-6.07	1.31e-09	-1.07	0.115	-9.26	0
25-44	-0.000205	0.000253	-0.809	0.419	-0.00492	0.00323	-1.52	0.128	-0.47	0.118	-3.99	6.74e-05
45-64	0.000157	0.000232	0.676	0.499	0.000921	0.003	0.307	0.759	-0.125	0.108	-1.15	0.25
65+	-0.00268	0.000628	-4.27	1.96e-05	0.0324	0.00472	6.86	6.74e-12	0.508	0.112	4.55	5.4e-06
Gender												
Male	-0.0038	0.00345	-1.1	0.271	-0.0031	0.00201	-1.54	0.123	-0.0439	0.073	-0.601	0.548
Female	-0.00298	0.000605	-4.93	8.16e-07	0.0317	0.0052	6.1	1.05e-09	0.209	0.137	1.53	0.125
Education												
HBO/WO	0.000405	0.000359	1.13	0.26	0.0052	0.00462	1.13	0.26	0.315	0.17	1.86	0.0632
MBO	0.00055	0.000212	2.59	0.00956	0.00787	0.00278	2.84	0.00457	0.297	0.1	2.96	0.00312
Primary/high school	0.000622	-5.43	5.51e-08	0.0212	0.00474	4.46	8.16e-06	-0.081	0.113	-0.716	0.474	
Car												
Yes	0.00078	0.000193	4.05	5.17e-05	0.00888	0.00249	3.56	0.000372	0.2	0.0921	2.17	0.03
No	-0.00358	0.000623	-5.75	8.83e-09	0.0204	0.00467	4.36	1.31e-05	-0.0132	0.112	-0.118	0.906
Purpose												
Mandatory	0.000878	0.00018	4.87	1.11e-06	0.0123	0.00233	5.27	1.36e-07	-0.0612	0.0868	-0.705	0.481
Recreational	-0.00357	0.000616	-5.79	6.84e-09	0.0187	0.00455	4.1	4.1e-05	0.189	0.105	1.79	0.0731
Frequency												
Low	0.000144	0.000189	0.762	0.446	0.00225	0.00241	0.933	0.351	0.328	0.0886	3.7	0.000213
Medium	-0.0006	0.00037	-1.62	0.105	-0.00728	0.00479	-1.52	0.129	-0.0928	0.179	-0.519	0.604
High	-0.00299	0.000608	-4.93	8.35e-07	0.0269	0.00432	6.22	4.9e-10	0.0651	0.0884	0.737	0.461
Parking duration												
>48	-0.000245	0.000293	-0.836	0.403	-0.138	0.0587	-2.36	0.0185	0.0347	0.136	0.256	0.798
24-48	-0.00425	0.000497	-8.54	0	-1.34	0.147	-9.11	0	-1.13	0.214	-5.27	1.39e-07
12-24	-0.00399	0.000482	-8.28	2.22e-16	-1.02	0.124	-8.22	2.22e-16	-1.08	0.214	-5.04	4.67e-07
0-12	-0.00255	0.000619	-4.11	3.88e-05	0.0288	0.00436	6.62	3.64e-11	0.217	0.087	2.5	0.0125
Bike												
Electric	0.00369	0.000511	7.23	4.94e-13	0.0452	0.00606	7.45	9.15e-14	1.64	0.183	8.95	0
Other	0.000417	0.000234	1.78	0.0743	0.00461	0.00297	1.55	0.121	0.0817	0.107	0.763	0.445
Regular	-0.00313	0.000611	-5.13	2.97e-07	0.0243	0.00432	5.63	1.8e-08	-0.00252	0.0882	-0.0286	0.977
Weekend												
Yes	-0.00104	0.000258	-4.02	5.86e-05	-0.0151	0.00336	-4.49	6.97e-06	-0.202	0.127	-1.6	0.11
No	-0.00287	0.000608	-4.73	2.25e-06	0.0288	0.0043	6.7	2.13e-11	0.164	0.0859	1.9	0.0569
Night												
Yes	0.00322	0.000213	15.1	0	0.0408	0.00269	15.2	0	1.84	0.0945	19.5	0
No	-0.00371	0.000622	-5.96	2.48e-09	0.0149	0.00444	3.37	0.000762	-0.575	0.0943	-6.09	1.1e-09
Current												
Unguarded	-0.0738	0.00449	-16.4	0	-0.0408	0.00269	-15.2	0	-1.84	0.0945	-19.5	0
Guarded	-0.0025	0.000629	-3.97	7.04e-05	0.0558	0.00496	11.2	0	1.27	0.109	11.6	0
Location												
Rural	-0.000445	0.000207	-2.15	0.0317	-0.127	0.0422	-3.01	0.00262	-0.102	0.097	-1.05	0.295
Suburban	-0.000398	0.000245	-1.63	0.103	-0.0287	0.0515	-0.558	0.577	-0.314	0.116	-2.7	0.00695
CityCentre	-0.00268	0.000612	-4.38	1.17e-05	0.0274	0.00427	6.41	1.44e-10	0.256	0.0919	2.78	0.00536
Operation												
Intercity	0.000161	0.000171	0.943	0.345	0.00223	0.00219	1.02	0.309	.286	0.0795	3.6	0.000317
Sprinter	-0.00309	0.000614	-5.02	5.05e-07	0.0258	0.00447	5.78	7.5e-09	-0.0341	0.0985	-0.346	0.729

	Shelter				Sur				WT			
	Value	Std. Error	t-test	p-value	Value	Std. Error	t-test	p-value	Value	Std. Error	t-test	p-value
Age												
<25	0.896	0.118	7.59	3.11e-14	-0.935	0.117	-7.98	1.55e-15	0.188	0.0404	4.66	3.16e-06
25-44	0.262	0.122	2.15	0.0317	-0.373	0.12	-3.11	0.00185	0.0138	0.0411	0.335	0.738
45-64	-0.00655	0.111	-0.0589	0.953	-0.042	0.11	-0.383	0.702	-0.0114	0.0369	-0.31	0.757
65+	-0.185	0.0948	-1.95	0.0511	.465	0.092	5.05	4.36e-07	-0.184	0.0308	-5.97	2.41e-09
Gender												
Male	-0.00332	0.0759	-0.0437	0.965	-0.0495	0.0747	-0.663	0.507	-0.0265	0.026	-1.02	0.308
Female	0.0728	0.127	0.575	0.565	0.232	0.123	1.88	0.0603	-0.104	0.0425	-2.44	0.0145
Education												
HBO/WO	-0.246	0.175	-1.41	0.159	0.226	0.172	1.31	0.189	-0.0909	0.0601	-1.51	0.13
MBO	-0.287	0.104	-2.77	0.00565	0.273	0.103	2.66	0.00783	-0.129	0.0361	-3.57	0.000354
Primary/high school	0.295	0.102	2.89	0.00386	-0.0587	0.0999	-0.587	0.557	-0.0432	0.034	-1.27	0.205
Car												
Yes	-0.341	0.095	-3.59	0.000332	0.249	0.0941	2.65	0.00802	-0.135	0.0329	-4.1	4.06e-05
No	0.331	0.0951	3.48	0.000493	-0.0326	0.0918	-0.355	0.723	-0.0383	0.0317	-1.21	0.226
Purpose												
Mandatory	-0.115	0.0893	-1.29	0.199	0.234	0.0877	2.67	0.00761	0.103	0.0283	3.63	0.000287
Recreational	0.15	0.0882	1.7	0.0888	-0.00737	0.0843	-0.0875	0.93	-0.231	0.031	-7.43	1.05e-13
Frequency												
Low	-0.177	0.0909	-1.95	0.0517	0.265	0.0901	2.95	0.00321	-0.015	0.0308	-0.487	0.626
Medium	-0.268	0.195	-1.37	0.17	-0.0398	0.184	-0.216	0.829	0.208	0.0672	3.1	0.00194
High	0.13	0.0671	1.94	0.0525	0.0867	0.0634	1.37	0.171	-0.129	0.0215	-6.03	1.63e-09
Parking duration												
>48	-0.0124	0.142	-0.0871	0.931	-0.108	0.137	-0.79	0.43	-0.00151	0.0478	-0.0316	0.975
24-48	1.51	0.223	6.78	1.22e-11	-1.38	0.222	-6.21	5.37e-10	0.031	0.0077	4.06	4.95e-05
12-24	1.52	0.223	6.83	8.61e-12	-1.15	0.218	-5.27	1.33e-07	0.0303	0.0076	3.95	7.73e-05
0-12	-0.0372	0.064	-0.581	0.561	0.262	0.0604	4.34	1.45e-05	-0.165	0.0204	-8.08	6.66e-16
Bike												
Electric	-1.76	0.192	-9.19	0	1.71	0.186	9.18	0	-0.276	0.0493	-5.6	2.17e-08
Other	-0.23	0.113	-2.04	0.0412	0.0458	0.109	0.419	0.675	-0.0559	0.0384	-1.45	0.146
Regular	0.238	0.0651	3.66	0.000253	0.0261	0.0613	0.426	0.67	-0.109	0.0207	-5.28	1.3e-07
Weekend												
Yes	0.328	0.13	2.52	0.0117	-0.364	0.128	-2.84	0.00451	0.117	0.0452	2.59	0.00968
No	0.0342	0.0626	0.547	0.584	0.198	0.0589	3.36	0.000775	-0.154	0.0199	-7.76	8.22e-15
Night												
Yes	-1.8	0.0974	-18.5	0	1.77	0.0951	18.6	0	-0.293	0.0291	-10.1	0
No	0.739	0.0704	10.5	0	-0.481	0.0654	-7.36	1.86e-13	-0.0254	0.0222	-1.15	0.252
Current												
Unguarded	1.8	0.0974	18.5	0	-1.77	0.095	-18.6	0	0.293	0.0291	10.1	0
Guarded	-1.06	0.0923	-11.5	0	1.29	0.0896	14.4	0	-0.319	0.0268	-11.9	0
Location												
Rural	0.244	0.1	2.44	0.0148	-0.204	0.0988	-2.06	0.0392	0.0585	0.0343	1.71	0.0876
Suburban	0.258	0.12	2.15	0.0313	-0.231	0.119	-1.94	0.0519	0.0466	0.0417	1.12	0.263
CityCentre	-0.0962	0.0715	-1.34	0.179	0.3	0.068	4.41	1.02e-05	-0.178	0.0231	-7.74	1.02e-14
Operation												
Intercity	-0.201	0.0826	-2.44	0.0148	0.248	0.0813	3.05	0.00231	0.0473	0.0284	1.66	0.0962
Sprinter	0.191	0.0788	2.42	0.0156	0.00994	0.0749	0.133	0.894	-0.172	0.0263	-6.54	6.18e-11

Interactions after iteration

Table G.4, Estimated parameters MNL-model including significant interactions

MNL	Value	Std err	t-test	p-value	Rob, Std err	Rob, t-test	Rob, p-value
ASC_A	3,77	0,207	18,2	0	0,211	17,8	0
ASC_B	3,13	0,11	28,6	0	0,108	28,9	0
B_AGE1	-0,529	0,0772	-6,86	6,95E-12	0,0758	-6,99	2,80E-12
B_BIKE1	0,933	0,137	6,8	1,06E-11	0,139	6,71	1,91E-11
B_CAR	0,494	0,142	3,48	0,000496	0,139	3,55	0,00039
B_CAR_COST	-0,197	0,0887	-2,22	0,0263	0,0871	-2,26	0,0237
B_COST_FP	0,0365	0,00483	7,55	4,35E-14	0,00489	7,46	8,62E-14
B_COST_L	-0,748	0,0909	-8,23	2,22E-16	0,0892	-8,39	0
B_CURRENT	-0,612	0,123	-4,96	6,94E-07	0,126	-4,86	1,18E-06
B_CURRENT_REP	-0,701	0,137	-5,11	3,22E-07	0,14	-5,01	5,37E-07
B_CURRENT_SHEL	0,707	0,13	5,45	5,17E-08	0,136	5,21	1,93E-07
B_CURRENT_SUR	-0,447	0,136	-3,28	0,00102	0,139	-3,22	0,00128
B_FP_L	0,0815	0,0193	4,23	2,38E-05	0,0198	4,12	3,72E-05
B_FP_Q	-0,00319	0,000673	-4,73	2,22E-06	0,000689	-4,63	3,73E-06
B_FREQ2	-0,758	0,153	-4,95	7,34E-07	0,179	-4,24	2,26E-05
B_FREQ2_WT	-0,291	0,0667	-4,37	1,23E-05	0,0796	-3,66	0,000248
B_PD1_COST	-0,17	0,0661	-2,57	1,00E-02	0,0679	-2,51	0,0122
B_PD2_COST	-1,54	0,202	-7,61	2,84E-14	0,226	-6,82	9,39E-12
B_PD3_COST	-0,763	0,232	-3,29	0,000992	0,239	-3,2	0,0014
B_PURPOSE_FP_L	0,0228	0,00512	4,44	8,83E-06	0,00562	4,05	5,14E-05
B_REP	0,591	0,134	4,41	1,05E-05	0,142	4,17	3,03E-05
B_SHEL	-0,44	0,113	-3,9	9,45E-05	0,117	-3,76	1,71E-04
B_SUR	0,48	0,113	4,23	2,31E-05	0,117	4,09	4,24E-05
B_WKND_FP_L	0,0148	0,00553	2,68	0,00745	0,00571	2,59	0,00952
B_WT	-0,159	0,022	-7,24	4,61E-13	0,0223	-7,12	1,08E-12

G.3. Nested logit

Biogeme syntax

```
import pandas as pd
import biogeme.database as db
import biogeme.biogeme as bio
import biogeme.models as models
from biogeme.expressions import Beta
from biogeme import *
from biogeme.expressions import Beta, DefineVariable, bioDraws, PanelLikelihoodTrajectory, MonteCarlo, log

# Read the data
df = pd.read_csv('Data_16_3_1.txt', '\t')
database = db.Database('pilot', df)

# allows to use the names of the variable as Python variable.
globals().update(database.variables)

# Removing some observations
exclude = (Bike_AV ==0)
database.remove(exclude)

#[Beta] - Parameters to be estimated
ASC_A          = Beta('ASC_A',0,-3000,3000,0)
ASC_B          = Beta('ASC_B',0,-30,30,0)
ASC_C          = Beta('ASC_C',0,-3000,3000,1)
B_SUR          = Beta('B_SUR',0,-1000,1000,0)
B_REP          = Beta('B_REP',0,-1000,1000,0)
B_COST_L       = Beta('B_COST_L',0,-1000,1000,0)
B_WT           = Beta('B_WT',0,-1000,1000,0)
B_SHEL         = Beta('B_SHEL',0,-1000,1000,0)
B_COST_FP      = Beta('B_COST_FP',0,-1000,1000,0)
B_FP_L         = Beta('B_FP_L',0,-1000,1000,0)
B_FP_Q         = Beta('B_FP_Q',0,-1000,1000,0)
MU = Beta('MU', 0.5, 0.1, 10, 0)

#[Utilities]
Alt1 = ASC_A + B_SUR * paid_sur + B_REP * paid_repair + B_COST_L * paid_cost + B_FP_L * paid_fp  + B_FP_Q *
(paid_fp**2) + paid_cost * paid_fp  * B_COST_FP  + B_WT * paid_WTPaid
Alt2 = ASC_B + B_WT * free_wtfree + B_SHEL * free_shelter
Alt3 = ASC_C

#[Choice set and availability]
choiceset = {1: Alt1,2: Alt2,3: Alt3}
#availability = {1: availability1,2: availability2,3: availability3}

#Definition of nests:
# 1: nests parameter
# 2: list of alternatives
Bike = MU, [1,2]
NoBike = 1.0, [3]
nests = Bike, NoBike

# Definition of the model. This is the contribution of each observation to the log likelihood function.
# The choice model is a nested logit, with availability conditions
logprob = models.lognested(choiceset, None, nests, Choice)

# Create the Biogeme object
biogeme = bio.BIOGEME(database, logprob, numberOfDraws=500)
biogeme.modelName = 'NL_Basis_final'

# Estimate the parameters
results = biogeme.estimate()

# Get the results in a pandas table
pandasResults = results.getEstimatedParameters()
print(pandasResults)
pandasCorrelations = results.getCorrelationResults()
pandasCorrelations
pandasGeneralStat = results.getGeneralStatistics()
pandasGeneralStat
```

Estimation report

Number of estimated parameters:	11
Observations:	6144
Excluded observations:	1344
Init log likelihood:	-5879.714
Final log likelihood:	-4167.009
Likelihood ratio test for the init. model:	3425.41
Rho-square for the init. model:	0.291
Rho-square-bar for the init. model:	0.289
Akaike Information Criterion:	8356.018
Bayesian Information Criterion:	8402.64
Final gradient norm:	4.6851E-03
Nbr of threads:	8
Algorithm:	BFGS with trust region for simple bound constraintsProportion analytical hessian: 0.0%
Relative projected gradient:	1.006642e-06
Number of iterations:	131
Number of function evaluations:	352
Number of gradient evaluations:	111
Number of hessian evaluations:	0
Cause of termination:	Relative gradient = 1e-06 <= 6.1e-06
Optimization time:	0:00:01.219440

Estimated parameters

Table G.5, Estimated parameters NL-model

Name	Value	Std err	t-test	p-value	Rob. Std err	Rob. t-test	Rob. p-value
ASC_A	7	0.461	15.2	0	0.578	12.1	0
ASC_B	6.03	0.458	13.2	0	0.571	10.6	0
B_COST_FP	0.0421	0.00353	11.9	0	0.00295	14.3	0
B_COST_L	-0.918	0.0474	-19.4	0	0.0467	-19.7	0
B_FP_L	0.117	0.017	5.4	6.82e-08	0.0131	7	2.58e-12
B_FP_Q	-0.00369	0.000609	-4.91	9.27e-07	0.000469	-6.37	1.92e-10
B_REP	0.187	0.0587	3.18	0.00148	0.0546	3.42	0.000634
B_SHEL	0.0701	0.0614	1.14	0.254	0.0413	1.7	0.09
B_SUR	0.199	0.0569	3.49	0.000483	0.0371	5.35	8.89e-08
B_WT	-0.176	0.0188	-9.37	0	0.0142	-12.4	0
MU	-2.67	0.318	-8.4	0	0.433	-6.16	7.06e-10

G.4. Mixed logit, panel and nest effect

Biogeme syntax

```
import pandas as pd
import biogeme.database as db
import biogeme.biogeme as bio
import biogeme.models as models
from biogeme.expressions import Beta
from biogeme import *
from biogeme.expressions import Beta, DefineVariable, bioDraws, PanelLikelihoodTrajectory, MonteCarlo, log

# Read the data
df = pd.read_csv('Data_16_3_1.txt', '\t')
database = db.Database('pilot', df)

# allows to use the names of the variable as Python variable.
globals().update(database.variables)

# They are organized as panel data. The variable ID identifies each individual.
database.panel("ID")

# Removing some observations
exclude = (Bike_AV ==0)
database.remove(exclude)

#[Beta] - Parameters to be estimated:
ASC_A        = Beta('ASC_A',0,-3000,3000,0)
ASC_B        = Beta('ASC_B',0,-30,30,0)
ASC_C        = Beta('ASC_C',0,-3000,3000,1)
B_SUR        = Beta('B_SUR',0,-1000,1000,0)
B_REP        = Beta('B_REP',0,-1000,1000,0)
B_COST_L     = Beta('B_COST_L',0,-1000,1000,0)
B_WT         = Beta('B_WT',0,-1000,1000,0)
B_SHEL       = Beta('B_SHEL',0,-1000,1000,0)
B_COST_FP    = Beta('B_COST_FP',0,-1000,1000,0)
B_FP_L       = Beta('B_FP_L',0,-1000,1000,0)
B_FP_Q       = Beta('B_FP_Q',0,-1000,1000,0)

#Error Component (Nests):
MU_Bike = Beta('SIGMA_Bike',0,None,None,0)
MU_NoBike= Beta('SIGMA_NoBike',1,None,None,1)
EC_Bike = SIGMA_Bike * bioDraws('EC_Bike','NORMAL')
EC_NoBike= SIGMA_NoBike * bioDraws('EC_NoBike','NORMAL')

#[panel]
Sigma_panel = Beta('Sigma_panel',0,-100,100,0)
Zero = Beta('Zero',0,-100,100,1)
Zero_sigma_panel = Zero + Sigma_panel * bioDraws('Zero_sigma_panel','NORMAL')

#[Utilities]
Alt1 = ASC_A + B_SUR * paid_sur + B_REP * paid_repair + B_COST_L * paid_cost + B_FP_L * paid_fp  + B_FP_Q *
(paid_fp**2) + paid_cost * paid_fp  * B_COST_FP  + B_WT * paid_WTPaid +EC_Bike + Zero_sigma_panel
Alt2 = ASC_B + B_WT * free_wtfree + B_SHEL * free_shelter + EC_Bike + Zero_sigma_panel
Alt3 = ASC_C + EC_NoBike

#[Choice set and availability]
choiceset = {1: Alt1,2: Alt2,3: Alt3}
# Define the contribution to the log likelihood function is slightly different for the panel effects model
obsprob = models.logit(choiceset,None,Choice)
condprobIndiv = PanelLikelihoodTrajectory(obsprob)
logprob = log(MonteCarlo(condprobIndiv))

# Create the Biogeme object
biogeme = bio.BIOGEME(database, logprob, numberOfDraws=500)
biogeme.modelName = 'ML_nestsEC_panel_Basis'

# Estimate the parameters
results = biogeme.estimate()

# Get the results in a pandas table
pandasResults = results.getEstimatedParameters()
print(pandasResults)
pandasCorrelations = results.getCorrelationResults()
pandasCorrelations
pandasGeneralStat = results.getGeneralStatistics()
pandasGeneralStat
```

Estimation Report

Number of estimated parameters:	12
Sample size:	512
Observations:	6144
Excluded observations:	1344
Init log likelihood:	-6749.874
Final log likelihood:	-4123.239
Likelihood ratio test for the init. model:	5253.269
Rho-square for the init. model:	0.389
Rho-square-bar for the init. model:	0.387
Akaike Information Criterion:	8270.479
Bayesian Information Criterion:	8321.339
Final gradient norm:	2.3886E-03
Number of draws:	100
Draws generation time:	0:00:00.136096
Types of draws:	['EC_Bike: NORMAL', 'Zero_sigma_panel: NORMAL']
Nbr of threads:	8
Algorithm:	BFGS with trust region for simple bound constraints
Proportion analytical hessian:	0.0%
Relative projected gradient:	1.246998e-06
Number of iterations:	60
Number of function evaluations:	151
Number of gradient evaluations:	46
Number of hessian evaluations:	0
Cause of termination:	Relative gradient = 1.2e-06 <= 6.1e-06
Optimization time:	0:02:02.049418

Estimated Parameters

Table G.6, Estimated parameters ML-model

Name	Value	Std err	t-test	p-value	Rob. Std err	Rob. t-test	Rob. p-value
ASC_A	6.44	0.438	14.7	0	0.516	12.5	0
ASC_B	5.88	0.426	13.8	0	0.501	11.7	0
B_COST_FP	0.0276	0.00429	6.44	1.23e-10	0.00299	9.24	0
B_COST_L	-0.791	0.0518	-15.3	0	0.0453	-17.5	0
B_FP_L	0.0915	0.017	5.37	7.72e-08	0.0132	6.95	3.68e-12
B_FP_Q	-0.00298	0.00061	-4.89	1.02e-06	0.000471	-6.33	2.45e-10
B_REP	0.141	0.0857	1.65	0.0997	0.0649	2.17	0.0298
B_SHEL	0.0709	0.0615	1.15	0.249	0.0415	1.71	0.0876
B_SUR	0.161	0.0575	2.81	0.00502	0.0373	4.32	1.58e-05
B_WT	-0.144	0.0194	-7.43	1.1e-13	0.0137	-10.5	0
MU_Bike	2.42	0.226	10.7	0	0.241	10	0
Sigma_panel	1.66	0.288	5.79	7.18e-09	0.599	2.78	0.00546

G.5. Mixed logit, panel and nest effect with interactions

Biogeme syntax

```
import pandas as pd
import biogeme.database as db
import biogeme.biogeme as bio
import biogeme.models as models
from biogeme.expressions import Beta
from biogeme import *
from biogeme.expressions import Beta, DefineVariable, bioDraws, PanelLikelihoodTrajectory, MonteCarlo, log

# Read the data
df = pd.read_csv('Data_16_3_1.txt', '\t')
database = db.Database('pilot', df)

# allows to use the names of the variable as Python variable.
globals().update(database.variables)

# They are organized as panel data. The variable ID identifies each individual.
database.panel("ID")

# Removing some observations
exclude = (Bike_AV ==0)
database.remove(exclude)

#[Beta]
#Parameters to be estimated
ASC_A           = Beta('ASC_A',0,-3000,3000,0)
ASC_B           = Beta('ASC_B',0,-30,30,0)
ASC_C           = Beta('ASC_C',0,-3000,3000,1)
B_SUR           = Beta('B_SUR',0,-1000,1000,0)
B_REP           = Beta('B_REP',0,-1000,1000,0)
B_COST_L        = Beta('B_COST_L',0,-1000,1000,0)
B_WT           = Beta('B_WT',0,-1000,1000,0)
B_SHEL          = Beta('B_SHEL',0,-1000,1000,0)
B_COST_FP      = Beta('B_COST_FP',0,-1000,1000,0)
B_FP_L          = Beta('B_FP_L',0,-1000,1000,0)
B_FP_Q          = Beta('B_FP_Q',0,-1000,1000,0)
#Interactions
B_AGE1          = Beta('B_AGE1',0,-1000,1000,0)
B_CAR           = Beta('B_CAR',0,-1000,1000,0)
B_CAR_COST  = Beta('B_CAR_COST',0,-1000,1000,0)
B_CURRENT   = Beta('B_CURRENT',0,-1000,1000,0)
B_CURRENT_SUR          = Beta('B_CURRENT_SUR',0,-1000,1000,0)
B_CURRENT_REP          = Beta('B_CURRENT_REP',0,-1000,1000,0)
B_CURRENT_SHEL         = Beta('B_CURRENT_SHEL',0,-1000,1000,0)
B_FREQ2         = Beta('B_FREQ2',0,-1000,1000,0)
B_FREQ2_WT  = Beta('B_FREQ2_WT',0,-1000,1000,0)
B_PD1_COST  = Beta('B_PD1_COST',0,-1000,1000,0)
B_PD2_COST  = Beta('B_PD2_COST',0,-1000,1000,0)
B_PD3_COST  = Beta('B_PD3_COST',0,-1000,1000,0)
B_PURPOSE_FP_L         = Beta('B_PURPOSE_FP_L',0,-1000,1000,0)
B_WKND_FP_L = Beta('B_WKND_FP_L',0,-1000,1000,0)
B_BIKE1         = Beta('B_BIKE1',0,-1000,1000,0)

#Error Component (Nests):
SIGMA_Bike = Beta('SIGMA_Bike',0,None,None,0)
SIGMA_NoBike= Beta('SIGMA_NoBike',1,None,None,1)
EC_Bike = SIGMA_Bike * bioDraws('EC_Bike','NORMAL')
EC_NoBike= SIGMA_NoBike * bioDraws('EC_NoBike','NORMAL')

#[panel]
Sigma_panel = Beta('Sigma_panel',0,-100,100,0)
Zero = Beta('Zero',0,-100,100,1)
Zero_sigma_panel = Zero + Sigma_panel * bioDraws('Zero_sigma_panel','NORMAL')

#[Utilities]
Alt1 = ASC_A + B_SUR * paid_sur_sim + B_REP * paid_repair_sim + B_COST_L * paid_cost_sim + B_FP_L * paid_fp_sim
+ B_FP_Q * (paid_fp_sim**2) + paid_cost_sim * paid_fp_sim  * B_COST_FP  + B_WT * paid_WTPaid_sim\
+ B_AGE1 * Age1\
+ B_FREQ2 * Frequency2 + B_FREQ2_WT * paid_WTPaid_sim * Frequency2\
+ B_PD1_COST * paid_cost_sim * Park_duration1 \
+ B_PD2_COST * paid_cost_sim * Park_duration2 \
+ B_PD3_COST * paid_cost_sim * Park_duration3 \
+ B_CURRENT * Current+ B_CURRENT_SUR * paid_sur_sim * Current + B_CURRENT_REP * paid_repair_sim * Current
\
+ B_WKND_FP_L * paid_fp_sim * Weekend \
+ B_PURPOSE_FP_L * paid_fp_sim * Purpose \
```

```
+ B_CAR * Car+ B_CAR_COST * paid_cost_sim * Car \
+ B_BIKE1 * Bike1 \
+ EC_Bike + Zero_sigma_panel
Alt2 = ASC_B + B_WT * free_wtfree_sim + B_SHEL * free_shelter_sim \
+ B_FREQ2_WT * free_wtfree_sim * Frequency2 \
+ B_CURRENT_SHEL* free_shelter_sim * Current\
+ EC_Bike + Zero_sigma_panel
Alt2 = ASC_B + B_WT * free_wtfree + B_SHEL * free_shelter \
+ B_FREQ2_WT * free_wtfree * Frequency2 \
+ B_CURRENT_SHEL* free_shelter * Current\
+ EC_Bike + Zero_sigma_panel

Alt3 = ASC_C + EC_NoBike

#[Choice set and availability]
choiceset = {1: Alt1,2: Alt2,3: Alt3}
#availability = {1: availability1,2: availability2,3: availability3}

#[Model]
# Define the contribution to the log likelihood function
# is slightly different for the panel effects model
obsprob = models.logit(choiceset,None,Choice)
condprobIndiv = PanelLikelihoodTrajectory(obsprob)
logprob = log(MonteCarlo(condprobIndiv))

# Create the Biogeme object
biogeme = bio.BIOGEME(database, logprob,numberOfDraws=500)
biogeme.modelName = 'ML_16_interaction_1-1'

# Estimate the parameters
results = biogeme.estimate()

# Get the results in a pandas table
pandasResults = results.getEstimatedParameters()
print(pandasResults)
pandasCorrelations = results.getCorrelationResults()
pandasCorrelations
pandasGeneralStat = results.getGeneralStatistics()
pandasGeneralStat
```

Estimation report

Number of estimated parameters:	26
Sample size:	512
Observations:	6144
Excluded observations:	1344
Init log likelihood:	-6749.874
Final log likelihood:	-3599.642
Likelihood ratio test for the init. model:	6300.464
Rho-square for the init. model:	0.467
Rho-square-bar for the init. model:	0.463
Akaike Information Criterion:	7253.284
Bayesian Information Criterion:	7367.719
Final gradient norm:	3.0011E-02
Number of draws:	100
Draws generation time:	0:00:00.103073
Types of draws:	['Zero_sigma_panel: NORMAL']
Nbr of threads:	8
Algorithm:	BFGS with trust region for simple bound constraints
Proportion analytical hessian:	0.0%
Relative projected gradient:	4.412929e-06
Number of iterations:	108
Number of function evaluations:	279
Number of gradient evaluations:	86
Number of hessian evaluations:	0
Cause of termination:	Relative gradient = 4.4e-06 <= 6.1e-06
Optimization time:	0:09:31.787526

Estimated values after iteration

Table G.7, Estimated parameters ML-model including significant interactions

Name	**Value**	**Std err**	**t-test**	**p-value**	**Rob, Std err**	**Rob, t-test**	**Rob, p-value**
ASC_A	7,1	0,528	13,4	0	0,58	12,2	0
ASC_B	6,33	0,493	12,9	0	0,508	12,5	0
B_AGE1	-0,524	0,0783	-6,69	2,27E-11	0,169	-3,1	0,00192
B_BIKE1	0,947	0,143	6,64	3,19E-11	0,342	2,76	0,00569
B_CAR	0,528	0,143	3,69	0,000227	0,212	2,49	0,0127
B_CAR_COST	-0,198	0,0893	-2,22	0,0263	0,0821	-2,42	0,0157
B_COST_FP	0,0375	0,00487	7,69	1,44E-14	0,00386	9,71	0
B_COST_L	-0,763	0,0918	-8,32	0	0,087	-8,78	0
B_CURRENT	-0,802	0,13	-6,17	6,81E-10	0,189	-4,24	2,28E-05
B_CURRENT_REP	-0,688	0,138	-4,99	6,06E-07	0,158	-4,35	1,38E-05
B_CURRENT_SHEL	0,477	0,139	3,43	0,000607	0,105	4,54	5,54E-06
B_CURRENT_SUR	-0,46	0,137	-3,36	0,000773	0,104	-4,4	1,08E-05
B_FP_L	0,0825	0,0194	4,24	2,20E-05	0,0184	4,48	7,38E-06
B_FP_Q	-0,00318	0,000679	-4,68	2,88E-06	0,000579	-5,48	4,16E-08
B_FREQ2	-0,431	0,209	-2,06	0,0395	0,19	-2,27	0,0232
B_FREQ2_WT	1,09	0,305	3,56	0,000373	0,541	2,01	0,0448
B_PD1_COST	-0,417	0,177	-2,36	0,0183	0,178	-2,34	0,0194
B_PD2_COST	-1,54	0,204	-7,57	3,80E-14	0,426	-3,62	0,000295
B_PD3_COST	-0,782	0,233	-3,35	0,000808	0,336	-2,33	0,02
B_PURPOSE_FP_L	0,0203	0,00583	3,48	0,000494	0,00596	3,41	0,000653
B_REP	0,562	0,134	4,18	2,89E-05	0,156	3,6	0,000315
B_SHEL	-0,279	0,119	-2,34	0,0191	0,0881	-3,16	0,00155
B_SUR	0,49	0,114	4,3	1,71E-05	0,0909	5,39	6,96E-08
B_WKND_FP_L	0,0143	0,00586	2,44	0,0146	0,00607	2,36	0,0183
B_WT	-0,166	0,0223	-7,44	1,00E-13	0,0184	-9,03	0
MU_Bike	-1,52	0,309	-4,93	8,42E-07	0,261	-5,83	5,69E-09
Sigma_panel	2,91	0,315	9,23	0	0,331	8,77	0

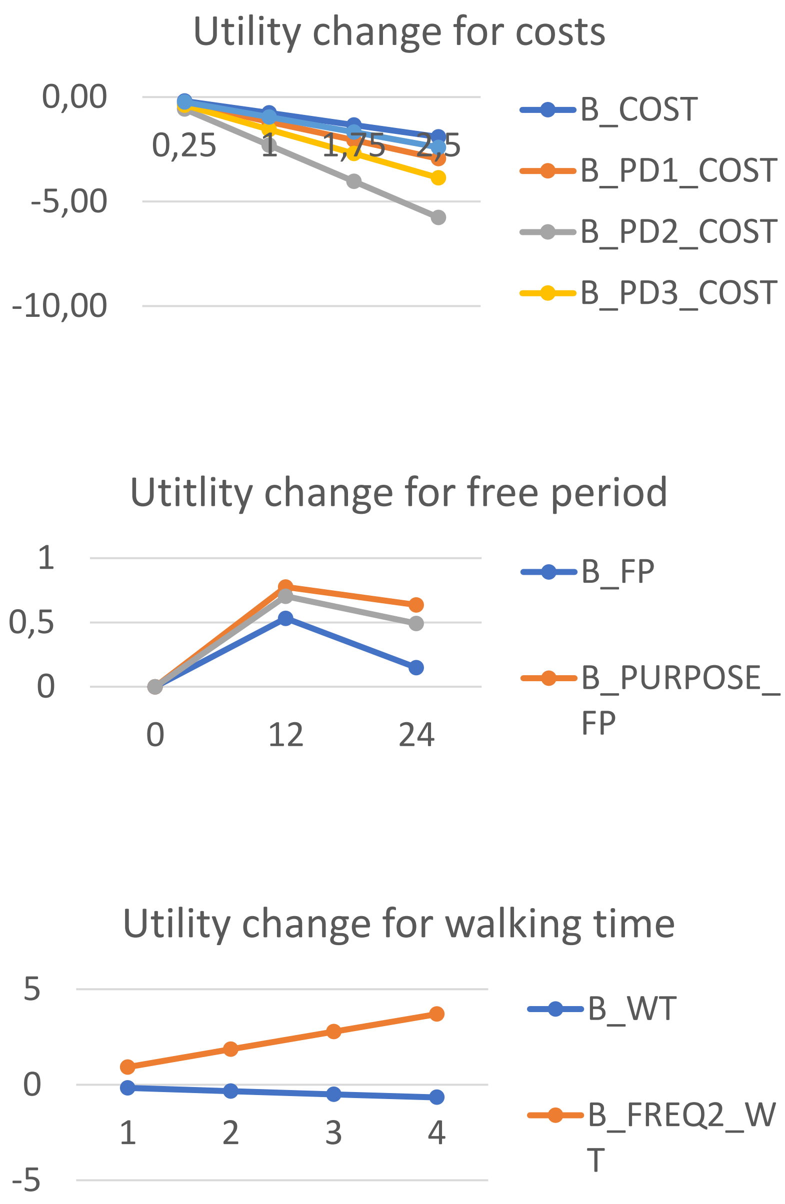

Figure G.1, Attributes and the change in utility for the values within the range

G.6. Mixed logit, panel for non-bike users

Biogeme syntax

```
import pandas as pd
import biogeme.database as db
import biogeme.biogeme as bio
import biogeme.models as models
from biogeme.expressions import Beta
from biogeme import *
from biogeme.expressions import Beta, DefineVariable, bioDraws, PanelLikelihoodTrajectory, MonteCarlo, log

# Read the data
df = pd.read_csv('Data_16_3_1.txt', '\t')
database = db.Database('pilot', df)

# allows to use the names of the variable as Python variable.
globals().update(database.variables)

# They are organized as panel data. The variable ID identifies each individual.
database.panel("ID")

# Removing some observations
exclude = (Bike_AV ==1)
database.remove(exclude)

#[Beta] - Parameters to be estimated:
ASC_A       = Beta('ASC_A',0,-3000,3000,0)
ASC_B       = Beta('ASC_B',0,-30,30,0)
ASC_C       = Beta('ASC_C',0,-3000,3000,1)
B_SUR       = Beta('B_SUR',0,-1000,1000,0)
B_REP       = Beta('B_REP',0,-1000,1000,0)
B_COST_L    = Beta('B_COST_L',0,-1000,1000,0)
B_WT        = Beta('B_WT',0,-1000,1000,0)
B_SHEL      = Beta('B_SHEL',0,-1000,1000,0)
B_COST_FP   = Beta('B_COST_FP',0,-1000,1000,0)
B_FP_L      = Beta('B_FP_L',0,-1000,1000,0)
B_FP_Q      = Beta('B_FP_Q',0,-1000,1000,0)

#Error Component (Nests):
#MU_Bike = Beta('SIGMA_Bike',0,None,None,0)
#MU_NoBike= Beta('SIGMA_NoBike',1,None,None,1)
#EC_Bike = SIGMA_Bike * bioDraws('EC_Bike','NORMAL')
#EC_NoBike= SIGMA_NoBike * bioDraws('EC_NoBike','NORMAL')

#[panel]
Sigma_panel = Beta('Sigma_panel',0,-100,100,0)
Zero = Beta('Zero',0,-100,100,1)
Zero_sigma_panel = Zero + Sigma_panel * bioDraws('Zero_sigma_panel','NORMAL')

#[Utilities]
Alt1 = ASC_A + B_SUR * paid_sur + B_REP * paid_repair + B_COST_L * paid_cost + B_FP_L * paid_fp  + B_FP_Q *
(paid_fp**2) + paid_cost * paid_fp  * B_COST_FP  + B_WT * paid_WTPaid + Zero_sigma_panel
Alt2 = ASC_B + B_WT * free_wtfree + B_SHEL * free_shelter + Zero_sigma_panel
Alt3 = ASC_C

#[Choice set and availability]
choiceset = {1: Alt1,2: Alt2,3: Alt3}
# Define the contribution to the log likelihood function is slightly different for the panel effects model
obsprob = models.logit(choiceset,None,Choice)
condprobIndiv = PanelLikelihoodTrajectory(obsprob)
logprob = log(MonteCarlo(condprobIndiv))

# Create the Biogeme object
biogeme = bio.BIOGEME(database, logprob, numberOfDraws=500)
biogeme.modelName = 'ML_nestsEC_panel_Basis'

# Estimate the parameters
results = biogeme.estimate()

# Get the results in a pandas table
pandasResults = results.getEstimatedParameters()
print(pandasResults)
pandasCorrelations = results.getCorrelationResults()
pandasCorrelations
pandasGeneralStat = results.getGeneralStatistics()
pandasGeneralStat
```

Estimation report

Number of estimated parameters:	11
Sample size:	112
Observations:	1344
Excluded observations:	6144
Init log likelihood:	-1476.535
Final log likelihood:	-914.5803
Likelihood ratio test for the init. model:	1123.909
Rho-square for the init. model:	0.381
Rho-square-bar for the init. model:	0.373
Akaike Information Criterion:	1851.161
Bayesian Information Criterion:	1881.064
Final gradient norm:	2.7639E-03
Number of draws:	100
Draws generation time:	0:00:00.022016
Types of draws:	['Zero_sigma_panel: NORMAL']
Nbr of threads:	8
Algorithm:	BFGS with trust region for simple bound constraints
Proportion analytical hessian:	0.0%
Relative projected gradient:	1.822377e-06
Number of iterations:	63
Number of function evaluations:	158
Number of gradient evaluations:	48
Number of hessian evaluations:	0
Cause of termination:	Relative gradient = 1.8e-06 <= 6.1e-06
Optimization time:	0:00:25.142805

Estimated parameters

Table G.8, Estimated parameters ML-model for non bike-train users

Name	Value	Std err	t-test	p-value	Rob, Std err	Rob, t-test	Rob, p-value
ASC_A	6,14	0,857	7,17	7,70E-13	0,804	7,64	2,20E-14
ASC_B	4,93	0,812	6,07	1,26E-09	0,819	6,02	1,72E-09
B_COST_FP	0,0241	0,0104	2,32	0,0205	0,00661	3,65	0,00026
B_COST_L	-0,733	0,114	-6,46	1,08E-10	0,0971	-7,55	4,53E-14
B_FP_L	0,0572	0,0262	2,18	0,0294	0,0262	2,18	0,0293
B_FP_Q	-0,0000219	0,00165	-0,0133	0,989	0,00109	-0,0202	0,984
B_REP	-0,143	0,226	-0,635	0,525	0,135	-1,06	0,289
B_SHEL	0,233	0,144	1,62	0,106	0,0944	2,47	0,0136
B_SUR	0,279	0,131	2,13	0,033	0,098	2,84	0,00446
B_WT	-0,123	0,0474	-2,59	0,00948	0,0318	-3,87	0,000108
Sigma_panel	-3,32	0,503	-6,6	4,14E-11	0,412	-8,07	6,66E-16