The Missing Connection with Bus-Based P&Rs?

A Comprehensive Analysis of all Bus-Based Park-and-Ride Facilities in the Netherlands and the Search for Possible New Influencing Factors.

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Preface

Over the past 8 months I have been writing my master's thesis called "The Missing Connection with Bus-Based P&Rs". All Dutch Park-and-Ride facilities with only a bus line as connecting public transport were analysed in both a quantitative and qualitative manner. The ultimate goal of this research was to identify the factors that influence the success of these so-called "bus-based" P&R facilities.

After completing the bachelor's degree in Geography, Spatial Planning and Environment last year, I chose to focus more deeply on the planning aspect and specifically on the mobility field. I personally have a great interest in the operation and use of public transport, which I see as the best alternative to the car, and I expect that P&R facilities could certainly contribute to a modal shift on a large scale. However, from personal experience I have a disappointing view of bus-based P&Rs, as every time I go to university I see a state-of-the-art P&R facility that is unfortunately completely empty. At the same time, I think that there is a lot of potential in this concept. That is why I research this topic and wrote this thesis to meet the graduation requirements of the master's program in Spatial Planning, with a specialization in Urban and Regional Mobility, at Radboud University Nijmegen.

This thesis is intended for policy makers in the field of mobility. Based on the results and the final conclusion drawn, they may be able to adjust their policy in order to improve the situation of 'their' bus-based P&Rs.

While writing this master's thesis, just like with my bachelor's thesis last year, I mainly had difficulty 'getting started'. Especially after the approval of the proposal, I lacked the incentive to collect the necessary data. However, the regular 'Tuesday thesis meetings' with my supervisor Goos van Lent, an Advisor from Royal HaskoningDHV, and my fellow thesis writers (Stefan, Lena and Imola) helped enormously in finding that motivation. I would also like to thank my supervisors dr. Sander Lenferink and prof. dr. Arnoud Lagendijk (on behalf of Radboud University), and Jasper Homrighausen, who together with Goos served as a supervisor on behalf of Royal HaskoningDHV, for their help and feedback over the past few months.

Finally, I would like to sincerely thank all respondents who helped with this research by taking the time for the survey and/or interview. Without them, obtaining results and ultimately completing this research would never have been possible. I therefore hope to repay them, and possibly also policy makers in other municipalities, by sharing my conclusions to help them improve their bus-based P&R facilities.

The last four years, I have gained a lot of knowledge at Radboud University and writing my final thesis based on the mobility concept that I see every time I travel to and from university, completes this academic cycle. I hope that you, and many policy makers in the field of mobility, will learn from this thesis and restore the 'Missing Connection' with Bus-Based P&Rs.

Victor Frijns

Abstract

In recent decades, it has become clear that Park-and-Ride (P&R) facilities with only a bus as connecting public transport are generally not a great success in the Netherlands. On the other hand, for users as well as policy makers and researchers, the train is often seen as the best connecting transport to a P&R facility, while the bus is somewhat ignored and seen as a second choice. In this thesis, however, the focus is shifted to the bus and therefore the situation of all bus-based P&R facilities in the Netherlands is examined. The aim of this research is to ultimately determine which factors influence this situation and which factors are therefore necessary to achieve bus-based P&R success.

This research uses a mixed method, combining desk research with a quantitative survey and a qualitative multiple case study. Prior to the survey, the academically long-known P&R evaluation criteria are determined based on a literature study, which can be used for the survey. In this second phase of the research, experts are asked to assess 16 Dutch bus-based P&Rs, based on the established evaluation criteria. From these survey results, eight intriguing cases are selected that are further investigated using an inductive coding method, to ultimately determine the most important factors that influence the situation of Dutch bus-based P&Rs.

The results challenge accepted theories and provide insightful information into the factors that influence the P&R situation. A number of preconditions are presented that can serve as the key to P&R success for both current and future bus-based P&R facilities. In addition, a new factor is also mentioned that may contribute to increasing this success.

Ultimately, it can be concluded that the situation of Dutch bus-based P&R facilities mainly depends on three factors, all of which can be classified as ‘features of the destination’. This concerns the accessibility, parking capacity and parking costs of the city centre. These three preconditions must be met to create a positive bus-based P&R situation. The recommendation that emerges most clearly from this thesis is that municipalities that are considering a bus-based P&R facility or already have a facility, should first focus on these three factors, as these form the basis for achieving P&R success.

Contents

1. Introduction

1.1 Historical context & Reason for this research

While some people might think that Park and Ride (P&R) facilities are a relatively new concept that only grew in size and use at the end of the twentieth century, that is actually not the case. Already at the end of the 19th century, the (very) early precursor of this phenomenon could be seen in the form of stabled horse-drawn carriages around train stations (Bailey and Dimitrio, 1972; Runkel, 1993; Kunstler, 1994). However, this involved so-called 'informal' P&R sides, which were not based on a well-founded planning idea and only functioned as a short extension of the mobility chain. Only later did this principle of interconnected means of transport begin to grow, mainly in the United States, due to economic prosperity and the resulting growing car use and suburbanization (Zijlstra et al., 2013). Figure 1 represents this P&R concept schematically, showing that travellers park their car in one central location, which in most cases is easily accessible by car (e.g. a parking lot along a highway), and then use public transport to get to their final destination (Ortega, Tóth, & Péter, 2021).

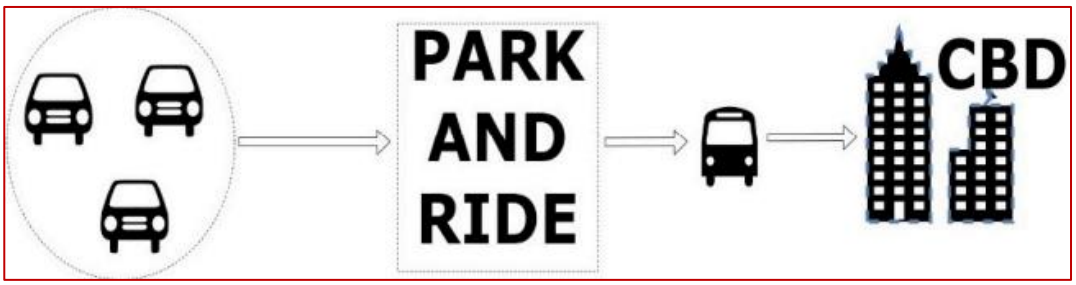


Figure 1: The Concept of P&R (Ortega, Tóth, & Péter, 2021).

Especially after the 1970s, the interest and deliberate planning of P&R facilities by transport planners, scientists and policy makers grew enormously (Bailey & Dimitrio, 1972; Meek, et al., 2008; Runkel, 1993). According to Spillar (1997), this was partly due to the first oil crisis, which showed that basing the entire transport network on the use of cars alone is unsustainable and somewhat risky. As a result, the arrival of P&R facilities around the world was gradually seen as the sign of the changing perception of cars. During this period, car-related problems were often pointed out such as environmental damage, growing numbers of traffic accidents, endless traffic jams and the growing resistance to the demolition of historic city centres to create space for roads. More and more people started to see the car no longer as an accessible solution, but rather as a mobility-slowing and increasingly dangerous problem (Zijlstra et al., 2013).

During this same period, the number of public transport users actually decreased, meaning that P&R facilities could be used as an 'instrument' to play the new 'melody' of a shared and connected mobility chain. And this tune was certainly listened to by transport planners in both the United States and Europe. The number of P&R facilities in this part of the world grew by almost 220% and it also turned out that the number of parking spaces per facility had quadrupled (Runkel, 1993).

However, from the 1990s onwards this increasingly positive image of P&R facilities gradually changed. Criticism came from environmental groups, among others, who stated that the construction of P&R facilities caused damage to the countryside and the city edges (Meek et al., 2008). In addition, scientific research later showed that many of the intended effects were not or hardly achieved in practice (Topp, 1995; Pickett & Gray, 1996), or even had undesirable negative consequences for traffic and the environment in the form of increased car use (Parkhurst, 1995). This reverse implementation of the concept reduced the initial enthusiasm for P&R facilities (Zijlstra et al., 2013).

But as with most planning implementations, bad periods alternated with good periods and the P&R principle as an extension of the mobility chain returned to the minds of policymakers after the turn of the century (Meek et al., 2010; Dijk & Montalvo, 2011). A possible explanation for this revaluation of this concept can be found in the rise of 'pragmatic multi-modalism', in which people no longer strive to realize a modal shift but rather work on stronger chains and the integration of modalities (Shaw & Walton, 2001). Travellers are not forced, but tempted, to make sensible and sustainable choices (Zijlstra et al., 2013).

This can also be seen in the policy of the Dutch government, which invested enormously in the expansion and improvement of P&R facilities at stations as part of their action plan called "On the (Train) Track of Growth" (Ministerie van Verkeer en Waterstaat, 2007). In 2018, CROW's KpVV Dashboard, a Dutch Knowledge Institute for Traffic and Transport, showed that there were 453 P&R locations in the Netherlands (figure 2) and almost 80% of which could be found at train stations (Zijlstra, 2020). This was partly due to the plan of the Dutch Secretary for Infrastructure and the Environment, Wilma Mansveld, who aimed to double the number of parking spaces at P&R facilities at train stations. The goal was to get 15,000 extra road users out of the car and onto the train every day, but it was also noted that other modalities, such as the bus, should increasingly serve as a connecting point in the existing mobility chain (Van Gompel, 2013).

Figure 2: Distribution of P&R locations and Carpool places in the Netherlands (KpVV, 2013).

The use of P&R facilities as an instrument to direct mobility flows is therefore very present in current Dutch policy. However, many researchers are also sceptical about this approach. For example, Baas et al. (2012) conclude that 65 to 80 percent of the users of P&R facilities at stations in the Netherlands live within walking or cycling distance of the station, and Zijlstra et al. (2015) see that on average only 15 road users are 'intercepted' per 100 parking spaces at a station. In addition, the space that becomes available on the road due to the presence of P&R facilities may be filled by others, which detracts from the P&R objective of 'less road traffic' Parkhurst, 2000; Mingardo, 2013).

These are just a few examples of sceptical views from the scientific literature on P&R facilities and their effects. As a Master student, I am both a major user of Dutch public transport and a car user. From my own experience, I can say that I am also very sceptical about P&R facilities and their supposed influence. Every time I take the bus to the train station I see an almost empty P&R location. This concerns the case of "P&R Genneper Parken" in the south of Eindhoven, the fifth largest city in the Netherlands.

This P&R facility opened in 2021, but it has not (yet) become a success. The facility has 641 parking spaces, four direct bus lines to the centre of Eindhoven, and a parking daily rate of only 4 euros, as opposed to the average €4 p/hour paid for a parking space in the city centre (Gemeente Eindhoven, n.d.-a), but P&R Genneper Parken is still not popular. In the first half of 2021, it even turned out that on average only 25 people parked their cars in the facility, meaning that more than 95% of the parking space was not used every day (Omroep Brabant, 2021). This can partly be blamed on the COVID-19 pandemic, which meant that people could not shop freely, there were no events and most people worked from home. However, the P&R location is still fairly empty these days, even without COVID-19 restrictions, and is even labelled as the 'Ghost Garage' of Eindhoven (Omroep Brabant, 2022).

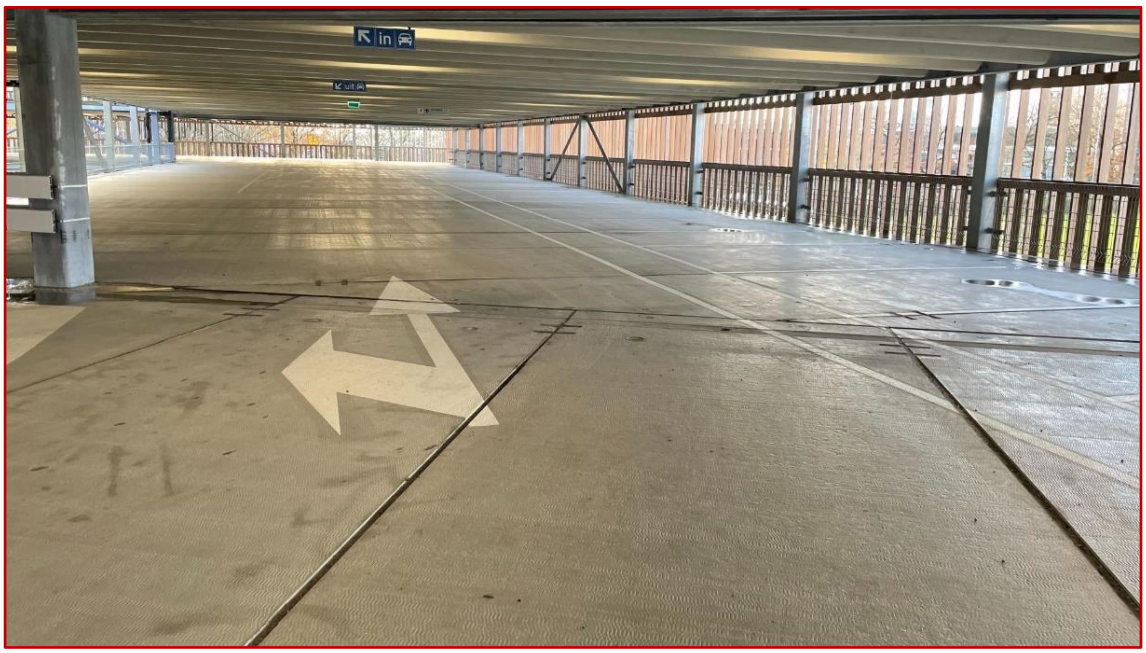


Figure 3: The standard image of the almost €20 million 'Ghost Garage' of Eindhoven (Omroep Brabant, 2021).

According to traffic expert Van der Waerden, the municipality, as initiator and operator, should not only arrange good parking and bus service, but also advertise more specifically and significantly increase parking rates in the centre. This *carrot-and-stick approach* should ultimately ensure that the P&R location in Eindhoven becomes popular and successful (Omroep Brabant, 2022).

This is just an example of a poorly functioning P&R facility that I personally often encounter. What is interesting about this Eindhoven P&R facility is that there is only a bus as a connecting means of public transport. This could possibly be a reason for the low occupancy rate. Bus-based transport often has a worse image compared to rail transport, due to its lesser reliability and lower level of comfort (Axhausen et al., 2001). As a result, both users and governments are more likely to opt for rail-based urban transport over the bus-based alternative, despite the higher implementation challenges and costs of rail transit (Wu & Pojani, 2016).

However, there are a number of examples, both worldwide and in the Netherlands, that show that bus-based P&R transport can be successful. For example, the five bus-based P&Rs around the city of Groningen turned out to be a significant success story in contrast to their Eindhoven 'colleague'. These Groningen facilities have been in use since the late 1990s and two of them have even been significantly expanded, with the number of parking spaces more than doubling. According to mobility advisor Jaap Immiga, this good Groningen performance can be explained by the high-quality public transport and the easily accessible locations of the transport hubs around the city. Immiga also states that the P&R bus should be able to get to the city centre as easily as possible, and that free parking and collaborations with employers, for example in the form of a travel allowance scheme for employees, can also contribute to the success of these bus-based P&Rs (Groningen Bereikbaar, 2021). In short, the goal was to create a comfortable and efficient travel experience through an attractive and well-functioning P&R facility, and that certainly led to success in the case of Groningen.

So, compared to Eindhoven, Groningen is a lot more successful in the field of (bus-based) P&R facilities. This is also evident from the average occupancy rates of P&R locations in both areas. For example, the average occupancy of P&R facilities in the Province of Groningen is 58%, while the same indicator in the Eindhoven region is only 8% (CROW, n.d.). Unfortunately, no data is available on specific *bus-based* P&Rs, but the general occupancy rates of P&R facilities clearly indicate that the P&Rs in Groningen are being used better. Thus, there are clearly major differences between cities and/or regions within the Netherlands in terms of P&R facilities and their success.

This brief comparison between Eindhoven and Groningen shows that implementing a P&R facility does not consist of simply building a parking lot at an accessible bus stop. It is a coherent approach consisting of, among other things, inviting qualities of the P&R location and repellent characteristics of other parking spaces in, for example, the city centre (Zijlstra, 2020).

1.2 Problem Statement; Train-based vs. Bus-based

As mentioned above, the Park-and-Ride phenomenon has been recurring in the transport system in recent decades. Due to the 'enticing' effect of the P&R facilities and the additionally 'unattractive' characteristics of other (parking) places, travellers choose to move from point A to point B in a multimodal and sustainable manner (Zijlstra, 2020). The use of public transport is central to this.

In the Netherlands, P&R cases are often still mainly train-oriented, while other means of transport, such as the bus or tram, are seen as a less-important, additional aspect to the existing car-train journey chain. This can also be seen in table 1, which shows the distribution of the number of P&R facilities by complementary public transport facility. Although the train facilities, including the "intercity" and "stoptrein" (local trains), provide by far the majority of the onward public transport connections, the occupancy rate for all types of public transport modes is virtually the same in the Netherlands (CROW, n.d.). This therefore shows that the presence

of a train track does not immediately mean that a P&R location is used more or less. Many more factors play a role in the success or failure of a P&R facility.

Type openbaar vervoer	Totaal	Gemiddeld aantal parkeerplaatsen	Gemiddelde bezettingsgraad
Intercity	74	230	58%
Stoptrein	282	104	60%
Bus/tram/metro	97	248	61%
Totaal	**453**	**152**	**61%**

Table 1: Number of P&R locations by public transport facility (CROW, n.d.).

Nevertheless, both this table from CROW-KpVV (n.d.) and the aforementioned program "On the (Train) Track of Growth" of the Dutch Ministry of Transport and Water Management (2007) show that in the past decade the Dutch government mainly focused on improving chain mobility based on train-oriented transfer connections at P&R facilities. In collaboration with the principal passenger railway operator in the Netherlands, *Nederlandse Spoorwegen* (NS), the government decided to invest in the construction, expansion and improvement of P&R facilities at train tracks and (existing) stations. The role of the bus or other public transport modalities was partly ignored and even literally mentioned as a second choice: "secondly, it is about coordinating the connections between the trains and other modalities such as the bus" (Ministerie van Verkeer en Waterstaat, 2007, p.17).

On the other hand, this choice for train-based P&R facilities is understandable, because of its different function compared to bus-oriented ones. The purpose of the parking spaces at stations is to ensure that travellers leave their cars before they enter the highway (CROW, n.d.). In this case there are so-called "P&Rs with an origin function", where there is a relatively short *pre-transport* (e.g. by car) and a long use of the line-haul service (by public transport) (figure 4). The users of these origin-P&Rs often have destinations in Dutch cities that are served by intercity stations. By using the train they avoid long car journeys, traffic jams, and any parking search time and costs near their final destination (KpVV, 2013).

At bus-based P&R facilities we are mostly dealing with a different type, namely "P&Rs with a destination function" (or *destination-P&Rs*). These are P&R facilities that are in most cases located on the supply routes of urban agglomerations. They are characterized by a long(er) *pre-transport* by car for and a relatively short use of the public transport service, for example the bus (figure 4). This often requires a high-frequency radial public transport line to the city centre (which has poor/expensive access to cars). This type of P&R location makes a city centre more accessible and at the same time aims to alleviate traffic congestion to and from the city (KpVV, 2013).

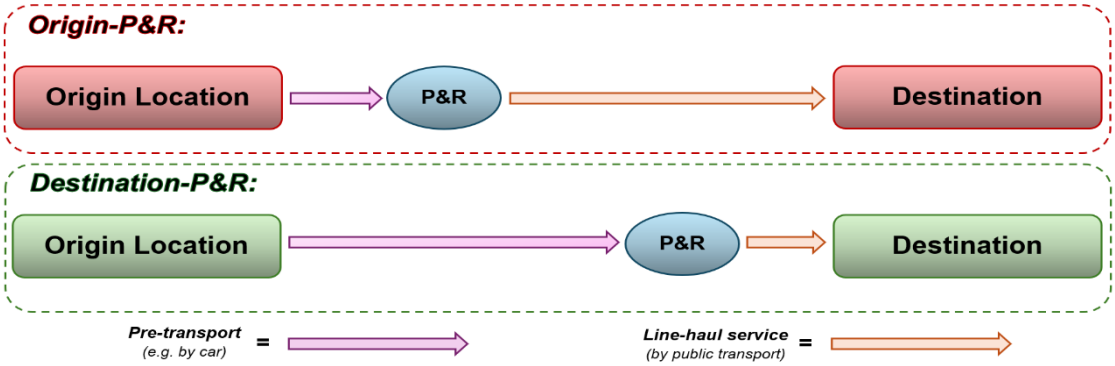


Figure 4: Difference between 'origin-P&Rs' and 'destination-P&Rs' (Own work based on KpVV (2013)).

This second type of P&R facilities, which is aimed at high-frequency public transport in densely populated urban areas, consisting of mostly busses, trams and metros, is therefore relatively less present in the Dutch transport network (CROW, n.d.). The train as 'follow-up transport mode' at P&R facilities, however, is present everywhere in the Netherlands, both in the cities and in the more peripheral region, and is central to both government investments and research reports, as is discussed further in Chapter 1.4.1.

This preference for trains over the use of buses, but also trams and metros, is clearly visible in the Netherlands (KpVV, 2013), while studies from abroad have shown that there is indeed potential in these *destination-P&Rs*. For example, a British study shows that, despite the view from the 1990s that P&R in its current guise could actually exacerbate rather than alleviate the problems of traffic congestion, fuel consumption and emissions, there are alternative models that offer potentially significant improvements (Meek et al., 2008). These forms of broadening chain mobility, using high-frequency bus lines, could possibly also solve the similar issue experienced on this side of the Channel.

However, little research has been done into the situation of bus-based P&R facilities in the Netherlands and this concept is also less socially known compared to the train-oriented alternative. It also appears from both scientific research and the media, as well as my own experience, that there are varying stories of success and failure regarding bus-based P&R facilities. The theoretical literature does provide a clear picture of certain factors and conditions for a well-working P&R facility, as can be read later in Chapter 2, but the question is whether there may be other factors that influence the situation of specifically *bus-based* P&R facilities in the Netherlands.

1.3 Research Objective & Questions

Now that the historical context, the (personal) reason for this research and the problem statement have all been established and explained, it is necessary to look at the ultimate goal of this research and the associated research questions. The ultimate aim of this research was to investigate which factors influence the situation, and therefore the success, of bus-based P&R facilities in the Netherlands. These factors may already be known in the literature or may not yet have been established academically. Through various research phases, which are presented below (figure 5), this final research goal was achieved and the guiding principle in these phases was the following main research question:

> ***"What is the current situation of Dutch bus-based P&R facilities, based on existing evaluation criteria from the literature, and what factors influence this situation?"***

This research question was then divided into three parts, each of which could be answered with its own sub-question. First of all, the existing evaluation criteria from the scientific literature had to be determined. This was done on the basis of a literature study, which can be found in Chapter 2. The sub-question drawn up for this phase of the research is as follows:

1. ***What are the evaluation criteria identified in the existing scientific literature that can be used to assess the situation of bus-based P&R facilities?***

The next step in the research was to map the current situation of the Dutch P&R facilities. This was done on the basis of a survey that was subsequently shared with a number of experts in the field of specific P&Rs in the Netherlands. These experts have assessed the P&R facility known to them on the previously established evaluation criteria from the first sub-question. Based on their answers and assessments, the following second sub-question could be answered:

2. ***How do the contacted experts assess the current situation of Dutch bus-based P&R facilities based on the evaluation criteria outlined in the literature?***

Finally, the third part of this study looked in more detail at eight interesting cases, which were selected based on the answers of the experts in the survey. This concerned, for example, municipalities with P&R facilities that performed worse or better than others, or municipalities that had remarkable features or a unique situation. In this in-depth part of the research, these cases were analysed based on interviews with experts to find out how their situation came about and whether other factors may have played a role in the situation. This multiple case study therefore provided a more general picture of the factors that influence the situation, or the success and failure, of bus-based P&R facilities. The established evaluation criteria from the first research phase, in combination with the survey results from phase #2, have led to the formulation of this following third and final sub-question:

3. ***What factors cause the situation of Dutch bus-based P&R facilities, and are there any additional unidentified factors that influenced this?***

To systematically approach these three parts of the research, consisting of a literature review, a survey and eight broad case studies, and ultimately answer the main question, the three sub-questions were answered step by step. Figure 5, shown below, schematically shows each phase completed in this research.

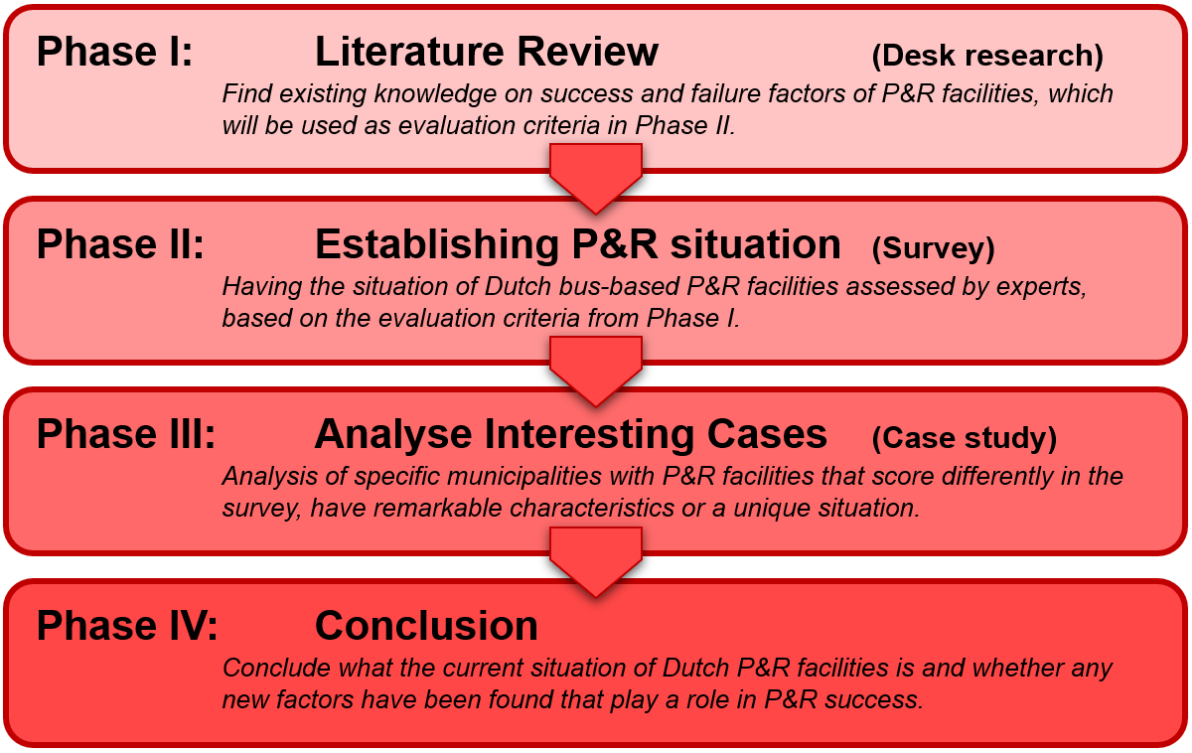


Figure 5: Four phases of this research on bus-based P&R facilities (Own work).

1.4 Relevance

With the research objective and questions clearly established, we can now delve into the relevance of researching Dutch bus-based Park and Ride facilities. Below, first the scientific and then the social relevance is discussed. This first part describes how and in what form this research has contributed to the existing academic knowledge in the field of P&R facilities. Finally, this paragraph ends with a description of how the results and conclusions of this research can possibly improve the current situation and increase the use of P&R facilities to eventually solve the contemporary problems of poorly running bus-based P&Rs in the Netherlands.

1.4.1 Scientific Relevance

First of all, it can be said that this research contributes to the scientific understanding of urban transport planning by providing an in-depth analysis of bus-based P&R facilities in Dutch municipalities. In addition, it can be stated that relatively little research has been done into bus-based P&R facilities, both in the Netherlands and the rest of the world, and that the knowledge from these studies is relatively old. An example of this existing research gap is discussed below.

Bus P&Rs in the Netherlands and the UK

As briefly mentioned in Chapter 1.1, there are different views on the P&R phenomenon. Some policymakers are very enthusiastic about this concept (Bailey & Dimitrio, 1972; Meek, et al., 2008; Runkel, 1993), while some researchers view it with scepticism due to the unachieved intended effects and the negative consequences (Topp, 1995; Parkhurst, 1995; Pickett & Gray, 1996). Opinions on this subject are thus divided, but the results of implemented P&R facilities in the Netherlands show a clear difference with those of other European countries.

A research by Bos and Van der Heijden (2005) showed that in the Netherlands the general lack of success with P&Rs is generally attributed to the insufficient excess demand for parking spaces in city centres and a lack of sustainable political support. In the United Kingdom, on the other hand, bus-based P&R facilities have become very popular in recent decades (TAS Partnership, 2007). The Netherlands and the United Kingdom are two of the most densely populated European states and have therefore faced similar mobility problems in terms of urban sustainability earlier and more severely (Dijk & Parkhurst, 2014). As a result, they are seen as the two pioneers in the field of innovative parking policy (Stienstra, 2004), and it is precisely the difference in this policy that has ensured that the Netherlands and the UK have noticed differences in the success of P&R facilities over the years.

While Dutch policy opted for public ownership of the public transport service and the provision of P&R facilities integrated into existing public transport lines, the UK opted for a different approach in which there is a private public transport service and P&Rs are offered as a dedicated service (Dijk & Parkhurst, 2014).

These differences in national P&R policies have shown different evolutions over the past decades. In the Netherlands, the government decided relatively early (1990s) to provide support in the form of a series of national policy and financing programs designed to promote intermodal, integrated chain mobility, including P&R. The British trajectory, on the other hand, consisted of a 'bottom-up' initiative by mainly individual local authorities that wanted to tackle the growth of urban traffic through investments in P&R facilities from their own capital (Parkhurst et al., 2012). This British bottom-up approach has ultimately ensured that P&R facilities on the English side of the Channel today run better than in the Netherlands. Figure 6 shows the problems identified by Bos and Van der Heijden (2005) in the field of P&R facilities, as well as the largest differences between Dutch and British policy on this subject.

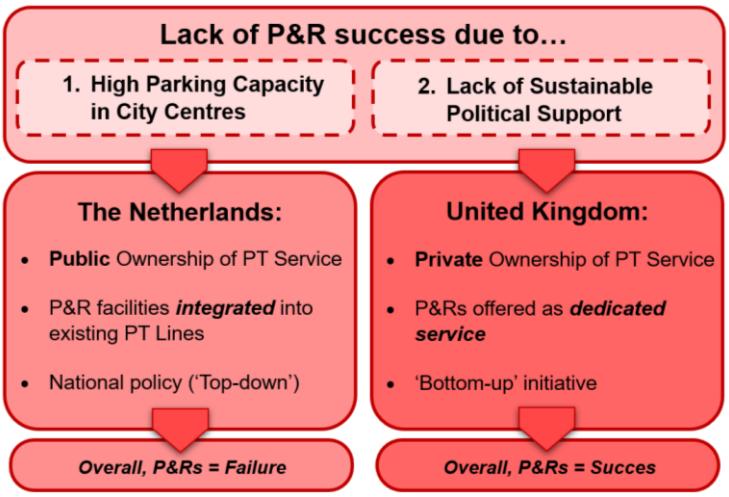


Figure 6: Difference between the Dutch and British policy on P&R facilities (Own work based on Dijk & Parkhurst (2014) and Parkhurst et al. (2012)).

The studies mentioned therefore show that until approximately 10 years ago we can conclude that the British P&R policy has led to more success in the field of P&Rs. However, after that time there are virtually no sources to be found that further explain this difference between the countries, or describe the current, or at least more recent, state of Dutch bus-based P&R facilities. There is therefore relatively little research that has specifically focused on the analysis of bus-based P&R facilities in the Netherlands in recent years.

Besides, these Dutch bus P&Rs are often included in the same studies as other train-P&Rs, in which they are hardly or not discussed at all due to the relatively lesser presence of bus-based P&Rs (Mingardo, 2016). In the few cases where recent specific research is conducted into bus-based P&R facilities, this often concerns a study in the United Kingdom. Therefore, these British studies will mainly be used in the following literature review of Chapter 2.

There is therefore a research gap, where too little is known about Dutch P&R facilities in general, and in the few cases where research has been conducted, it mainly looks at train-based facilities in the Netherlands or bus-based P&Rs only in the UK. In addition, this knowledge is often relatively old, which could mean that the findings and observations made in those studies may have changed or even no longer apply today. It is therefore important to focus this research specifically on bus-based P&R facilities in the Netherlands. The findings in this study offered the opportunity to validate and refine existing theoretical models regarding P&R facilities, contributing to the evolution and accuracy of urban transportation planning frameworks.

1.4.2 Societal Relevance

In addition to scientific relevance, the research must also be societal relevant. The research focused on identifying and further analysing the current situation of bus-based P&R facilities in the Netherlands. This ultimately led to a number of specific Dutch P&R facilities that stood out in some way, for example based on evaluation criteria from the literature, being brought to attention and further investigated. This in-depth research revealed new success or failure factors, ultimately allowing policy makers to improve the effectiveness of bus-based P&R facilities. Success in this endeavour could in the future lead to greater use of public transport, reduce individual car use, reduce traffic congestion and contribute to a more sustainable and efficient urban transport system, which in this time and age of climate change will help reduce CO2 and air pollution that allows environmental objectives to be achieved (Mingardo, 2016).

The greatest and probably most visible progress that this research can make possible is the improvement of the commuting experience (Zijlstra et al., 2013). The research focuses on bus-based P&R facilities, which in turn directly concerns the experience of commuters. Findings from this study provide preconditions for the success of bus-based P&R facilities, ultimately allowing future P&R projects to take this (currently unknown) factors into account. This may have the effect of increasing the usability and convenience of bus-based P&R facilities in the future. This not only promotes a positive perception of public transport options, in this case buses, but also encourages a modal shift towards more sustainable and shared modes of transport (Meek et al., 2008; Zijlstra et al., 2013).

These positive social contributions are generally taken care of by three actors, namely: the national government, which stands for interregional accessibility and the condition of the environment; cities and regions, which focus on quality of life, accessibility and the competitive position of the companies established in their area; and thirdly, road authorities who have a daily responsibility for traffic flow on ‘their’ road network (KpVV, 2013). The practical insights that may emerge from this research will enable city planners and policymakers to allocate resources more efficiently.

By understanding the factors that influence the success of bus-based P&R facilities, decision makers can make informed choices that maximize the positive impact on public transport accessibility and overall transport efficiency.

2. Literature Review & Theoretical Framework

Now that the research problem, the objective, the questions and the relevance have been determined, we can zoom in more deeply on the first sub-question and stage of this research (shown in Figure 5), namely: the literature review. In this chapter we will first look at the overall definition, the users and the functioning of P&R facilities. Secondly, the different P&R types are discussed, followed by a closer look at the evaluation criteria for P&R facilities and the current criticism thereof. Ultimately, these factors that determine the success or failure of facilities will be central to the conceptual model, which serves as the common thread in this research, and is based on the current scientific knowledge summarized in this chapter.

2.1 Definition & Context of P&Rs

As mentioned above, the concept of Park-and-Ride is a form of traffic demand management that concerns certain public transport facilities that are spread over a certain (urban) area. It serves as a connection point that offers private vehicle users the opportunity of a modal shift and a chance switch to a more sustainable mode of transport, such as buses or trains (Antolín et al., 2019). In most cases, this phenomenon concerns commuters who want to travel from their origin point, usually their home, to a central destination, for example the city centre. The journey there is often inconvenient to make with a private vehicle due to, among other things, heavy traffic or insufficient parking facilities at the destination (Parkhurst, 2000).

This accessible transfer point thus gives private transport users the option to transfer to the transit system in a certain (urban) area, where the connection and accessibility of public transport is generally much better, making the journey more convenient (Parkhurst & Meek, 2014). As mentioned before, this study will only analyse bus-based P&R facilities, which means that only P&Rs with a connection to the bus network, and therefore no other public transport means, such as train, tram or metro, will be considered.

2.1.1 Who are the P&R users?

Although a description of P&R facilities is given above, there is not really one clear and agreed definition of this concept. “What it actually is” and “what it should be” are effortlessly confused due to the phenomenon of ‘theory led by policy’. This phenomenon, as the name suggests, involves a situation in which academic concepts are influenced or guided by practical policy considerations. In other words, the development of theoretical concepts is driven by the needs or objectives of policy makers and the real-world problems they are trying to address (Lovering, 1999). As a result, the term Park-and-Ride is surrounded by a certain degree of ambivalence. Every station or bus stop with a parking space can be seen as a P&R facility in the broadest sense of this concept (KpVV, 2013). This has meant that, according to Zijlstra (2020), it is important to distinguish between the P&R-*action* and the P&R-*facility*, as these make a difference in the target groups that are relevant for an evaluation of P&R facilities.

First of all, the ‘Park-and-Ride’ concept concerns an ‘act’ of multimodal travel, as mentioned above. A P&R ‘facility’ is a location with a planned facility constructed by a competent authority, such as the government or a public transport authority. There are various motives for constructing such a facility, such as reducing car traffic in the urban environment or encouraging more sustainable transport. The P&R facility is then used as an instrument to have an intended target group perform a certain (P&R) action (Zijlstra, 2020).

In the ideal scenario, facility, action and target group correspond perfectly, but this is obviously not always the case. Table 2 shows the four possible target groups that ‘arise’ from the interaction between P&R facility and P&R action. This provides the following options:

A1. This is the perfect example of reaching the right target group. For example, a motorist who would normally cover the entire distance of his journey by car, but now parks at a P&R facility to continue traveling by public transport (Zijlstra, 2020).

A2. Facility and practice are not necessarily linked. For example, motorists are not necessarily bound to a P&R facility; After all, they can park their car in different places and then make a P&R action, in other words: continue their journey by public transport (Zijlstra, 2020). This is also confirmed by a study by Pickett & Gray (1993) on the London Underground, which showed that the number of P&R actions was three times as high as the number of parking spaces at P&R facilities. It is therefore important to additionally check the actual use of the facility if we want to make statements about the contribution of certain planned P&Rs. When researchers look at the number of travellers who are 'intercepted' by the P&R facility, they must distinguish between the group that actually uses the facility and the so-called "informal P&R travellers" (Zijlstra, 2020).

B1. There is also the possibility that the P&R facility is used by motorists who do not then travel by public transport, but only park their car because they have to be in the vicinity of the P&R location. Activities other than the 'normal' P&R action are difficult to rule out because P&Rs are often relatively cheap or even free public facilities. Users of the parking facility can therefore also be citizens who want to park their car somewhere cheaper, without the expensive parking permit that is often required in cities (Zijlstra, 2020). This is called the Park-and-Walk principle by Mingardo (2013); the unintended effect that motorists use the P&R as a normal parking facility, without using the public transport connection, because the P&R is within walking distance of their final destination. In principle, this does not necessarily have to be seen as something negative, but for bus-based P&Rs these users are the wrong target group.

B2. Finally, there are non-multimodal trips that do not interact with the P&R facility. This group shows that their movements are often too marginal to note any measurable or noticeable effects, making P&R actions and facilities peripheral phenomena (Zijlstra, 2020).

	A: P&R action	B: No P&R action
1. P&R facility	Possible target group (A1)	Wrong target group (B1)
2. Not via P&R facility	Informal P&R travellers (A2)	Other (B2)

Table 2: Four main groups of travellers that could be relevant for the evaluations of P&R facilities (Zijlstra, 2020).

It is therefore important that this study looked at the distinction between 'ordinary' travellers/commuters and the actual users of Dutch P&R facilities in order to make a correct assessment. However, it soon became apparent that an in-depth study among users, in which each user is assessed on his use of the P&R facility, was very extensive and difficult to do with the available data. That is why this knowledge was kept in mind in the further research phases, but there was no deeper research into the type of user per P&R facility discussed. Nevertheless, during the interviews with experts, questions were asked about this subject and any knowledge about it, which allowed for a clearer picture and a better evaluation of the situation of the P&R facilities.

2.1.2 Pre- and post-transport

The choice to use the P&R system to get from point A to point B ensures that the mobility chain is expanded. Travellers have to transfer from one mode of transport to another to get to their final destination and since most forms of public transport do not provide door-to-door service, pre- and post-transport is an unavoidable and important part (Zijlstra et al., 2013).

Pre- and post-transport refers to the *access* (pre-) and *egress* (post-) modes of transport used before or after the use of the 'main mode of transport' (Krygsman, 2004). This can also be seen in figure 7, which gives an example of a multimodal travel movement. The modes of transport on the origin side (on the left in figure 7) are called the "access modes", while the modes on the destination side (right) are called "egress modes". The lines in the middle, between these two sides, represent the line-haul services. In the case of the bus-based P&R system, this middle line is the journey that the bus makes, and the left circle could therefore represent a P&R location (Krygsman, 2004).

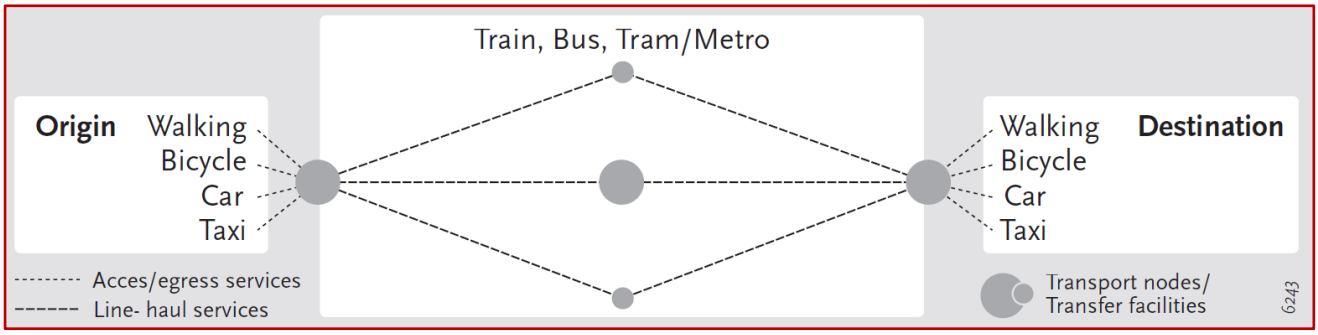


Figure 7: Schematic outline of multimodal transport (made by Krygsman (2004) based on Vork et al. (1998)).

The important role of access and egress modes is confirmed by another study by Krygsman, Dijst and Arentze (2004), which shows that 20 to 50% of the total travel time of public transport journeys consists of pre- and post-transport. In addition, it appears that as the travel distance becomes shorter, the importance of pre- and post-transport increases. The mode and quality of reaching the bus-based P&R and the later departure after using the bus service therefore weigh in on the assessment of the trip and therefore also in the assessment of the public transport services (Krygsman, 2004). Compared to other means of transport, the use of your own private car would be best in several respects as an access or egress mode. A car is hardly limited in range, provides comfort and shelter from weather conditions and is always available at your front door (Zijlstra et al., 2013). But why wouldn't people then constantly use the car and simply ignore the public P&R system, if using a car is so much more beneficial?

This has to do with the benefits that travellers get from transferring at a P&R location. This stopover gives travellers the opportunity to eliminate the effort and possible stress of driving and parking in city centres and replace it with a simple bus line. In addition, parking at a P&R facility ensures that car users pay a lower parking fee and do not have to deal with lengthy traffic jams. Public transport also offers a nice alternative in the urban context due to its high frequency of services (e.g. multiple bus lines) and special facilities (e.g. bus lane), which means that the use of public transport saves time compared to normal car use (Zijlstra et al., 2013).

> "*In short, the city is less suitable for cars, while the public transport system can play its strengths there. By leaving the car behind on the road and continuing the journey by public transport, the traveller can benefit from the benefits that both modes offer*" (Zijlstra et al., 2013, p.5).

Nevertheless, we must bear in mind that these advantages of P&R facilities are partly dependent on the pre- and post-transport as Krygsman (2004) mentions in his research. The quality of the access and egress modes must be of a certain value to convince people to use P&Rs and this quality was therefore taken into account in the assessment of the overall trip and the P&R location.

2.2 Typology of P&R facilities

In addition to the kind of users and the pre- and post-transport, the type of P&R facility also plays a role in the evaluation. There are various types of P&Rs, as was already mentioned in chapter 1.2, in which a distinction was made between *origin-P&Rs* and *destination-P&Rs* (figure 4). Here the difference was found in the location of the P&R facility in relation to the origin location or destination, which determined the function of the P&R and the length of the journey made using public transport (figure 4). Origin-P&Rs had a relatively shorter pre-transport (or access mode) and a longer use of the public transport, while the opposite is true for P&Rs with a destination function (KpVV, 2013). This thesis therefore mainly focused on destination P&Rs, as bus-based P&Rs often cover a relatively short part of the journey. However, not all bus-based P&Rs in the Netherlands have a destination function and there are also a number of origin P&RS. Both types have therefore been included to optimally analyse Dutch bus-based P&Rs.

But this distinction based on location compared to origin location and destination can be divided even more specifically and extensively on the basis of the specific location of the P&R in the spatial environment, which occur in many theoretical evaluations (EU, 2005; Meek et al., 2008; Zijlstra, 2020; Province of Utrecht, 2022). A distinction is then made based on the location and function of the P&R facility in the travel chain.

At the beginning of this century, there was still a division into three categories, namely: “Remote P&Rs”, whose function was to collect commuters at their origin destination, usually in suburban residential areas; “Peripheral P&Rs”, which aims to intercept commuters just before their final destination, located on the edge of the city; and third, “Local P&Rs”, which are used to intercept commuters somewhere along their journey (between origin and destination), for example at non-residential locations such as major transport corridors (EU, 2005; Meek et al., 2008).

However, more recent evaluations of P&R facilities use an enlarged and more detailed version with not three, but five categories. These are the following five types of P&Rs, which are also depicted in figure 8 below:

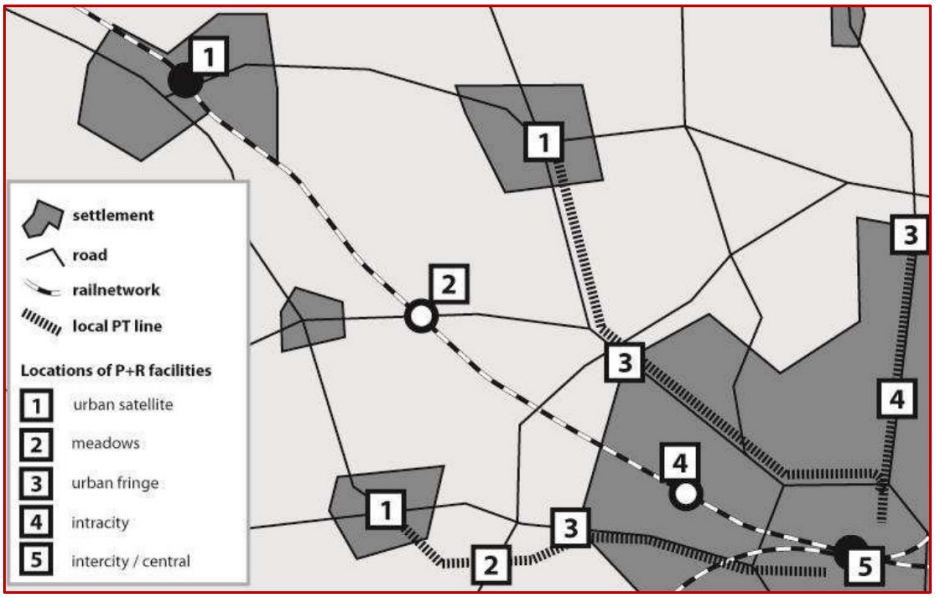


Figure 8: Schematic representation of the different types of locations of P&R facilities (Zijlstra et al., 2013).

1. First, the *Satellite P&R*. We find this type of P&R near a group of potential users, but it is located outside the big city, which will be the final destination for the majority of this group of travellers (Zijlstra et al., 2013). This type is, according to Stelling (2011) and Baas et al. (2012) comparable to the aforementioned 'P&R with origin function'; a facility that 'intercepts' commuters before they enter the highway and allows them to travel a relatively long distance by public transport (KpVV, 2013). This P&R is generally located a considerable distance from the city at a train station in a regional core, meaning that most users live within a radius of a few kilometres, making for a small catchment area. An example from the Dutch province of Utrecht is the town 'Woerden', as shown in figure 9; a medium-sized city with a train line to the central, large city (Provincie Utrecht, 2022).

Figure 9: The satellite P&R facility at Woerden station and its location in relation to the larger city of Utrecht. The train connection between these two cities is indicated in orange (Own work made with Open Street Map (2024)).

2. The second type are the *Rural Transport Nodes*, or as it is labelled by some Dutch and Belgian researchers: "P&Rs in the middle of the meadows". This P&R facility is, as the name suggests, some distance from both residential areas and the economic heart of a region (Zijlstra et al., 2013). Located in a strategic location, where the main road network and public transport services meet, this type of P&Rs has a large catchment area. The users have either first travelled a longer distance on the highway along which the P&R facility is located or come from villages in the area (Provincie Utrecht, 2022). A concrete example of a Rural P&R facility is the 'Lage Zwaluwe' station along the A16, between Rotterdam and Breda (figure 10). This was constructed to get motorists off the highway and onto the train during large-scale maintenance work on the nearby Moerdijk Bridge to prevent further congestion (Zijlstra, 2020).

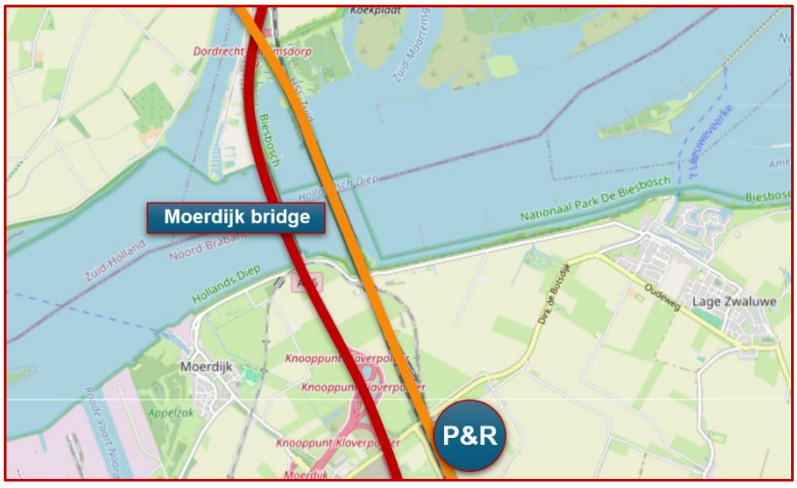


Figure 10: The Rural P&R at Lage Zwaluwe station and its location in relation to the Moerdijk Bridge. The train track is indicated in orange, the A16 highway in red. The presence of this P&R therefore offers a perfect alternative for motorists if there is congestion, for example, due to road works (Own work made with Open Street Map (2024)).

3. The *Urban Fringe Facility* is the third P&R type. These are facilities that have been built by local authorities, such as municipalities, on important access and exit roads on the edge of urban areas (Zijlstra et al., 2015). Travellers are given the opportunity to park their car in a cheaper place before entering the city and continue their journey by public transport. The public transport facilities at these locations are very frequent and there is a commute between the city-edge parking and the city centre all day long. This, in combination with its accessible location, also ensure that the catchment area of this type of P&R facilities is relatively large. Users can come from both local residential areas and more distant regions from across the country (think of day trippers, for example) (Provincie Utrecht, 2022).

   This type of P&R is particularly popular in the United Kingdom, partly due to its location on cheap land within the municipal boundaries, which makes the development of the facility easier. But there are also have plenty of examples of this P&R-type in the Netherlands. For example, both “P&R Genneper Parken” in Eindhoven (Omroep Brabant, 2021), mentioned in the Chapter 1.1, and “P&R Pettelaarpark” in ‘s-Hertogenbosch are P&R facilities with a high-frequency bus line, located on the edge of the city (figure 11) (Zijlstra et al., 2013).

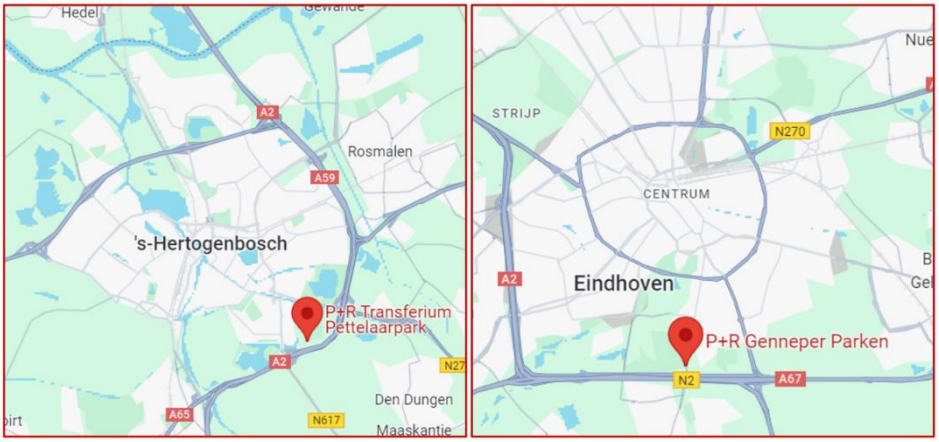


Figure 11: On the left you can see the location of P&R Pettelaarpark in relation to the centre of 's-Hertogenbosch. The right image shows the location of P&R Genneper Parken in relation to the centre of Eindhoven (Own work made with Google Maps (n.d.-a)).

4. The fourth type of P&R locations are *Intra-urban sites*. These are parking facilities at public transport hubs in the urban area. Most users of these P&R facilities reach them by non-motorized vehicle (on foot or by bicycle), but for those who come by car, there is also a possibility to park (Zijlstra, 2020; Province of Utrecht, 2022) . However, the size of these P&R locations is limited by their location in the densely built-up urban area, if one can even speak of a 'formal P&R facility'. In the Netherlands, this facility is in most cases built as a parking lot next to an existing main public transport line, which makes it different from, for example, a city-edge P&R that has been developed for a specific purpose (Zijlstra et al., 2013).

   According to White (2002), an intra-city P&R facility only occurs in large cities with at least 500,000 inhabitants. Certain metro stations in the London Underground could therefore also be labelled as this type of facility (Transport for London, 2010). However, in the Netherlands, due to the relatively low population and smaller cities, compared to the rest of the world, these conditions are not taken into account very strictly, which is why P&Rs at stations such as Utrecht Overvecht and Amersfoort Schothorst are also regarded as examples of Dutch intra-urban sites (figure 12) (Provincie Utrecht, 2022).

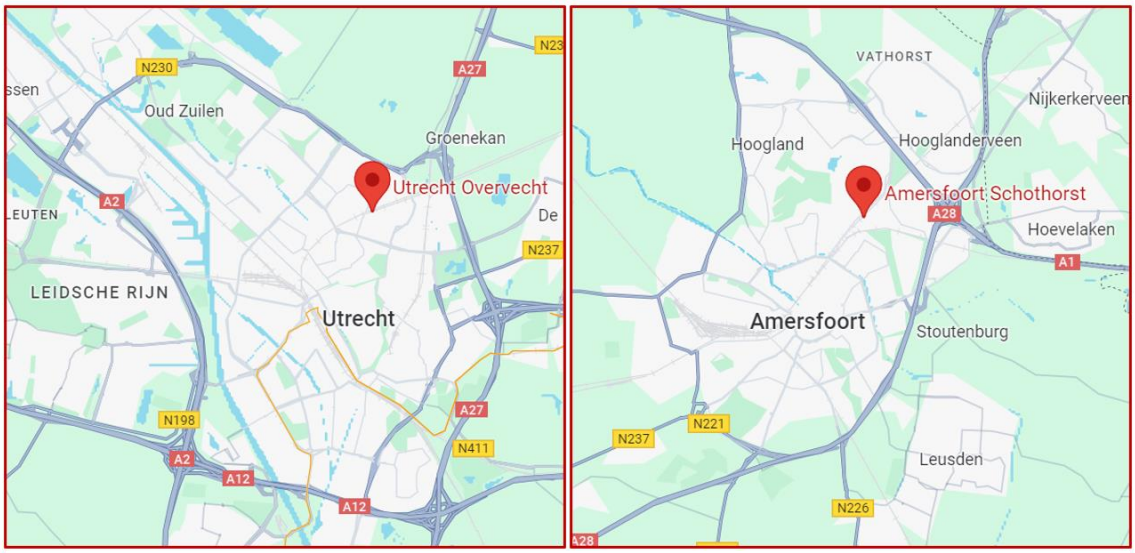


Figure 12: On the left you can see the P&R location at Utrecht Overvecht Station compared to the centre of Utrecht. The right image shows the location of the P&R facility at Amersfoort Schothorst in relation to the centre of Amersfoort. In both cases, the P&R facility is located in the urban area and offers a train connection to both the city centre and to other (urban) areas (Own work made with Google Maps (n.d.-b)).

5. Finally, there is the fifth type: *Central P&R Facilities*. This parking is usually located at a major public transport nodes within an urban area, which has high connectivity and the convergence of multiple forms of public transport (Zijlstra, 2020). It therefore shows similarities with P&R type 1, the “Satellite P&R”, in the form that both types in most cases consist of a station, with an intercity connection, in the middle of a residential area. However, the difference lies in the larger size, greater number of destination options (due to the high-quality public transport facilities) and the higher parking costs (due to its central location) that Central P&R Facilities have compared to type 1 (Zijlstra et al., 2013).

   Approximately every central station of a large Dutch city with a parking lot can serve as an example for this type of P&R facility. A concrete example can nevertheless be found in Breda, where the roof of the new station functions as a car parking lot and there are a number of fast intercity/international train connections to, for example, Rotterdam, Schiphol, Amsterdam, Brussels and Antwerp (Zijlstra, 2020).

This subdivision is just a simplified representation of the five different types, but in practice this is of course not as straightforward as it now seems. For example, there are usually no clear boundaries between cities and provinces, which can cause confusion. In addition, some intra-city P&Rs can easily be confused with city-edge facilities, and it has also been shown that types 1 and 5 can be similar in some respects (Zijlstra et al., 2013). Imagine if someone parks his car at Amersfoort Station and takes the train to Utrecht, is this a Satellite P&R facility (type 1) or a Central P&R facility (type 5)? This is not clearly defined in the literature. It is therefore only a simplification of the larger whole of P&Rs (Zijlstra, 2020).

Because this study focused on *bus-based* P&R locations, it primarily discusses *Urban Fringe facilities.* This third type of P&Rs usually has a direct bus line to the city centre, as the examples in figure 11 already indicated, and is (in most cases) constructed specifically for this purpose, rather than added to an existing situation. However, this does not mean that only this P&R type has been discussed. In phase II of this research, all bus-based P&Rs in the Netherlands were analysed by means of a survey. Facilities in eight municipalities were then further investigated in depth in phase III in the form of case studies (figure 5). But before the next phase can be looked at, the well-known evaluation criteria from the literature must first be addressed. This is discussed in the coming paragraphs.

2.3 Zijlstra's (2020) critique on current evaluations

In order to properly analyse the bus-based Park-and-Ride facilities in the Netherlands, a number of experts have been contacted through a survey to assess each P&R facility on certain variables. This method of data collection is discussed later in this thesis (Chapter 3), while in this section the main focus is on identifying the meaning of a successful P&R, as mentioned in the scientific literature. The question therefore is: how do we determine 'P&R-success', and what are the most recently identified factors that could potentially help us evaluate the current situation of Dutch bus-based P&Rs? These questions, which relate to the first sub-question from Chapter 1.3, are discussed in this section by reviewing the recent criticism by Zijlstra (2020).

2.3.1 Current limitations

First of all, Zijlstra's (2020) article, in which he discusses the role of P&R in research and policy, shows that, in his view, the usual approaches to P&R evaluations are quite limited and not entirely correct, and this is due to the following three parts:

1. The lack of attention to fairness and efficiency;
2. The reversal of means and ends;
3. And finally, the need to separate the effects of the P&R facility and the effects of the accompanying measures.

His criticism calls for broadening the current scope of evaluations and therefore these three points will first be addressed one by one before we can proceed with determining the meaning of 'P&R success' and the necessary evaluation criteria.

2.3.2 Fairness and efficiency as evaluation criteria?

When evaluating policy measures from a societal perspective, the aspects of 'effectiveness', 'efficiency' and 'fairness' are central. These three facets should therefore predominate in policy evaluations, such as the assessment of P&Rs, but in practice they are not always taken into account (Van Wee, 2011).

Effectiveness is about the extent to which a policy measure achieves its goal, think (in relation to a P&R) of 'the reduction of the absolute number of cars parked in the city centre'. *Efficiency*, on the other hand, is usually about the ratio between costs and benefits in achieving that goal. For example, the construction of a P&R facility can be particularly effective, but it can also be very intrusive and expensive, which may make it less efficient. For this reason, a comparison with other types of measures, such as a reduction in parking capacity in the city centre or the improvement of public transport options, can also be very useful when assessing efficiency (Meek et al., 2011).

The third aspect that is not often taken into account in practice is the *fairness* in the distribution of benefits and burdens or risks and opportunities (Van Wee, 2011; Martens, 2017; Jeekel, 2018). For example, the development of a P&R facility can, sometimes unintentionally, cause traffic to become busier in certain places than in others, causing some residents to be disadvantaged and others to benefit. An investment in a P&R location can also be at the expense of other possible investments, which can again create an unfair situation (Zijlstra, 2020).

The literature shows that there is only limited discussion of these three aspects. And if one of these aspects is concerned, the effectiveness of the intervention is mainly examined, but a comparison with other measures, regarding efficiency compared to alternative policies, is always neglected. The distribution issue, which relates to fairness, is also not addressed in evaluations surrounding P&R policy, while many governments say they strive for social

objectives, for example regarding participation and equal distribution of opportunities (Van Wee, 2011; Martens, 2017). There are therefore opportunities for a more comprehensive evaluation of P&R facilities with regard to efficiency and fairness (Zijlstra, 2020).

This evaluation of effectiveness and efficiency has, to the extent possible, been more prominent in this study, as it provides a comparison of all bus-based P&R facilities in the Netherlands. However, the degree of depth and concreteness of this comparison is questionable, but more will be said about this later in the discussion (Chapter 6).

The fairness in the distribution of opportunities and risks is not addressed in this study, because no in-depth research has been conducted into the P&R user groups, but only into the state of the Dutch P&Rs. However, this could possibly emerge from a follow-up study.

2.3.3 'End-means reversal'

The second point of criticism by Zijlstra (2020) on the current approach to P&R evaluations is the one-sided focus on the means, and not the ends. This is a striking fact that can often be found in studies into the effectiveness of P&R facilities, which mainly look at the use of the facility and the change in traffic flows that will result from it. However, the frequently mentioned ends of P&R are generally not considered, such as reducing emissions or relieving parking pressure (Meek et al., 2009; Dijk & Montalvo, 2011). If we were to look at these aspects, the respective amount of emissions or the number of vehicles parked in the city centre would have to be monitored in the evaluations, but so far this is still to a limited extent.

If researchers and policymakers only look at the means in the form of the use of a P&R (e.g. in the form of an occupancy rate percentage), it may simply be the case that new or more motorists have taken their place on the road, causing the so-called 'gain', thanks to the P&R measure, is cancelled out. The P&R facility may be full (means), but if the traffic or the number of parked cars in the city centre does not decrease, this means that the P&R has not achieved its goal; the means do not meet the end. Zijlstra (2020, p.10) describes this beautifully in a metaphor: *"the operation was successful, but the patient died"*.

There are only a few studies that translate the effectiveness of the means into the effectiveness with regard to the ends. Parkhurst (1995) is one of them. In his article he 'translates' car kilometres into emissions and also takes into account the extra vehicle kilometres of the more frequent bus services. However, this is a fairly unique exception. Measuring P&R-induced changes, in the form of differences in traffic flows or emissions, is often extremely complicated. In addition, researchers must also take into account other changes that may occur over time, such as economic developments, population growth or temporary changes to the road network. It is therefore logical that, for example, a government, as initiator and operator of the P&R facility, would like to have its P&R measure evaluated due to the high investment, but to do this in the correct and comprehensive manner, by looking at the ends and not just the means, makes this like looking for a needle in a haystack (Zijlstra, 2020).

It is therefore very relevant for this research to also monitor the stated ends of the P&R facilities in order to properly assess them. However, Zijlstra (2020) already shows above that such an in-depth investigation of both the means and the ends is very extensive and difficult. That is why it was chosen not to investigate this further in this study. This does not alter the fact that this theory was included in the questions in the survey and the interviews, in which the experts from the various municipalities were asked about their knowledge in this area. Based on this theory, it was possible to critically evaluate the P&R assessment of the experts before a definitive conclusion was drawn.

2.3.4 Distinction P&R measures & other supporting measures

The third and final point that needs to be taken into account to broaden the current scope of evaluations is to distinguish between the effects of P&R facilities and those of other measures. The development of a P&R is often part of a package of implemented measures, such as reduced maximum speeds or higher parking rates in the city centre. This means that the P&R measure is not solely responsible for the resulting change (Zijlstra, 2020).

On a smaller scale, it appears that P&R facilities already cause many changes in themselves, in the form of, for example, higher service levels of public transport, or upgraded hubs, with waiting areas, supervision or even a shop. On the other hand, we also see that such packages of measures also influence people's travel behaviour. It is therefore necessary in a proper evaluation not to fully attribute the resulting effect to the P&R facility, but to separate it from the other interventions made and also recognize their effect (Zijlstra, 2020).

In practice, this disconnect is very complicated, as you cannot know which measure has caused which change in travel behaviour. Therefore, for a proper evaluation, there must first be a thorough explanation of the package of measures. This way, every intervention introduced is clearly visible and it can therefore be determined more accurately what the effect of the P&R facility and the other measures has been (Zijlstra, 2020).

It is therefore very relevant for this research to have a clear picture of the package measures of each bus-based 'P&R municipality' prior to the experts' opinion, because this makes the evaluation a lot more accurate. In this study, the experts contacted were often well informed about the overall traffic policy in their municipality, which made it easier to distinguish the P&R share in achieving certain goals from the other measures. However, it is of course not possible to make a perfect distinction, because P&R implementations are almost always part of a package of measures. Nevertheless, the experts have provided a clear picture of their municipality's situation, which means that Zijlstra's (2020) criticism has been processed correctly.

2.3.5 Most recent P&R success measure

The three points of criticism listed by Zijlstra (2020) indicate what must be taken into account when drawing up, administering and obtaining results. This now gives us the opportunity to delve deeper into the actual meaning of P&R success. Because if it is clear what is meant by 'success', in the context of P&R facilities, it will also become clearer what is needed to achieve it and therefore also which variables should be assessed in the survey.

As briefly mentioned above, the *occupancy rate* or *utilisation percentage* of a P&R facility is often seen by governments and researchers as the way to evaluate such a facility. However, counting the number of "users", which essentially only represent the number of parked cars, on any given working day, does not provide a representative picture of the overall condition of the P&R location, as was also mentioned in Chapter 2.1.1 (Zijlstra, 2020). Another way is to survey users on the site to find out what people's travel behaviour is. Here, counting the number of parked vehicles is ignored and only qualitatively focuses on the travel behaviour of those present. This is essentially a good idea, but has often proven to be unrepresentative due to the small sample size (Zijlstra et al., 2015).

Zijlstra (2020) then devised a formula in which these research methods are combined to obtain the most representative possible picture of the effectiveness of P&R facilities. This effectiveness calculation in turn indicates how successful (or unsuccessful) a P&R facility is. On the one hand, a solid quantitative picture of the number of users from day to day (Q) is needed. On the other hand, a good qualitative picture is needed of the alternative travel behaviour of users of the site, in the (hypothetical) event that the facility were not available (P).

Both together determine the effectiveness (P * Q). After all, the number of vehicles at the P&R facility says nothing about the effectiveness of the intervention, as not all parked cars are equal to the P&R actions taken. This refers to cell B1 from table 2 (Chapter 2.1.1), which describes the wrong target group. In that case, motorists do use the facility by parking there, but choose not to make a P&R action, because, for example, they carry out their activities in the vicinity of the facility (Zijlstra, 2020).

In any case, there must be a change in travel behaviour, for example in the form of a P&R action, to determine an effect. Whether this is a positive or negative effect depends on how travel behaviour has changed (Zijlstra, 2020). For example, someone may decide to switch from using the car from door-to-door, to using a P&R facility. This is the intended purpose of the P&R facility. However, it may also be the case that someone first travels actively (walking or cycling) from door-to-door and now decides to go to the P&R by car and then continue their journey by bus. This has no positive effect on the environment, which in most cases is one of the most important objectives of P&R facilities. Therefore, this indicates that researchers and policy makers must also take into account these types of unanticipated behavioural changes that can also arise from a P&R intervention (Zijlstra, 2020).

The only difficulty with this formula is that it once again requires a comprehensive picture of the origin and destination of each traveller to determine the ‘P’ factor. The travel pattern must therefore be examined for each respondent, which is simply too extensive and therefore not possible in this study.

As a result, it can be concluded that, despite the recommendations from the recent research by Zijlstra (2020), the formula (P*Q) to determine the effectiveness of P&R facilities is too extensive. That is why the recommended ‘P’ was not included in the study and instead the relatively old and long-known variables were used. These are discussed in the next section and used in the rest of the research phases. Nevertheless, it is important to note that Zijlstra’s (2020) criticism was taken into account to critically reflect on the results found.

2.4 Criteria for the Evaluation

From Zijlstra’s (2020) criticism, described above, we can conclude that ‘old’ evaluation criteria miss the mark on several aspects, of which “end-means reversal” is one. A full parking lot says nothing about the intended goal of the P&R facility, which also concerns reducing emissions or parking pressure in city centres (Meek et al., 2009; Dijk & Montalvo, 2011). Therefore it was necessary for this research to broaden the scope, and focus on both the intended modal shift, as it is seen as the main objective, and the consequences that it causes (i.e. the ‘ends’).

The intended goals (or consequences) of this modal shift, initiated by the P&R concept, are to increase the proportion of urban public transport, and to reduce traffic congestion, parking pressure and vehicle emissions (Hamer, 2010; Rosli et al., 2012; Chen et al., 2016). These ends can be achieved by positively influencing the traveller’s travel choice and final travel pattern, from an individual travel mode to public transport (Liu et al., 2022).

According to Bos (2004), there are three main aspects that influence P&R travel behaviour of car-drivers, namely: quality of the P&R facility, quality of the connecting public transport, and the features of the destination. These three aspects can be subdivided into a number of variables, which served as the criteria that have been used in the evaluation of the Dutch bus-based P&R facilities in this study.

2.4.1 Quality of the P&R facility

The first category consists of aspects relating to the quality of the P&R facility. *Accessibility* of the facility is one of the most important aspects of this category. A P&R location must be accessible to the traveller at all times, without having to deal with long detours, traffic jams and/or overcrowded parking spaces (Keck & Lou, 1976; Morral, 1987; Zonneberg & Brohm, 1995). If a P&R facility is not easily accessible, it immediately loses its attractiveness, which influences a traveller's decision-making process and makes him or her more likely to choose an alternative mode of travel, which in most cases is the car (Bos, 2004).

In addition to accessibility, the *quality of the parking lot* itself also plays a role in the attractiveness of the P&R facility. A well-maintained parking lot, which has a relatively lower parking fee than its city centre counterpart, and where travellers do not have to walk long from their car to the bus, increases the comfort and pace of their journey, making the use of the P&R more pleasant (Bos, 2004). Options to reserve a parking space in advance or a Kiss-and-Ride place also give travellers a reason to cross the P&R threshold (Bos & Van der Heijden, 2005).

Besides, facilities that are provided to ease the waiting time ("*waiting time softeners*"), such as heated bus shelters or kiosks, are also beneficial for the attractiveness and therefore the quality of the P&R facility (Bos & Van der Heijden, 2005). In addition, if there is an option to combine certain activities ("*activities combiners*"), such as a P&R with a supermarket or a gas station, they can also have a convincing effect on the decision-making process of travellers (Bos, 2004).

Finally, the *safety* aspect is perhaps the most important factor determining the quality of the P&R facility. A safe environment for both travellers themselves and their cars is essential for creating comfort and attractiveness (Foote, 2000; Koens et al., 2000). To achieve a safe P&R, there must be some form of supervision, for example in the form of parking attendants or cameras. But often the simple presence of people in a well-lit environment is enough to create social control (Seik, 1997; Foote, 2000). Combining facilities, such as a supermarket or restaurant, would only enhance this social control and at the same time also make the P&R facility more attractive (Bos, 2004).

Customer-wish Pyramid

CROW (2015) shows that the aspects of this category can also be seen as part of the *customer-wish pyramid* in figure 13. The quality of the P&R is slowly 'built up' based on the customer-determined importance of the P&R characteristics. Only higher-level quality requirements can be considered if the underlying requirements are of sufficient quality. It is clear that the bottom layer 'safety and reliability', which also refers to the reliability of the onward transport, that is discussed in the next paragraph, indicates the basic conditions for the use of a P&R. If this is not present, a P&R is not attractive and therefore of poor quality (Empaction Mobility, 2018).

One layer above the two basic conditions mentioned we find 'pace'. This aspect is also part of the 'dissatisfiers', in other words: aspects that a traveller takes for granted and therefore expects at a P&R facility. If a facility does not meet these expectations, this will lead to dissatisfaction among users and the quality will therefore be considered lower (CROW, 2015). By 'pace' we mean, among other things, the travel distance to the P&R (in time) and the walking distance from the parking lot to public transport.

Above the 'convenience' layer, which is discussed in the next paragraph (2.4.2), there is the 'comfort' and the 'experience', or perception, that people have when using the P&R facility. This includes the additional facilities, quality of waiting area and the services available in the

parking lot. These aspects are also called the 'satisfiers' or *pull factors*, which contribute positively to customer satisfaction and can therefore increase the quality of the P&R facility.

In short, to ensure that travellers change their decision regarding their travel pattern, a P&R facility must meet the mentioned qualities. These ensure that this alternative mode of travel is more attractive than taking the car, which ensures that the modal shift, which is generally the main goal of P&R, is achieved.

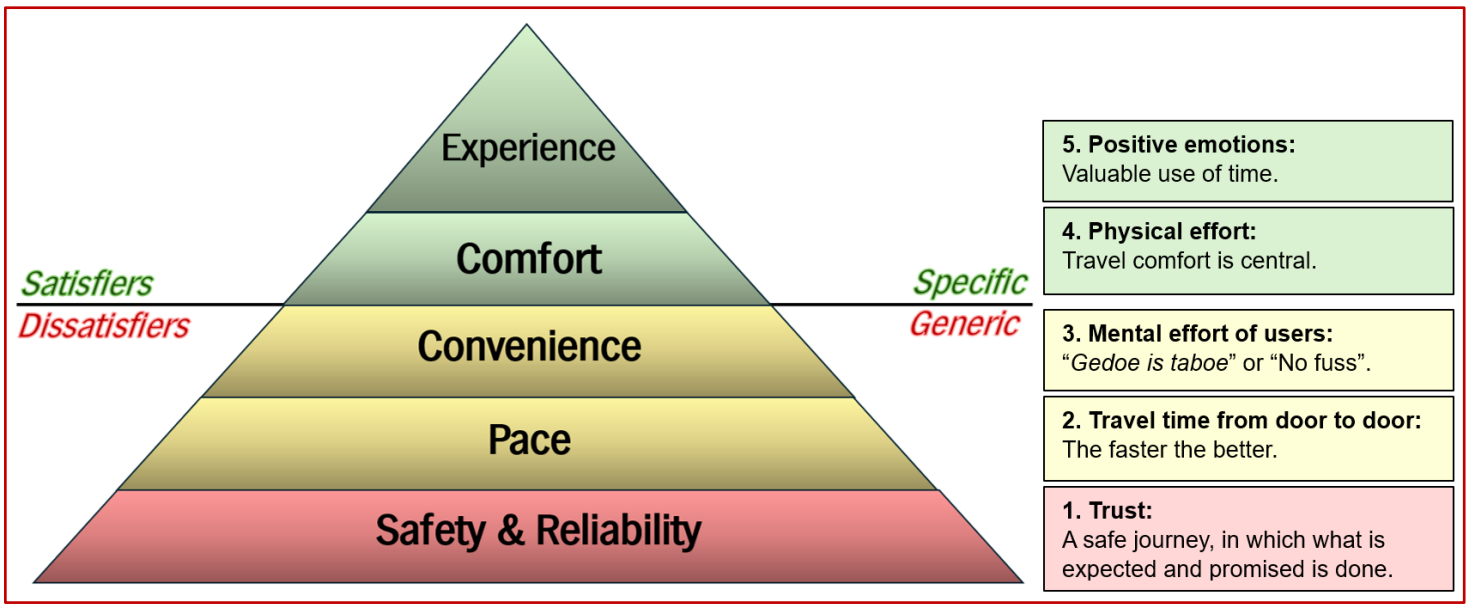


Figure 13: Customer-wish pyramid (Own work based on CROW (2015)).

2.4.2 Quality of Connecting Transport

The second category mentioned by Bos (2004) is the quality of the connecting transport. This includes three aspects that could mostly be located in the 'convenience' layer in the *customer-wish pyramid* (figure 13). Since this is considered a *dissatisfier*, the aspects that fall into this category are taken for granted by the traveller. If the aspects do not meet expectations, they lead to dissatisfaction, which can negatively influence the traveller's travel choice (CROW, 2015).

The first aspect in this category is the *reliability* of the connecting transport (Bos, 2004). There must be a frequent and fast public transport line with a large reach to ensure, among other things, that any transfers run seamlessly (Bruinsma et al., 1999; Gorter et al., 1999). A higher frequency of public transport gives motorists the freedom to be assured of connecting transport at any time of the day, which increases the ease of use, or convenience, of the P&R facility (Bos, 2004).

Secondly, there are the *features* of the connecting public transport. Consider the rate of a bus ticket that a traveller buys at the P&R facility. The higher this is, the less likely it is that people will use the P&R facility (Bos & Van der Heijden, 2005). In addition, other convenience-based matters, such as the chance of a seat or the available form of public transport, play a role. The former is closely linked to the 'comfort' layer of figure 13, while the latter is mainly related to the 'pace' layer (CROW, 2015). Travellers want to get to their destination as quickly as possible, and a metro or tram is often faster than a bus in terms of travel time. As a result, this faster form of public transport increases the value that people give to a P&R facility and therefore also influences their travel decision-making process (Bos, 2004). However, this will not be reflected in this study as it only focuses on bus-based P&R facilities in the Netherlands.

Finally, there is the informational aspect, which mainly concerns *knowledge about the journey* to the P&R and beyond. Travellers must know where they can find the P&R facility and this can be done, e.g. by means of signage along motorways (with electronic indications showing the number of available parking spaces). In addition, visible timetables both along the roads and at the P&R location itself can attract people to use the facility, making the modal shift a reality (Bos & Van der Heijden, 2005).

2.4.3 Features of the Destination

Finally, there is the third category, which, unlike the other two, does not really focus on the features of the facility or the public transport, but on the final destination. Travellers compare their possible car journey with the use of public transport via the P&R facility on the basis of the following aspects, and make their final travel choice based on that comparison (Bos, 2004).

The first aspect people look at is the *accessibility of their final destination*. Travellers mainly consider the time it takes to get to their destination, by taking into account any delays due to traffic jams that occur after passing the P&R, and the time it takes to find a parking space at their destination. If this time is faster compared to traveling via a P&R, people will most likely not opt for a P&R-action, but for the car (Bos, 2004).

In addition to accessibility of the final destination, the *costs incurred after passing the P&R* also play a role in the decision-making process. Parking costs or tolls that travellers have to pay on some roads form a barrier that is only crossed if one knows that it cannot be travelled in a more economical way (Bos, 2004). The toll will not apply in this study, due to its absence in the Dutch road network, but it can certainly be assumed that the parking costs in the city centre are weighed (perhaps unconsciously) by Dutch travellers against the costs of a parking space at the P&R facility.

Finally, there is the comparison made on the basis of *available information about travel time and car use*. If a traveller knows in advance that there will be extra travel time on the motorway due to, for example, road works or an incident, he is more likely to choose to use the P&R location if it appears to be faster according to his information (Bos, 2004). Especially today, with all kinds of navigation apps, such as Google Maps and Waze, travellers constantly have the opportunity to be informed of all events, both on the road and in public transport (Wagner et al., 2021). As a result, this information plays an even greater role in the final decision-making process of travellers and therefore also in the use of P&Rs.

2.4.4 External factors

Finally, there are external factors that influence the choice that travellers make based on their own character and ideas. This concerns, for example, personal characteristics, such as gender, age or education level. This can influence the way travellers normally travel or determine how committed they are to using their car (Bos & Van der Heijden, 2005).

In addition, certain conditions may change the travel choice. Consider the purpose of travel, weather conditions, time of day and whether there is luggage or other passengers. For example, a traveller is unlikely to park his car at a P&R facility if the buses are not running due to heavy snowfall.

These external factors do influence the choice that travellers make between car- and P&R-use, but these may be different for each user. Therefore, these are mentioned in this literature review and shown in the conceptual model in the next paragraph, but the aspects that fall within this category were not included in the criteria of the survey, as these external factors could not be tested for this research and are not relevant for the evaluation of Dutch bus-based P&R facilities.

2.5 Conceptual Model

In short, there are many aspects that play a role in the decision-making process of travellers. These are divided into the categories (Bos, 2004):

- The Qualities of the P&R facility;
- The Qualities of the Connecting Transport;
- And the Features of the Destination.

These three categories each contain a number of different variables listed above, which have been researched a number of times in recent decades, for example to find out which ones are considered most important by P&R users, and which have the most convincing influence on the decision-making process of travellers (MuConsult, 2000; Bos, 2004). This showed, as the *customer-wish pyramid* of CROW (2015) already suggested (figure 13), that the aspects of *safety* and *reliability* were considered the most important by P&R users, followed by the 'dissatisfiers', or the aspects that a traveller takes for granted, namely: 'pace' and 'convenience'. The satisfiers, on the other hand, are made up of *comfort* and previous *experiences*, and are the last two aspects that can influence travellers' decision-making processes (CROW, 2015).

With the three categories mentioned by Bos (2004) and the aspects from the *customer-wish pyramid* of CROW (2015), it is possible to look more specifically at the role of concrete variables that influence travellers' decision-making process and therefore also the potential use of P&R facilities. For example, a study by Davidson & Jefford (1992) shows that the most important variable is the *frequency of public transport*, which can be linked to the 'pace' & 'convenience' layers. People want to continue to travel spontaneously, and high frequency is the key to this. This aspect is followed by the *costs* of the P&R service; the lower the better, and the *accessibility* of the P&R location (Bos, 2004). Also, a study by Seik (1997) showed that *cost savings* and the *avoidance of traffic jams* prompted travellers to use the P&R.

What all these studies have in common is that they are relatively old and there is no focus on a specific type of P&R facility, as was already discussed in Chapter 1.4. It was therefore important that new and specific research is conducted. Despite the criticism of Zijlstra (2020), this study has been done on the basis of the 'long ago established' features of P&R travel modes (Bos, 2004), which will serve as criteria in the survey. The following two conceptual models (figure 14 & 15) have therefore been drawn up using, among others, the aspects from the categories established by Bos (2004). Figure 14 shows a simplified version and figure 15 shows the extended, detailed version, containing the various theories and criticisms from the literature review.

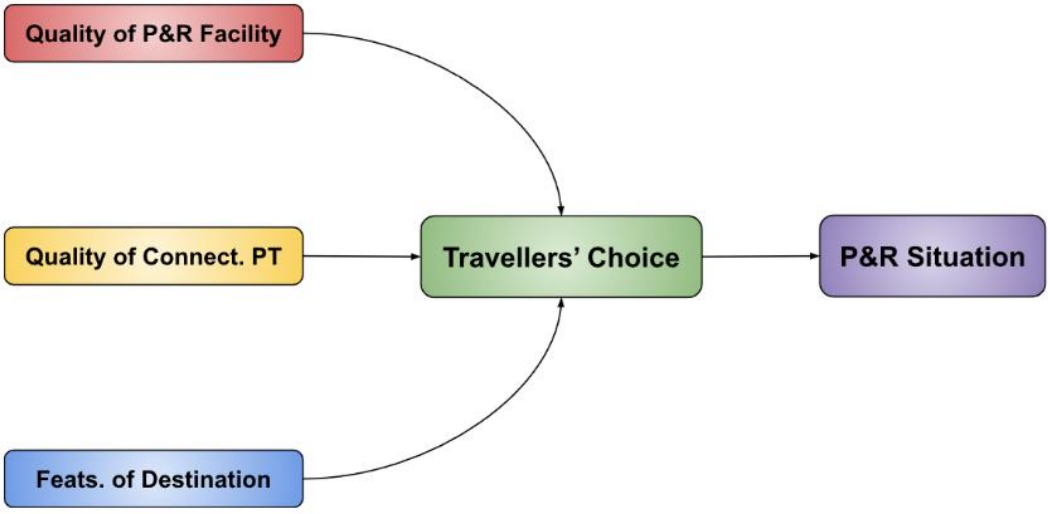


Figure 14: The simplified Conceptual Model (Own work).

2.5.1 Answer to the First Sub-Question

This literature review, in combination with figures 14 and 15, also broadly answer the first sub-question, which is as follows: “What are the evaluation criteria identified in the existing scientific literature that can be used to assess the situation of bus-based P&R facilities?”.

The literature review has shown that the situation, or ‘success and failure’ of P&R facilities mainly depends on its users, and therefore the travellers’ choice. This choice is in turn influenced by various factors, which are listed above, and serve as criteria for the traveller as to whether or not to use a P&R facility.

In short, the evaluation criteria (on the left in figure 15), that can be used to assess the current situation of Dutch bus-based P&R facilities, can be divided into three main groups according to the existing scientific literature, namely: the quality of the P&R facility, the quality of the connecting public transport and the features of the final destination, not taking into account external factors. This answer to the first sub-question is visually represented in the two conceptual models shown and these evaluation criteria will be further used in the following research phases.

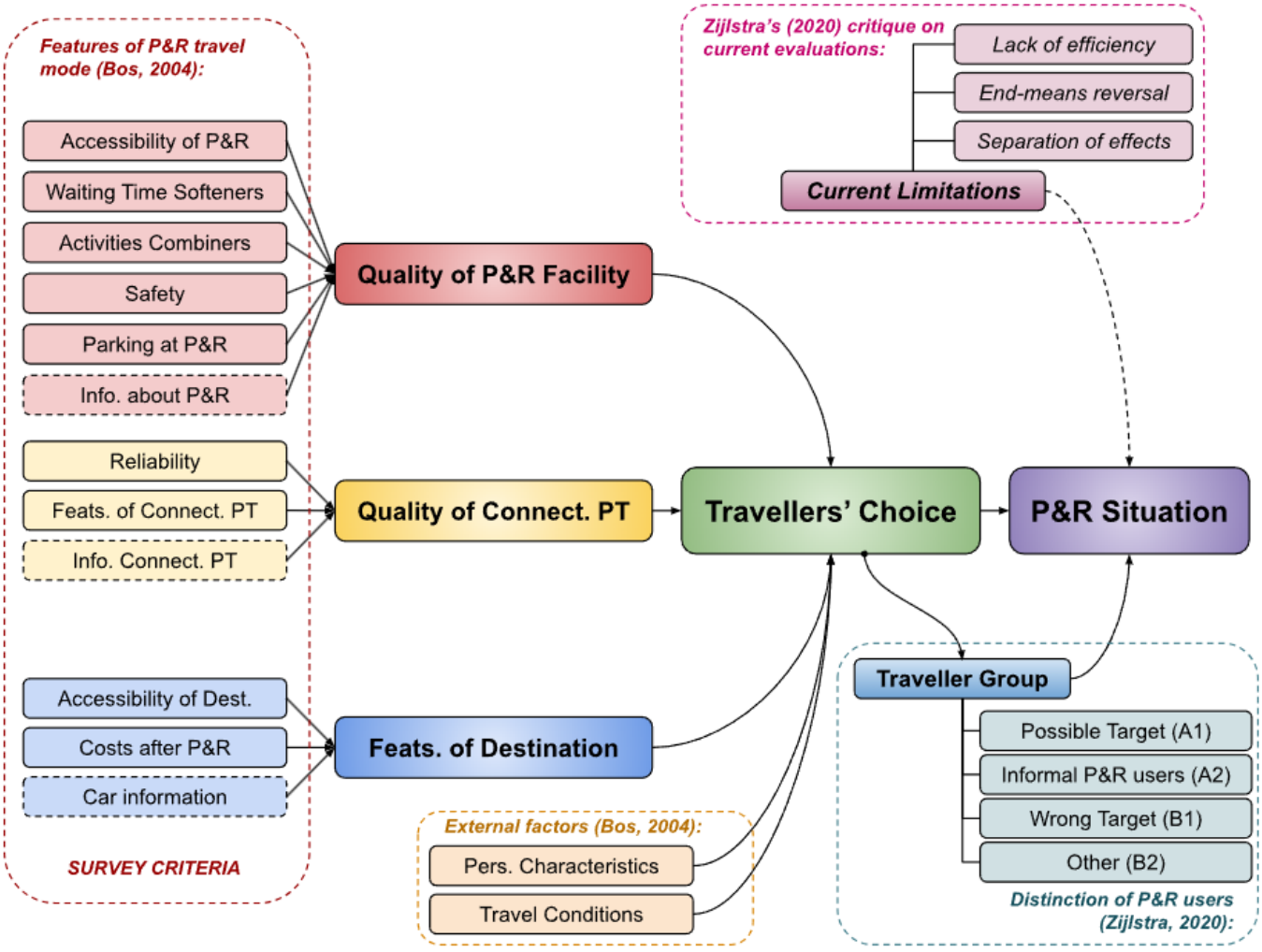


Figure 15: The extended, detailed Conceptual Model (Own work).

3. Methodology

Now that a general picture of the academic knowledge on this subject has been outlined, the conceptual model for this research has been drawn up and the first sub-question has been answered, we can look at the methodology. It will first be discussed what research strategy and methods will be used. The data collection and method of data analysis will then be discussed, and finally conclude with an explanation of the validity and reliability of this study.

3.1 Research Strategy

As mentioned before, the aim of this research was to initially investigate the situation of bus-based P&R facilities in the Netherlands through a survey on the basis of the criteria that were established in the literature relatively long ago. That is why, as the third phase of this research (see Figure 16), eight case studies were carried out, zooming in on a number of interesting cases. It has been analysed in which respects these cases relate and differ from each other, and how this came about. This has led to a 'new' ranking of factors (or evaluation criteria) being found that can explain the situation and success of bus-based P&R facilities in the Netherlands. All phases in this research, from the literature review to the eight case studies, ultimately ensured that the main research question could be answered properly in Chapter 5.

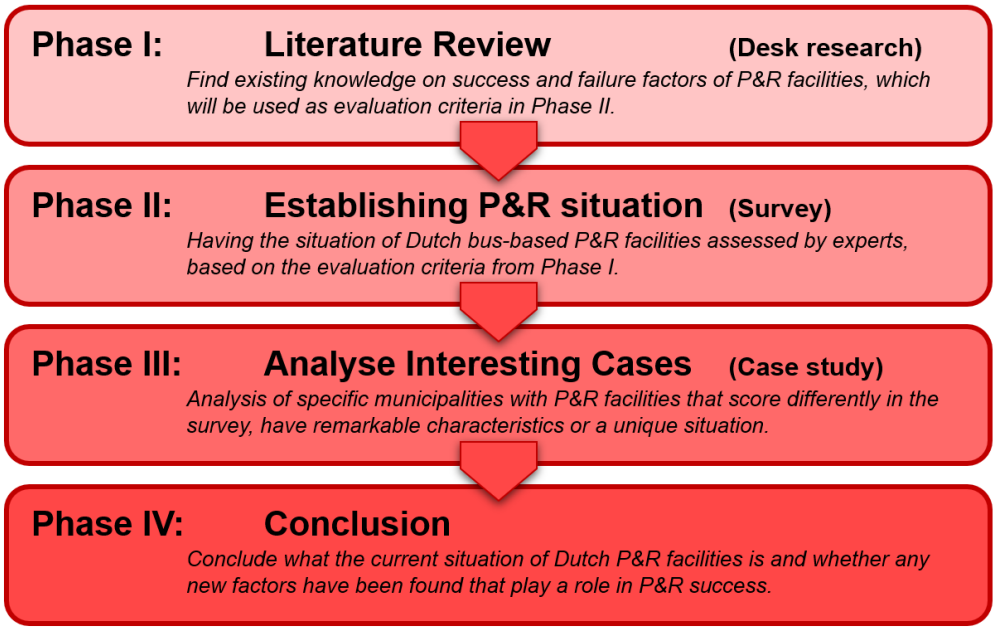


Figure 16: Four stages of this research on bus-based P&R facilities (Own work).

This description of the research indicates that an *exploratory research approach* was chosen for this dissertation. This approach focuses on discovering new academic knowledge on a particular research topic. On the one hand, it is an ambitious form of research that focuses on acquiring new knowledge. But on the other hand, it is a risky process that can result in lengthy research without the hoped-for innovative result (Swedberg, 2020).

In addition, the described research strategy shows that a *sequential explanatory design* was chosen for this research. This is a mixed-method research design in which quantitative data is used in the first phase followed by qualitative data in the second phase (Creswell et al, 2003). In this specific study, these form phases II and III respectively, as the literature review represents the first phase (figure 16). The reasoning for this approach is that the analysis of the quantitative data, as a first step in the research, provides a general understanding of the research problem and the overall situation of bus-based P&R in the Netherlands. The qualitative data and their analysis will in turn refine and explain those results by exploring the cases further in depth (Rossman & Wilson, 1985; Ivankova et al., 2006).

This research moves therefore from deductive reasoning to inductive reasoning. It is a mixed approach in which existing theories and frameworks related to the Park-and-Ride concept are first explained deductively, in the literature review. This means working from general principles to specific applications, to ultimately understand the situation of Dutch bus-based P&R facilities and the factors that influence them. Subsequently, the exploratory part of the research, consisting of the in-depth case studies, involved more inductive reasoning. Using specific data, an attempt is made to discover a new factor and/or to map the influence of long-known factors and then generalize this (Van Thiel, 2014). In this case, a number of main long-known factors as well as new factors have been discovered that explain the current situation of Dutch bus-based P&Rs.

In short, this research employs an exploratory approach to investigate bus-based P&R facilities in the Netherlands. The study uses existing evaluation criteria to conduct an in-depth analyses of intriguing cases, and identify (new) factors influencing P&R success. The research strategy involves a sequential explanatory design, moving from deductive reasoning in the literature review to inductive reasoning in subsequent expert surveys and case studies. This dynamic approach seeks to generate new insights within the framework of existing theories.

3.2 Research Method, Data Collection & Analysis

As the research strategy described above, this research consists of four phases (figure 16), the first of which serves as a theoretical foundation and the two middle parts relate to the actual data collection methods. These two are discussed one by one in this section.

3.2.1 "Establishing the P&R Situation" through a survey

First we look at phase II on "Establishing the P&R situation". Based on a survey with the established criteria from the literature study, a number of contacted experts, each of whom were well acquainted with the situation of the research group, made an assessment of one or more of the bus-based P&R facilities. A survey in the form of an online questionnaire was chosen here, as this form of research offers the opportunity to collect a considerable amount of data on a large number of topics (the criteria of Bos (2004)), which makes it a very efficient research approach (Van Thiel, 2014). This questionnaire was sent by e-mail to the experts, who were contacted via either the website of the P&R-municipality or the province, or via Royal HaskoningDHV, with whom this research was carried out in collaboration.

However, there was always a chance that no experts were available for a number of P&R facilities, or that the number of bus facilities turned out to be too large and therefore too ambitious for this research. Nevertheless, the stated goal always had to be kept in mind, which meant that this study had to provide a representative picture of all the Dutch bus-based P&R facilities. Ultimately, based on Google Maps and the ANWB Route Planner Map, which shows all P&Rs in the Netherlands, a total of 30 bus-based P&Rs were identified spread across 16 Dutch municipalities. These have all been contacted and only three municipalities did not respond. The further processing of this data is explained in more detail in Chapter 4.

The responding experts answered the survey questions using a seven-point Likert scale (figure 17). This is a research instrument in which the respondent must assess a number of statements. These statements were divided by sub-factor and after each sub-factor the respondent was given the opportunity to explain his answers.

The respondent's scores on the various items were then 'added together', to see how the respondent scores on the entire survey. The use of this scale makes it possible to analyse latent variables, or variables "that are not directly observable or measurable" (Vonglao, 2017, p. 337), such as 'accessibility' or 'comfort', and to later compare the assessments of the different bus-based P&R facilities (Van Thiel, 2014).

	Strongly disagree	Disagree	Slightly disagree	Undecided	Slightly agree	Agree	Strongly agree
There is a sufficient amount of parking spaces at [this] P&R facility.					✓		
The parking lot at [this] P&R facility is well maintained.		✓					

Figure 17: An example of questions, using a Likert scale, that could be shown in the questionnaire (Own work).

This comparison therefore consisted of 'adding up' the scores of different questions that belong to one overarching criterion. For example, for the main factor 'Quality of the P&R facility', 7 statements were presented to the respondents for the evaluation criterion 'Accessibility of the facility'. These were then assessed using the seven-point Likert scale, with "7" being the highest and "1" being the lowest score. In order to then say something about the *accessibility of the facility*, and the differences between the various P&Rs, the answers to the survey-statements had to be 'added together', for example to compare each midpoint and find possible outliers.

To do this, it was first important to determine what type of data was involved. Because this survey measure included a degree of agreement with certain points of view, it can be concluded that there was ordinal data. This type of data can be assessed or ranked, but the distance between the answers is not measurable. In fact, the differences between 'somewhat agree' and 'strongly agree' on a Likert scale with frequency response are not necessarily the same. "In other words, one cannot assume that the difference between responses is equidistant even though the numbers assigned to those responses are" (Sullivan & Artino, 2013, p.541).

With this knowledge, the ordinal data could be analysed, and the median was used as a measure of central tendency. The reason for this is that the median shows the 'middle number' when all the data is ordered from low to high. This means that this measure of central tendency separates the top and bottom half of the data, showing what the 'average' situation of the P&R is, without the extreme outliers influencing this and creating a wrong picture (Kostoulas, 2013). Based on the median of each P&R facility on each criterion, the different P&Rs could be compared with each other and thus the situation of bus-based P&Rs in the Netherlands was shown.

In short, phase 2 of this research had a research strategy in which an online questionnaire is used as a research method. This efficient approach aimed to collect various data based on the established criteria from the literature review. The Likert scale allowed comparisons between P&Rs and helped identify interesting cases within bus-based P&R facilities in the Netherlands.

3.2.2 Analysis of Case Studies

After the situation of the various Dutch bus-based P&R facilities had been mapped out and it had become clear which cases needed to be investigated in more depth, phase III of this research could be started, namely: "The analysis of the eight intriguing case studies". The emphasis was on a number of specific P&R facilities that stood out because of certain remarkable or unique aspects. For example, these facilities scored higher than others on the research criteria or in practice had to do with a unique location or role in the transport system. These were examined in depth in this third phase of the research. The exact reason for choosing these P&R facilities will be discussed in Chapter 4.

This analysis used a case study as a research strategy. The data on these cases already collected from the questionnaire was combined with qualitative data from semi-structured interviews to create a holistic picture of the P&R situation. Semi-structured interviews were conducted with experts who had knowledge of specific P&R facilities. This concerns mobility advisors or policy makers from the relevant municipalities, which will be further explained in Chapter 4.

Prior to conducting these semi-structured interviews, an interview guide was drawn up to shape the interview, but at the same time room was also left to improvise, to ask questions about certain answers or to let the interviewee tell his broader story (Kallio et al., 2016). By using this interview form, the interviewer has the opportunity to adapt his questions to the individual respondent, which creates more depth in the conversation (Fylan, 2005), and therefore allows the P&R situation to be described in a comprehensive way from the eyes of the interviewee.

These interviews were then transcribed and coded with ATLAS.ti, a program for, among other things, the analysis of qualitative data. An inductive coding method was used, in which three forms of coding were applied step by step to ultimately conclude, based on the interview data, how the situation came about, what factors played a role in this and how the factors relate to each other (figure 18).

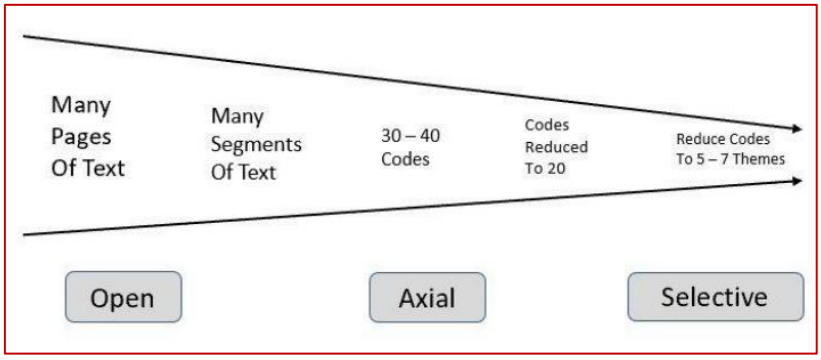


Figure 18: Overview of the inductive coding method (Williams & Moser, 2019).

This method consists of three coding forms. First of all, there was 'open' coding, where the data was expressed in broad themes and concepts. These are usually single words or short sentences linked to concepts (Flick, 2009). The second step consisted of 'axial' coding. The codes already assigned were then combined into overarching codes and the less relevant topics were omitted.

Finally, 'selective' coding was the last step. The main categories were drawn up from the data in order to subsequently make a statement about the situation of the selected bus-based P&R facility and the influencing factors (Williams & Moser, 2019). This method focused the data on certain points, allowing the third sub-question and the main research question to be answered. This will help future P&R projects or evaluations know which factors to pay attention to in order to achieve success in bus-based P&R facilities. But more will be said about this in later chapters.

The semi-structured interviews therefore served as the primary method of data collection in the case studies. In addition, where necessary, this data was supplemented with an analysis of any available (policy) documents that relate to the specific cases.

In summary, certain interesting and unique bus-based Park and Ride (P&R) facilities were the focus of the third phase of the study. Survey data was combined with qualitative information from semi-structured interviews with experts, using a case study strategy. Finding the role of both long-known and unknown factors, that influence the P&R situation, was the goal of the three-step inductive coding method. To gain an in-depth insight into the situation of the P&R facility, semi-structured interviews were the main data collection method, which were possibly supplemented with analysis of policy documents.

3.3 Validity & Reliability

Now that the method that has been used in this research is discussed, we can look at the different types of validity and reliability of this research. These components are discussed one by one for each research strategy used, starting with the internal validity of the survey and the case study.

3.3.1 Internal validity

Survey

'Validity' is related to the purity of research results and therefore the prevention of systematic errors in the research is central. There are many forms of validity, of which internal validity is one. This concerns the question of whether the results give the researcher the opportunity to draw the correct conclusions (Verhoeven, 2018).

A questionnaire has been used for the survey research. This concerned a Likert scale, which involved pre-structured, closed questions with fixed answer options, so that respondents were not given the opportunity to formulate their own answers. The advantage of this is that processing the answers given takes much less time and the research is therefore more efficient. In addition, this fixed question-answer structure guarantees a certain degree of internal validity, because each result is presented in the same way, making it easier to draw conclusions (Van Thiel, 2014).

In addition, attention had to be paid to the way in which the questions or statements in the questionnaire were asked. A question should not have a guiding, suggestive effect or be multi-interpretable, because it could then be understood differently by each respondent, which would then influence the results and internal validity (Van Thiel, 2014).

Case study

With the Case Study, particular attention had to be paid to the selection of the cases and their relationship to each other. In this study, eight cases were selected, each chosen based on their answers from the survey. This involved municipalities with excellent or disappointing P&R facilities as well as municipalities with a unique or remarkable P&R situation.

This is therefore a heterogeneous design in which several cases were compared to try to determine the effect of the long-known factors, i.e. the previously mentioned evaluation criteria, and also to identify new factors. Remember that the variation between the cases preferably concerns the independent variable, for example the time of implementation of the P&R, and not the dependent variable (King et al., 1994). Therefore, it was important to analyse the broader situation in a context-dependent manner in order to identify with greater certainty the factors that influence the success or failure of bus-based P&Rs. (Van Thiel, 2014).

3.3.2 External validity

Survey

The second form of validity is external validity. This relates to the generalizability of the research, which means whether the research meets certain conditions to make valid statements about a larger group or other situations (Verhoeven, 2018). As mentioned above, the survey research used a standardized questionnaire that not only made the research more efficient, but also made the data generalizable, which meant that there was a high degree of external validity.

However, this standardization can also pose a risk to validity, as it can introduce a degree of superficiality to the information collected. A questionnaire provides the direct answer to a question or statement, but it is unclear why the person thinks this way, leaving a lot of information unclear. Moreover, respondents do not always answer truthfully, give socially desirable answers or only give partial answers. And of course there was also a chance that respondents do not want to participate or simply do not respond. A lower size of the respondent group also means a lower certainty of generalizability and therefore lower external validity (Van Thiel, 2014).

However, this was not the case in this study. As mentioned above, all 16 P&R municipalities in the Netherlands were approached to complete the survey and only three did not respond. As a result, the non-response group is very small and there is no under- or over-representation of certain large/small municipalities or certain areas in the country. Figure 19 shows the Dutch municipalities that were contacted to complete the survey. The responding municipalities are shown in blue and the non-responders in orange. It can be concluded that the response group was large enough and very representative to make a situational sketch of all bus-based P&Rs in the Netherlands. The data found from the survey is therefore generalizable and it can therefore be said that external validity is guaranteed in this study.

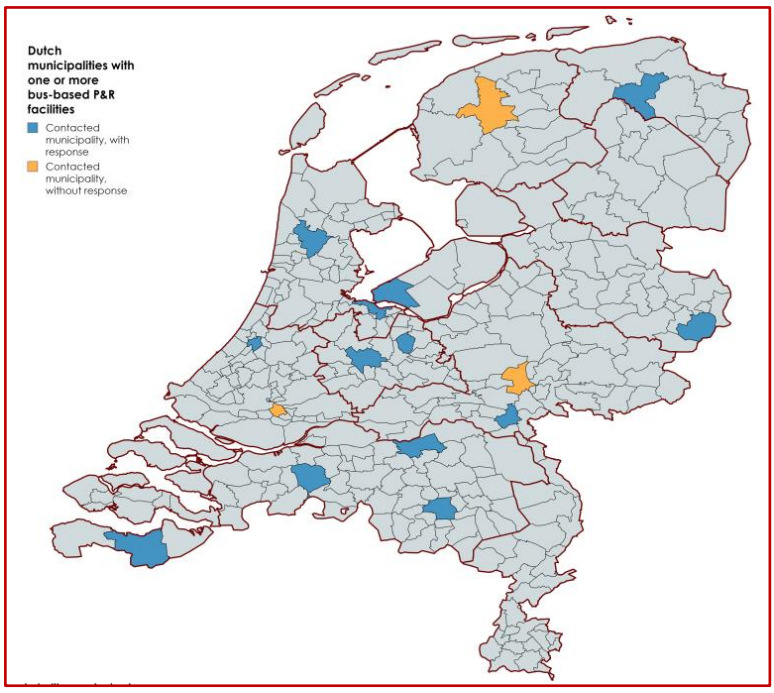


Figure 19: Map of the Netherlands showing all municipalities with a bus-based P&R facility (Own work using MapChart (n.d.)).

Case study

The external validity of a case study is generally understandably very low, as generalizing from one or a few cases to a larger group is virtually impossible (Flyvbjerg, 2006). Especially because this case study looked at heterogeneous cases, all with their own unique context, as mentioned above, the external validity was relatively low (Van Thiel, 2014).

However, the results found from the case studies relate to the factors that influence the situation of bus-based P&Rs in general. The combination of the eight case studies thus makes it possible to provide a broader picture of success factors of bus-based P&Rs. Therefore, despite the unique context of each case, there is still some form of generalizability and therefore higher external validity.

3.3.3 Reliability

Survey

The reliability of the research concerns the extent to which the research is “free of accidental errors” and therefore the question of whether the same results would be obtained if the research were carried out in exactly the same way (Verhoeven, 2018, p. 32). A tool for this would be keeping a logbook or record detailing the steps taken and the data sources used (Miles & Huberman, 1994). This allows subsequent researchers who want to deal with the same topic to consult the entire process at any time, for example to check the results (Van Thiel, 2014). However, in this study no detailed record was kept, but all steps taken, and sources used are clearly described.

If we look more specifically at the survey research, a questionnaire has been used that was completed online by the respondents. As mentioned before, there is always the chance that respondents interpret the question differently, do not answer truthfully, only answer partially or give socially desirable answers, because they know that they are participating in a study. This is a risk that cannot be ruled out, but can affect the reliability of the research. To prevent this and to guarantee the reliability of the survey results, a number of control questions were used in which the same question is asked again in a different way in order to check the respondent's answers (Van Thiel, 2014).

Case study

The case study strategy included eight research units. One expert was interviewed for each case, with the exception of the Groningen case where two experts were interviewed. These cases all have their own unique situation and context, which can be described differently by each expert, so that each repetition of the research can lead to different results. Researchers must therefore take this easily influenced reliability into account when conducting the same type of research.

In addition, this research involved the use of semi-structured interviews. "Generally speaking, the more structured the interview, the more reliable (…) the findings will be" (Van Thiel, 2014, p.100). Despite the fact that these semi-structured interviews still left room for improvisation or further questioning, the pre-established interview guide ensured that a certain pattern was adhered to, so that replicability was not compromised, and the results are still comparable and reliable (Van Thiel, 2014).

Finally, keeping a logbook or record detailing the course and steps of the research would also enhance the reliability of the case study (Miles and Huberman, 1994). But as mentioned above, this was not the case, and this thesis only shows the steps and the sources used.

4. Research Results

After explaining the known literature and the method used, it is now time to discuss the results found. In chapter 2.5 the conceptual model was shown, which serves as the common thread in this thesis (figures 14 and 15). It became clear that the situation of a bus-based P&R facility is influenced by the travel choices of individuals. These choices are in turn influenced by three main factors, namely: the quality of the P&R facility, the quality of the connecting public transport, and the features of the destination. These three factors include all kinds of (more concrete) evaluation criteria that were used in the survey and interview to ultimately answer the second and third sub-question. These long-known evaluation criteria from the literature therefore provided the answer to the first sub-question and at the same time formed a 'bridge' to the answer to the last two. These will be discussed in this chapter.

Firstly, it is briefly indicated where the various P&R facilities and the municipalities are located and how they were determined. Subsequently, the situation of the Dutch bus-based P&Rs is shown, based on the assessment of the respondents from the survey. After this has been clearly presented, we can move on to phase III, where the interesting cases are first presented one by one and then the results relating to the third sub-question are explained. In Chapter 5, a combination of all the results presented in this chapter ultimately led to an answer to the main question.

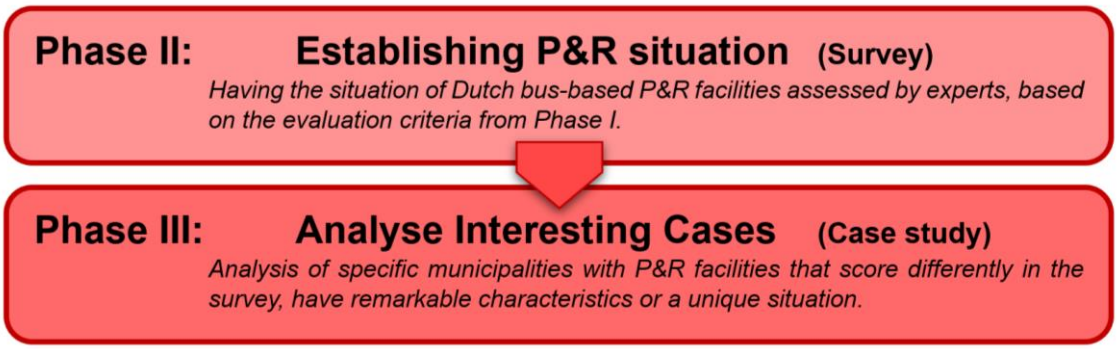


Figure 20: The two research phases discussed in this chapter (Own work).

4.1 Finding the bus-based P&Rs

First of all, it was important to determine how many bus-based P&Rs there actually are in the Netherlands and in which municipalities they are located. As shown in table 1 (in chapter 1.2), according to CROW (n.d.), of the 453 P&R facilities, there are 97 bus, tram and metro P&Rs in the Netherlands. However, this obviously does not mean that all these 97 facilities only have a bus line as connecting public transport. It therefore still had to be determined how many of these were actually 'bus-based'.

To this end, the contacts at Royal HaskoningDHV were first contacted to ask whether they had this data available. Unfortunately, this was not the case and that is why the websites of the ANWB (the Dutch National Road Users Service Organization) and Google Maps were used to check every known P&R facility in the Netherlands one by one to ultimately create a list of all Dutch bus-based P&Rs. The first mentioned website, the ANWB Route Planner, showed 281 locations spread throughout the Netherlands. However, no distinction was made based on connecting transport, which meant that both bus-based and 'other transport'-based facilities could be seen on the map. The website, on the other hand, did indicate very precisely where the P&Rs were located and whether there was a station or stop connected to it. This ultimately made it quite clear to determine a large part of the Dutch bus-based P&Rs.

However, the ANWB (n.d.) showed ‘only’ 281 P&Rs, while there were a total of 453 (CROW, n.d.). Therefore, Google Maps (n.d.-c) was used for the following two purposes:

1. To check the previously established P&Rs;
2. And to possibly determine new P&Rs that were not visible on the ANWB website.

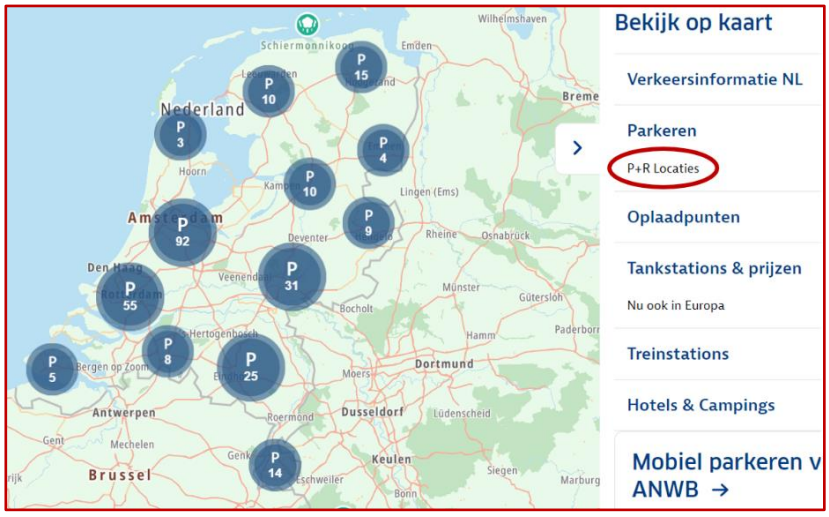


Figure 21: The ANWB Route Planner showing all 281 registered P&R facilities in the Netherlands (ANWB, n.d.).

This has meant that a number of previously identified, but incorrect P&Rs could be removed from the list and a number of facilities, which were previously unknown, were added to the list. An example of this is ‘P&R Hemriksein’ in Leeuwarden, which according to the ANWB (n.d.) still exists, but according to Google Maps (n.d.-c) is ‘permanently closed’. Later, more online searches revealed that this P&R facility was indeed closed at the end of 2023 due to the low number of users (Nieuws uit Friesland, 2023).

Two other examples of the opposite, namely facilities that are not shown by the ANWB (n.d.), but are shown by Google Maps (n.d.-c), are the P&R facilities ‘P&R Breda-West’ in the city of Breda and ‘P&R WST’ in Terneuzen. After online research, these two facilities were included in the list of Dutch bus-based P&Rs, ultimately resulting in 30 facilities spread over 16 municipalities (figure 22).

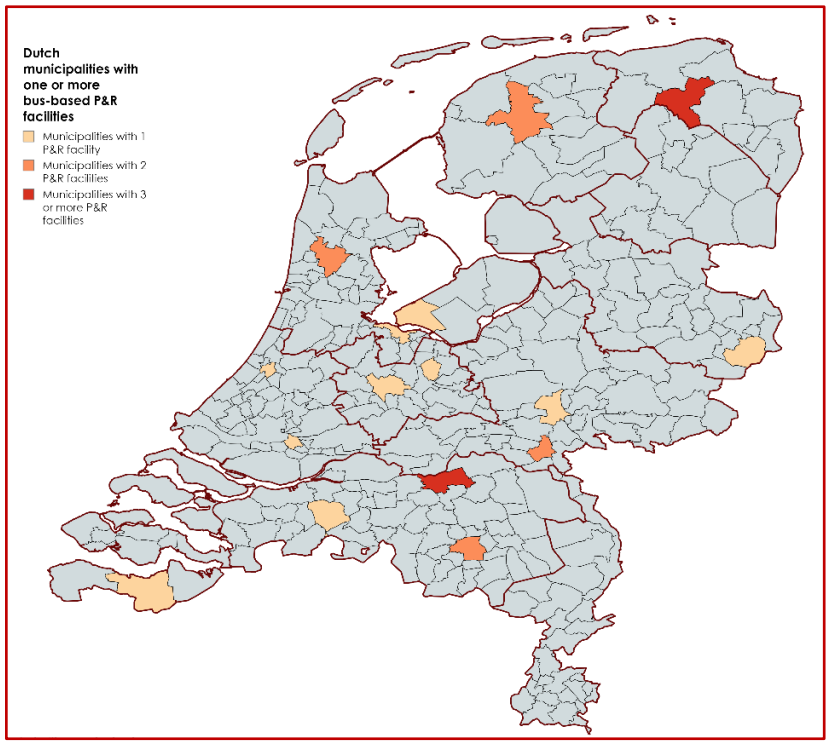


Figure 22: All established Dutch bus-based P&R facilities per municipality. The darker the municipality, the more P&R facilities it has (MapChart, n.d.).

This final list formed the starting point for phase II, namely the survey research, in which all these municipalities were asked to evaluate their P&R facility (or facilities) on the basis of a questionnaire. However, prior to the statistical analysis of these results, it was important to get an idea of each P&R. For example, it had to be clear what type of P&R it was, whether there was a combi-ticket scheme and whether travellers could park for free. In short, a context-dependent picture had to be created before zooming in deeper on the specific criteria.

That is why table 3 has been drawn up, which is shown on the next page. This presents, among other things, the P&R type based on location, the P&R type based on function, the combi-ticket prices, and whether the P&R is open (without barrier) or closed (with barrier). The survey also asked questions related to these topics and knowing this data prior to the analysis allowed for better understanding of the answers and better interpretation of the results.

#	City	P&R Facility Name	#	Type of P&R (Location)	Type of P&R (Function)	Combi-ticket	Open or Closed
1	Utrecht	Papendorp-Noord	1	*Urban Fringe*	*Destination*	*YES = €7*	*Closed*
2	Eindhoven	Meerhoven	2	*Urban Fringe*	*Destination*	*YES = €4,50*	*Closed*
		Genneper Parken	3	*Urban Fringe*	*Destination*	*YES = €4,50*	*Closed*
3	Groningen	Kardinge	4	*Urban Fringe*	*Destination*	*YES = €6,-*	*Open*
		Hoogkerk	5	*Urban Fringe*	*Destination*	*YES = €6,-*	*Open*
		Haren/A28	6	*Urban Fringe*	*Destination*	*YES = €6,-*	*Open*
		Reitdiep	7	*Urban Fringe*	*Destination*	*YES = €6,-*	*Open*
		Meerstad	8	*Urban Fringe*	*Destination*	*YES = €6,-*	*Open*
		Euroborg	9	*Urban Fringe*	*Destination*	*YES**	*Open*
		Leek	10	*Meadows*	*Destination*	*YES = €6,-*	*Open*
4	Almere	Almere 't Oor	11	*Urban Fringe*	*Destination*	*NO*	*Open*
		Stichtse Brug	12	*Satellite*	*Origin*	*NO*	*Open*
5	Breda	Breda-West	13	*Urban Fringe*	*Destination*	*NO*	*Open*
6	Nijmegen	Nijmegen-West	14	*Urban Fringe*	*Destination*	*NO*	*Open*
		Nijmegen-Noord	15	*Meadows*	*Destination*	*YES = €3,50*	*Closed*
7	Arnhem	GelreDome	16	*Urban Fringe*	*Destination*	*NO*	*Open*
		Arnhem-Noord	17	*Meadows*	*Destination*	*NO*	*Open*
8	's-Hertogenbosch	Pettelaarpark	18	*Urban Fringe*	*Destination*	*YES = €5,10*	*Closed*
		Deutersestraat	19	*Urban Fringe*	*Destination*	*YES = €5,10*	*Closed*
		De Vliert	20	*Intra-urban*	*Destination*	*YES = €5,10*	*Closed*
9	Enschede	Zuiderval	21	*Urban Fringe*	*Destination*	*YES = €3,-*	*Closed*
10	Leeuwarden	Kalverdijkje	22	*Urban Fringe*	*Destination*	*NO*	*Open*
11	Alkmaar	Bergermeer	23	*Urban Fringe*	*Destination*	*N/A*	*Open*
		Oudorp	24	*Urban Fringe*	*Destination*	*NO*	*Open*
12	Terneuzen	Busstation WST	25	*Urban Fringe*	*Destination*	*NO*	*Open*
13	Leiden	Haagweg	26	*Intra-urban*	*Destination*	*YES**	*Closed*
		'T Schouw A44	27	*Urban Fringe*	*Destination*	*N/A*	*Open*
14	Muiden	Muiden	28	*Meadows*	*Destination*	*NO*	*Open*
15	Ridderkerk	Oudelande	29	*Satellite*	*Destination*	*NO*	*Open*
16	Soest	Soesterberg	30	*Satellite*	*Destination*	*NO*	*Open*

* = There is a combination ticket arrangement, but the exact price may vary depending on the situation.

Table 3: All Dutch bus-based P&R facilities, which were established prior to the survey research. The yellow P&R names show the ten P&Rs that were approached to complete the survey, but did not respond or no longer even exist as a P&R facility.

4.2 Establishing the P&R Situation

As previously mentioned in the methodology, only three of the 16 P&R municipalities contacted did not respond. This concerns Arnhem, Leeuwarden and Ridderkerk, which have a total of four P&R facilities that are therefore not included in this study. In addition, after contacting the municipality of Alkmaar, it became clear that the two P&Rs in that municipality are no longer in use as such, despite the fact that they were still indicated as a P&R facility according to both ANWB (n.d.) and Google Maps (n.d.-c). This was also the case for 'P&R Arnhem-Noord', 'P&R

Almere Stichtse Brug' and 'P&R Leiden 't Schouw'. The latter has even been completely removed due to an infrastructural redesign of the adjacent highway and underuse of the facility. These three facilities no longer exist and are therefore not included in the survey database, bringing the total number of units (*N*) to 27 P&Rs. Finally, two other facilities, namely 'P&R Meerhoven' in Eindhoven and 'Nijmegen-West', were not assessed through the survey. Unfortunately, no experts could be found for these two facilities. All the not-assessed P&R facilities are shown in yellow in table 3.

Ultimately, it could be concluded that 20 of the 30 previously established P&R facilities were assessed by a total of 14 experts based on the evaluation criteria from the literature. In this section the survey results are systematically discussed per main factor, starting with the Quality of the P&R Facility.

4.2.1 Quality of the P&R Facility

As mentioned in the literature review and shown in the conceptual model, the main factor 'Quality of the P&R Facility', according to Bos & Van der Heijden (2005), consists of six concrete components that could partly be attributed to the customer-wish pyramid, shown in figure 13. For the benefit of the survey, and especially to keep it short but powerful, it was decided to combine a number of these sub-factors into one factor, leaving only 4 parts.

First, this concerned the 'Activity Combiners' and 'Waiting Time Softeners'. These are both factors that serve as 'satisfiers' in the customer-wish pyramid and contribute to the improvement of the 'comfort' and 'experience' layer. It was therefore decided to combine these in the survey under the name "Waiting Time Softeners". The name may therefore suggest that it only concerns waiting time softeners, but the questions in the survey addressed both sub-factors.

In addition, the sub-factor 'Info about the P&R', which can also be seen in the conceptual model (figure 15), is divided over the four sub-factors surveyed. Questions about signage to the P&R or signs about the availability of parking spaces were included in the 'accessibility' and 'parking' sections. Combining these factors resulted in the updated conceptual model from Figure 23.

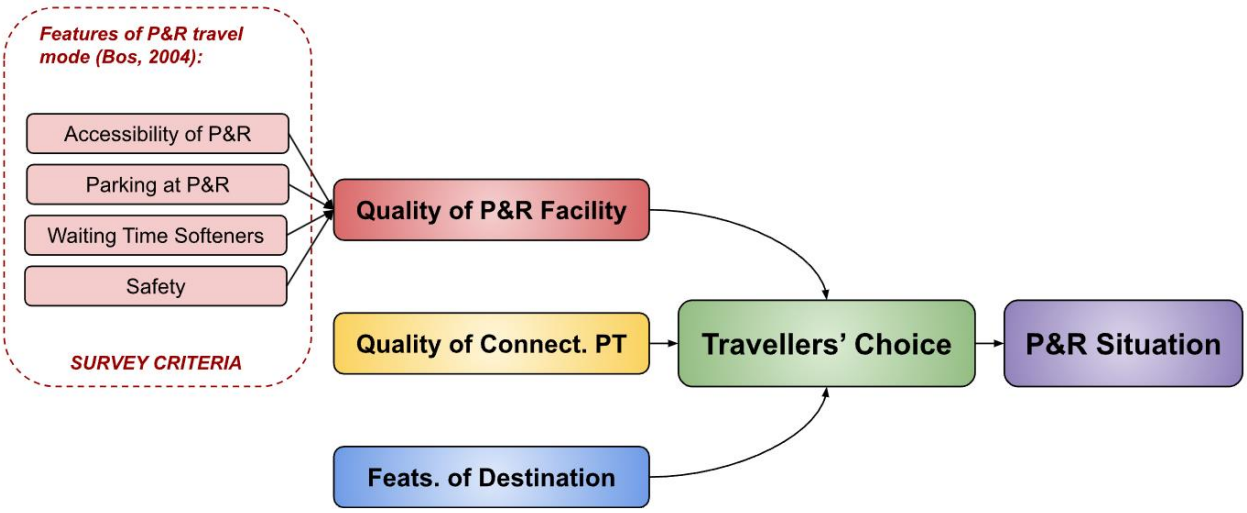


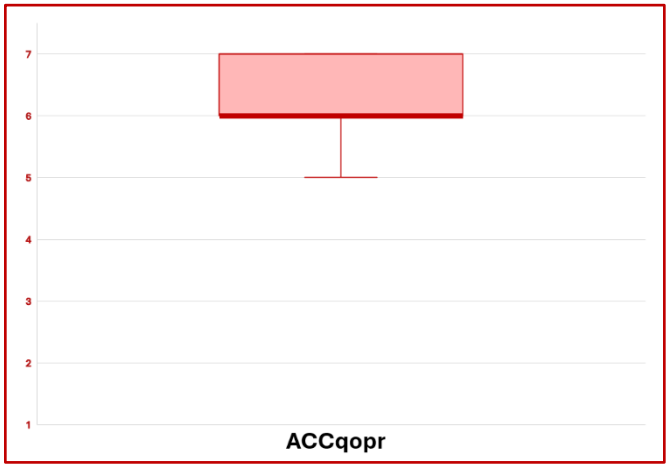
Figure 23: The updated conceptual model after merging the sub-factors of the 'Quality of the P&R Facility' (Own work).

Accessibility of the P&R Facility

The first sub-factor that plays a role in determining the quality of the P&R facility is its *accessibility*. All the experts were asked, among other things, whether the P&R is strategically located and whether the roads to the P&R facility are free of major traffic congestion. The answers of the experts shown in table 4 show that half of the experts gave the P&R accessibility a value of 6, which can be translated as a 'good' rating. In fact, 40% of experts even gave a 'very good' rating on the Likert scale (value of 7).

ACCqopr				
		Frequency	Valid Percent	Cum. Percent
Valid	5,00	2	10,0	10,0
	6,00	10	50,0	60,0
	7,00	8	40,0	100,0
	Total	*20*	*100,0*	
Missing	System	7		
Total		27		

Table 4: Frequency table of the values that experts have given to the accessibility of Dutch bus-based P&R facilities (Own work).



Graph 1: Box plot of the experts' assessment of the accessibility of the Dutch bus-based P&R facilities (Own work).

In addition, the median, or the middle point that gives the 'average' assessment of the accessibility of the P&R facilities, is a value of 6, which once again confirms that the experts assessed the accessibility of the bus-based P&R facilities in the Netherlands as 'good'. This median can be seen in the box plot from graph 1 by the bold line at the bottom of the box. The entire red box represents the interquartile range (IQR), which refers to the range in which the middle 50% of all data lies. The whisker shows the individual values that lie outside the IQR. In this case, these are the two P&Rs that received a value of 5 for their accessibility.

In short, based on these results we can say that the accessibility of the bus-based P&R facilities in Dutch municipalities was assessed by the experts as 'good' to 'very good'.

Parking at P&R Facility

The quality of the parking lot itself is the second sub-factor that impacts the P&R situation as it influences the attractiveness of the P&R facility and therefore also the travellers' choice. The survey asked, among other things, about traffic circulation, parking capacity and parking rates of the facility. Compared to the assessment of the accessibility of the P&R facility, table 5 shows a higher variety in values, which means that there are relatively more differences in assessment in this area between the different bus-based P&Rs. However, both table 5 and the box plot from graph 2 clearly show that the quality of the parking lot was assessed as relatively good, as the median again has a value of 6 and the IQR is between 6 and 7.

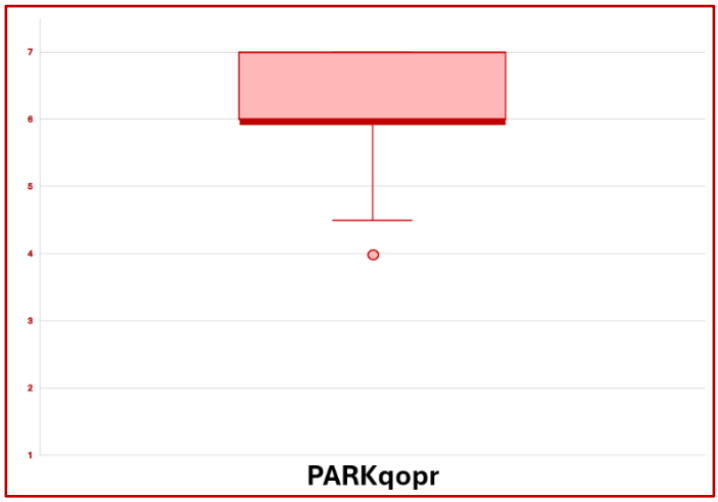
In addition, it should be noted that one outlier was found. This is the red dot that can be seen under the whisker in graph 2. This concerns P&R Breda-West, which scored relatively poorly on the questions relating to the combi-ticket scheme and the parking rates. The explanation of the contacted expert in the survey showed that this P&R facility is open (without barrier), which makes a link between parking ticket and public

PARKqopr				
		Frequency	Valid Percent	Cum. Percent
Valid	4,00	1	5,0	5,0
	4,50	1	5,0	10,0
	5,00	1	5,0	15,0
	6,00	10	50,0	65,0
	6,50	1	5,0	70,0
	7,00	6	30,0	100,0
	Total	*20*	*100,0*	
Missing	System	7		
Total		27		

Table 5: Frequency table of the values that experts have given to the quality of parking at Dutch bus-based P&R facilities (Own work).

transport not possible. He also indicates that the parking rate in the centre of Breda is very low, which means there is less reason for travellers to use the P&R.

However, P&R Breda-West still scores 'neutral' as an outlier, namely a value of 4 on the Likert scale, and the other Dutch bus-based P&Rs are, as mentioned, once again rated as 'good' to 'very good' for the quality of the P&R facility.



Graph 2: Box plot of the experts' assessment of the quality of parking at Dutch bus-based P&R facilities (Own work).

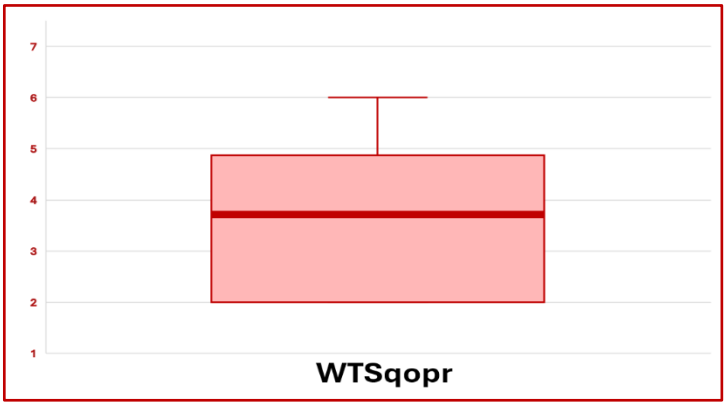
Waiting Time Softeners

Thirdly, the sub-factor 'Waiting Time Softeners' is discussed, which refers to both kiosks or sanitary facilities and activity combiners (e.g. supermarkets or gas stations). At a glance, table 6, and graph 3 in particular, shows that this is a completely different assessment compared to the previous two sub-factors. In this case the median has a value of 3.75; in other words, an assessment from 'neutral' to 'slightly poor'. However, 40% of the reviews have a value of 2, which means that two out of five bus-based P&Rs in the Netherlands score poorly on the quality of their waiting time softeners.

On the other hand, there are a small number of P&Rs that score relatively well in this area. Table 6 shows that 25% of the ratings given give a value of 5 or higher, which means that a quarter of Dutch bus-based P&Rs have 'slightly good' to 'good' rated waiting time softeners.

WTSqopr				
		Frequency	Valid Percent	Cum. Percent
Valid	2,00	8	40,0	40,0
	3,50	2	10,0	50,0
	4,00	4	20,0	70,0
	4,50	1	5,0	75,0
	5,00	3	15,0	90,0
	6,00	2	10,0	100,0
	Total	*20*	*100,0*	
Missing	System	7		
Total		27		

Table 6: Frequency table of the values that experts have given to the waiting time softeners at Dutch bus-based P&R facilities (Own work).



Graph 3: Box plot of the experts' assessment of the waiting time softeners at Dutch bus-based P&R facilities (Own work).

Safety of the P&R Facility

The fourth and final sub-factor belonging to the main factor 'Quality of the P&R Facility' is the safety of the facility. According to the customer-wish pyramid, this is the most important aspect that influences the traveller's choice, and it is seen as essential by the potential user (CROW, 2015). That is why the survey asked about, among other things, the level of social control, sufficient lighting and the presence of any security cameras or personnel.

If we then look at the frequency table 7 and the box plot graph 4, it is again clear that there is a higher variation in assessments of the P&Rs. However, in this case two values emerge most emphatically, namely '4' (neutral) and '6' (good). This split of ratings has resulted in the median having a score of 4.25; which translates to a 'neutral' to 'slightly good' result in this assessment. An explanation given by various experts in the survey is that there are security cameras at most P&Rs, but it is not clear whether these actually contribute to travellers' sense of safety.

On the other hand, this is definitely the case with P&Rs with security staff, which means that these facilities generally score higher on safety.

In general, Dutch bus-based P&R facilities are assessed as 'neutral' in terms of safety. However, it can be concluded that the P&Rs with security staff scored higher in this area.

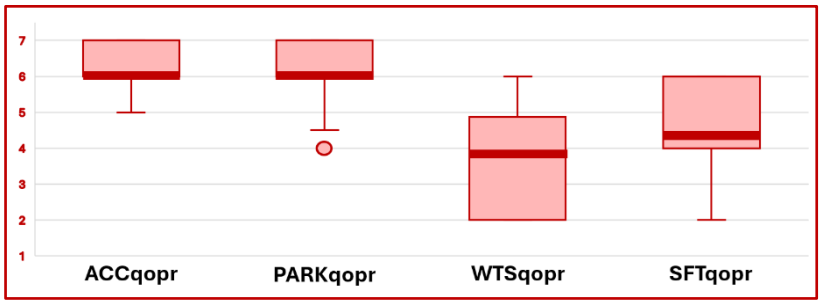
SFTqopr				
		Frequency	Valid Percent	Cum. Percent
Valid	2,00	1	5,0	5,0
	3,00	1	5,0	10,0
	4,00	8	40,0	50,0
	4,50	1	5,0	55,0
	5,00	1	5,0	60,0
	5,50	1	5,0	65,0
	6,00	7	35,0	100,0
	Total	*20*	*100,0*	
Missing	System	7		
Total		27		

Table 7: Frequency table of the values that experts have given to the safety of Dutch bus-based P&R facilities (Own work).

Graph 4: Box plot of the experts' assessment of the safety of Dutch bus-based P&R facilities (Own work).

Overall Quality of the P&R Facility

Now that all sub-factors have been discussed one by one, the general quality of the Dutch bus-based P&R facilities can be established. As described above, and also depicted in graph 5, the sub-factors 'accessibility' and the 'parking-related qualities' are 'good' to 'very good' according to the experts. This is slightly less the case with the other two subfactors, 'waiting time softeners' and 'safety', which had more variation among the assessments.

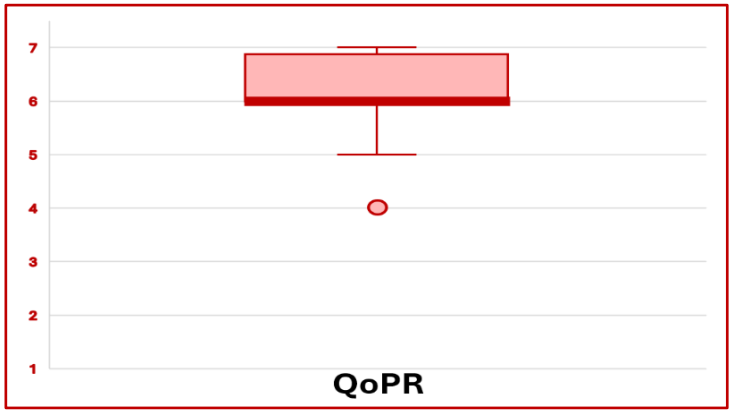


Graph 5: Box plot of the experts' assessment of all the subfactors belonging to the Quality of Dutch bus-based P&R facilities (Own work).

However, it can be concluded from table 8 and graph 6 that the quality of the Dutch bus-based P&R facilities receives an overall rating of '6', which means that the quality is 'good'. It can even be stated that a quarter of the P&Rs are considered 'very good' in terms of the quality of the facility. In short, the quality of bus-based facilities in the Netherlands is 'good' to 'very good' according to the contacted experts.

QoPR				
		Frequency	Valid Percent	Cum. Percent
Valid	4,00	3	15,0	15,0
	5,00	1	5,0	20,0
	6,00	10	50,0	70,0
	6,50	1	5,0	75,0
	7,00	5	25,0	100,0
	Total	*20*	*100,0*	
Missing	System	7		
Total		27		

Table 8: Frequency table of the values that experts have given to the overall quality of Dutch bus-based P&R facilities (Own work).



Graph 6: Box plot of the experts' assessment of the overall quality of Dutch bus-based P&R facilities (Own work).

Nevertheless, it should be noted that there were a number of outliers in graph 6. This concerned *Breda-West*, *Soesterberg*, and *Papendorp-Noord*. These generally all score 'neutral', in contrast to the other P&Rs. Therefore, one of these outlier facilities, namely P&R Breda-West, will be discussed in Chapter 4.3 as one of the deeply examined intruiging cases.

4.2.2 Quality of the Connecting Public Transport

The second main factor that appeared in the survey was the 'Quality of the Connecting Public Transport'. This main factor included three sub-factors, namely:

1. Reliability of the Connecting Public Transport (CPT);
2. Features of the CPT;
3. And the Available Information about the CPT (at the facility).

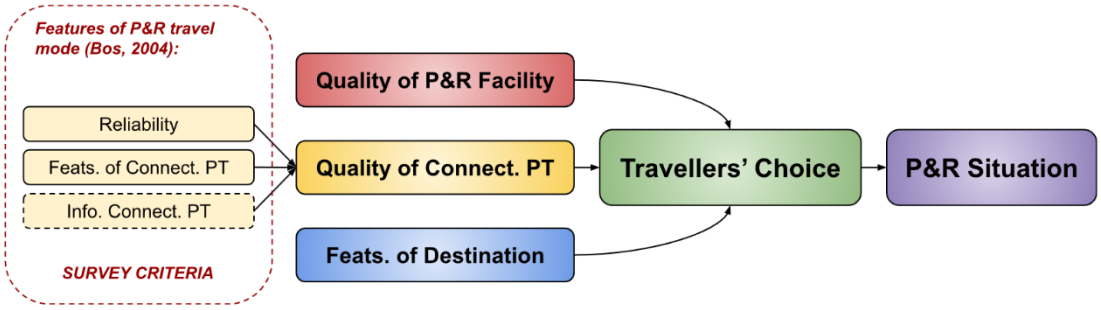


Figure 24: The specific conceptual model, showing only the sub-factors of the 'Quality of the Connecting Public Transport' (Own work).

These three sub-factors, as shown in the specific conceptual model in Figure 24, each influence travellers' choices in their own way, which in turn has an impact on the situation of the Dutch bus-based P&R. In this section the three sub-factors mentioned will be discussed one by one and will end with a general assessment of the main factor 'quality of the connecting public transport' by the experts.

Reliability of the Connecting Public Transport

The first sub-factor in this category that appeared in the survey was the reliability. With regard to this topic, the experts were asked to assess, among other things, the frequency, transfer and reliability of the available bus service.

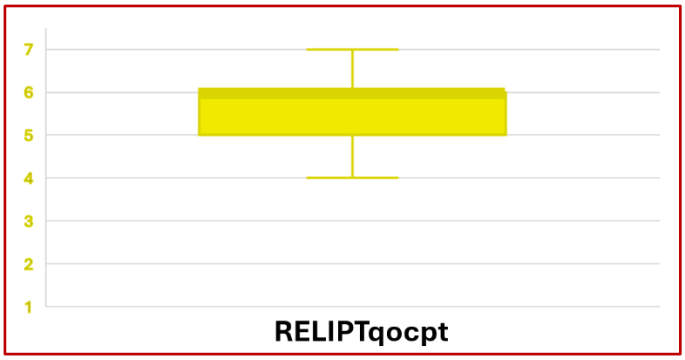
As a result, the reliability of the connecting public transport was rated as 'slightly good' to 'good', with some 'very good' ratings. These few high ratings ultimately led to the median having a value of '6', indicating a 'good' rating, which is also visible in graph 7.

In addition, table 9 also shows that more than 50% of the P&R facilities score a '6' or higher in terms of the reliability of the connecting bus service. So, this means that the public transport reliability of more than half of the P&R facilities is considered 'good' to 'excellent' by the experts.

RELIPTqocpt

		Frequency	Valid Percent	Cum. Percent
Valid	4,00	1	5,0	5,0
	5,00	8	40,0	45,0
	6,00	7	35,0	80,0
	7,00	4	20,0	100,0
	Total	*20*	*100,0*	
Missing	System	7		
Total		27		

Table 9: Frequency table of the values that experts have given to reliability of the CPT of Dutch bus-based P&R facilities (Own work).



Graph 7: Box plot of the experts' assessment of the reliability of the CPT of Dutch bus-based P&R facilities (Own work).

Features of the Connecting Public Transport

Secondly, the features of the connecting public transport had to be evaluated by the experts. Examples of this are the location of the bus stops, the chance of a seat on the bus, the quality/comfort of the bus.

The survey answers show that the P&Rs in the area of this sub-factor are also assessed as 'good' by the experts. The median again has a value of 6 and no less than 70% of the P&R facilities are rated as 'good' or even 'very good' (table 10).

However, there are two outliers, with an average value of 4.5 and 4, as can also be seen in graph 8. This again concerns P&R Breda-West, which was already an outlier for the previously discussed sub-factor, and P&R Haagweg in Leiden. For the former, the location of the bus stop was the main reason why this rating was so low. The bus stop is relatively far from the parking lot and is poorly accessible, making it neither convenient nor comfortable for the user.

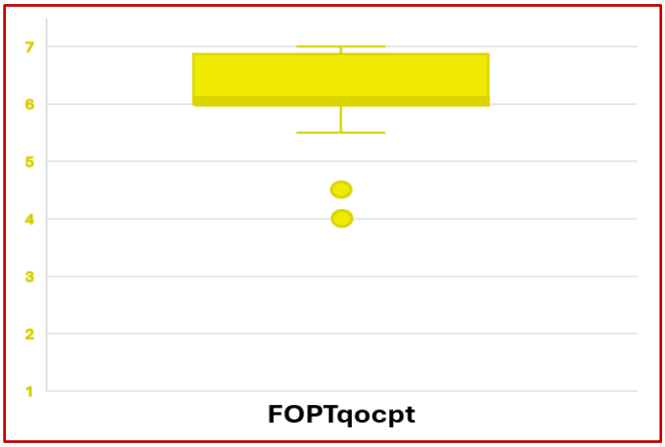
At P&R Haagweg, this relatively low rating was the result of the unique situation of this P&R. This is not a 'normal' bus service, but continuously running buses from the organization of this P&R site, namely: *Stichting Stadsparkeerplan Leiden* ('SSL' or Leiden Parking Plan Foundation). The buses have no timetable but run on request, which means there are no bus stops. As a result, the expert contacted indicated that this subject was difficult to assess, and most questions were answered 'neutrally'. This explains P&R Haagweg as an outlier.

In short, the features of the connecting public transport of the Dutch bus-based P&Rs are rated even higher than the reliability and are therefore considered 'good' to 'very good'.

FOPTqocpt

		Frequency	Valid Percent	Cum. Percent
Valid	4,00	1	5,0	5,0
	4,50	1	5,0	10,0
	5,50	2	10,0	20,0
	6,00	10	50,0	70,0
	6,50	1	5,0	75,0
	7,00	5	25,0	100,0
	Total	20	100,0	
Missing	System	7		
Total		27		

Table 10: Frequency table of the values that experts have given to the features of the CPT of Dutch bus-based P&R facilities (Own work).



Graph 8: Box plot of the experts' assessment of the features of the CPT of Dutch bus-based P&R facilities (Own work).

Available information about the CPT

The third and final sub-factor belonging to this main factor is the availability of information about the connecting public transport. The information referred to here relates, for example, to the timetable, possible destinations and live information about arrival and departure times.

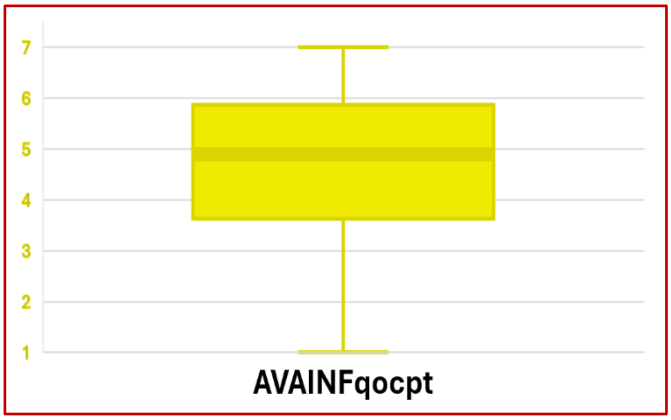
As shown in table 11, there is a wide variety of ratings. While some are a large built facility that has been specially developed for this purpose, other P&Rs are 'upgraded' carpool places with a bus stop. As a result, the two whiskers in the boxplot from graph 9 are also very extended. This also makes it relatively more difficult to make a statement about the general assessment of the available information.

However, the median ensures that it is possible to have a somewhat clear picture of the general situation of this sub-factor. This measure of central tendency shows a value of '5', which means that the 'average' rating of the available information about the CPT was 'slightly good'.

It can therefore be concluded that this sub-factor compared to the other two, Reliability and Features of the connecting public transport, had more variety in the assessments. Nevertheless it can be said that, in general, the available information about the connecting public transport on Dutch bus-based P&Rs is considered 'slightly good' by the experts.

AVAINFqocpt				
		Frequency	Valid Percent	Cum. Percent
Valid	1,00	1	5,0	5,0
	2,00	1	5,0	10,0
	3,00	1	5,0	15,0
	3,50	2	10,0	25,0
	4,00	1	5,0	30,0
	5,00	7	35,0	65,0
	5,50	2	10,0	75,0
	6,00	4	20,0	95,0
	7,00	1	5,0	100,0
	Total	20	100,0	
Missing	System	7		
Total		27		

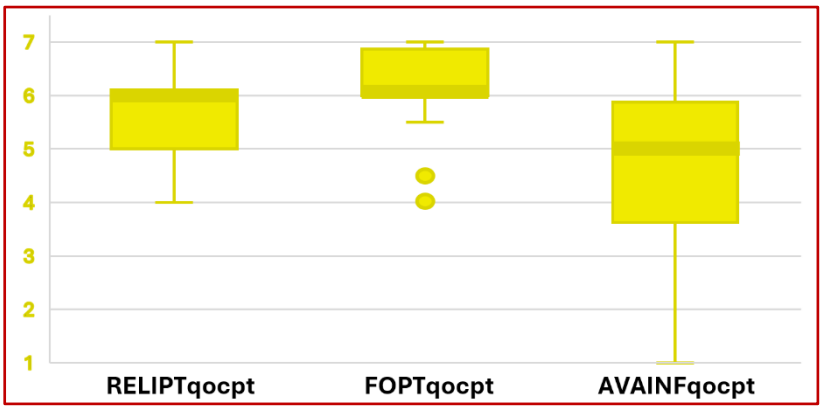
Table 11: Frequency table of the values that experts have given to the available information about the CPT of Dutch bus-based P&R facilities (Own work).



Graph 9: Box plot of the experts' assessment of the available information about the CPT of Dutch bus-based P&R facilities (Own work).

Overall Quality of the CPT

If we then combine these three sub-factors, we can look at the general picture of this main factor 'Quality of the Connecting Public Transport'. The previous parts showed that the reliability and features of the CPT both have a median of 6 and are therefore generally assessed as 'good'. However, experts are divided regarding the available information on this subject, but in general this sub-factor is also rated positively as 'slightly good'. This is all represented by Graph 10, which shows all three boxplots side by side.



Graph 10: Box plot of the experts' assessment of all the subfactors belonging to the Quality of the Connecting Public Transport of Dutch bus-based P&R facilities (Own work).

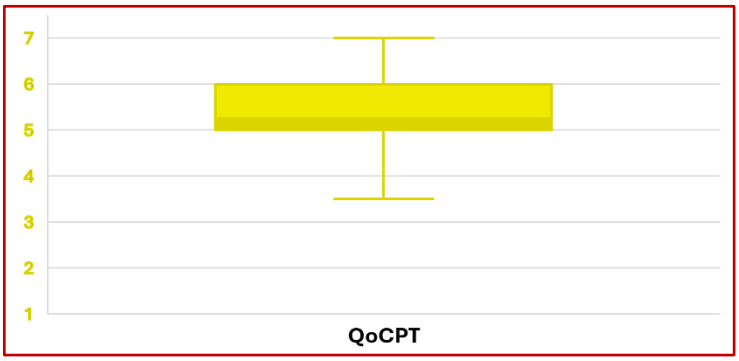
In addition, this graph shows that there were two outliers, namely P&R Breda-West and P&R Haagweg in Leiden. The unique situation of both P&Rs has been explained above and this was the reason to investigate these two P&R facilities in more depth in the next chapter, representing two of the eight intriguing cases.

The combination of the assessment of the three sub-factors gives the overall assessment of this main factor. From graph 11 we can see that, despite the fact that the IQR is between '5' and '6' and a number of P&Rs have also been assessed as 'very good' in this area, the median has a value of '5'. This is also reflected in table 12, which shows that almost half of the assessed P&R facilities have a score of '5'.

As a result, it can be concluded that the general assessment of the quality of connecting transport from Dutch bus-based P&R facilities is 'slightly good' according to the experts contacted.

		QoCPT		
		Frequency	Valid Percent	Cum. Percent
Valid	3,50	1	5,0	5,0
	4,50	1	5,0	10,0
	5,00	9	45,0	55,0
	6,00	6	30,0	85,0
	7,00	3	15,0	100,0
	Total	*20*	*100,0*	
Missing	System	7		
Total		27		

Table 12: Frequency table of the values that experts have given to the overall quality of the connecting public transport of Dutch bus-based P&R facilities (Own work).



Graph 11: Box plot of the experts' assessment of the overall quality of the connecting public transport of Dutch bus-based P&R facilities (Own work).

4.2.3 Features of the Destination

The third and last main factor that had to be discussed in this research phase in order to ultimately answer the second sub-question is the Features of the Destination factor. In addition to the factor discussed above, this also influences the travellers' choice and therefore the ultimate success or failure of the bus-based P&R facility.

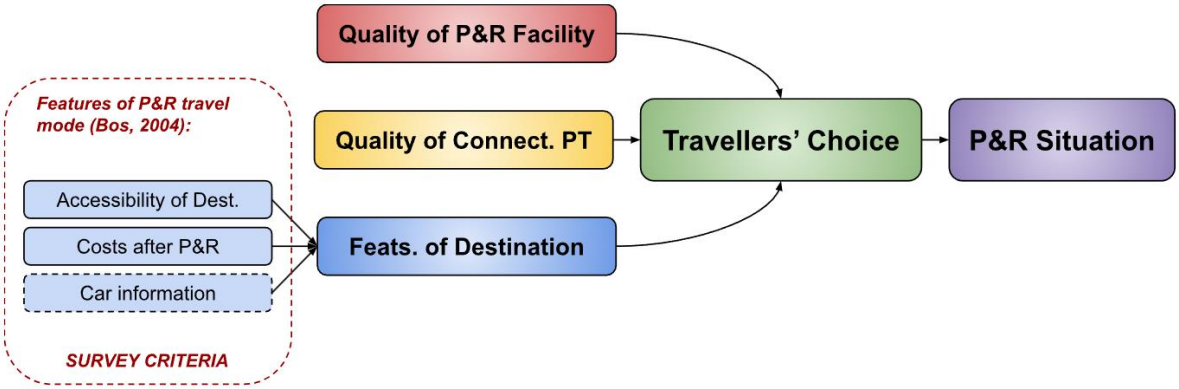


Figure 25: The specific conceptual model, showing only the sub-factors of the 'Features of the Destination' (Own work).

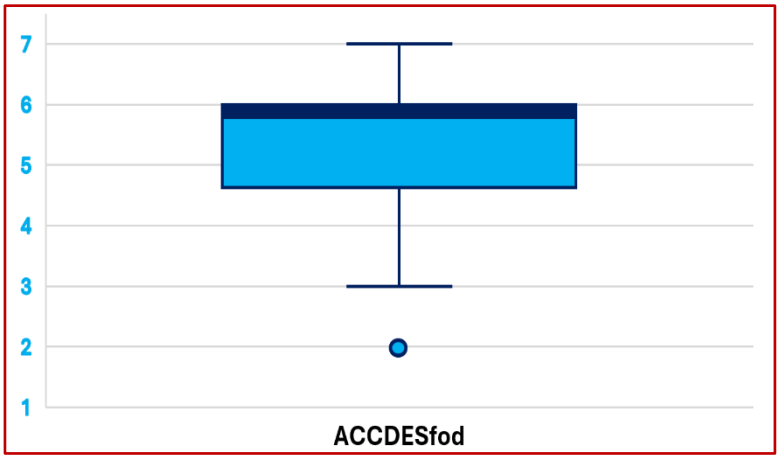
The Features of the Destination can be divided into three sub-factors, namely: the accessibility of the destination, the costs that motorists pay after passing the P&R and the car information, which relates to pre-trip and on-route knowledge. These three sub-factors are discussed one by one below.

Accessibility of the Destination

Firstly, the accessibility of the destination was examined. Travellers want to get to their destination as quickly as possible, without incurring any delays, e.g. in the form of congestion, after passing the P&R facility. In most cases, the traveller's final destination is the city centre and parking capacity plays a major role in the accessibility of this destination. That is why the survey asked, for example, how difficult it is for motorist to find a parking space in the city centre and whether the bus (from the P&R) makes the trip to the destination faster than the car.

ACCDESfod				
		Frequency	Valid Percent	Cum. Percent
Valid	2,00	1	5,0	5,0
	3,00	1	5,0	10,0
	3,50	1	5,0	15,0
	4,00	1	5,0	20,0
	4,50	1	5,0	25,0
	5,00	1	5,0	30,0
	5,50	1	5,0	35,0
	6,00	11	55,0	90,0
	7,00	2	10,0	100,0
	Total	*20*	*100,0*	
Missing	System	7		
Total		27		

Table 13: Frequency table of the values that experts have given to the accessibility of the destination via Dutch bus-based P&R facilities (Own work).



Graph 12: Box plot of the experts' assessment of the accessibility of the destination via Dutch bus-based P&R facilities (Own work).

From table 13 it could be deduced that there is again a high variety of answers, ranging from 'poor' to 'very good' assessments. However, it is also clearly visible that more than half of the P&R facilities were given a value of '6' by the experts. This median of '6', as can also be seen from the bold line in the box plot of graph 12, therefore indicates that the P&Rs are considered 'good' as an alternative to driving to and parking in the city centre.

Finally, the box plot again shows an outlier. This again concerns P&R Breda-West, which, despite having a high-quality bus connection to the centre, is much slower than the car, causing it to be an outlier.

Based on the expert assessments, it can be concluded that the accessibility of Dutch cities for motorists is relatively poor, as a result of which the Dutch bus-based P&R facilities can generally be seen as a 'good' alternative to car use.

Costs after passing the P&R

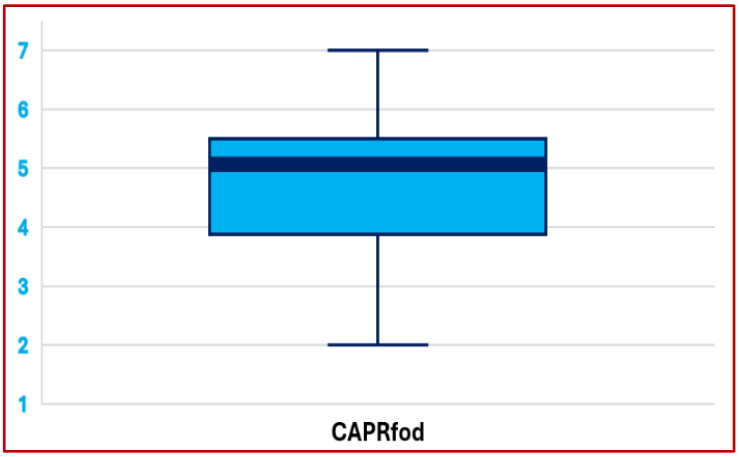
The next sub-factor belonging to the Features of the Destination concerns the costs that travellers pay after passing the P&R, compared to the costs that they would pay at the P&R facility. Consider the parking costs at the final destination or toll costs that travellers have to pay to get to their destination as subjects in the survey.

Table 14 shows that there is again a high variety of values, but in contrast to the previous subfactor, there is a more widespread distribution here. This can also be seen from the extended whiskers in graph 13. A reason for this could, for example, be the large differences in combi-ticket regulations. Some municipalities actively implement this policy through their P&R facilities, while others do not.

CAPRfod				
		Frequency	Valid Percent	Cum. Percent
Valid	2,00	1	5,0	5,0
	2,50	1	5,0	10,0
	3,00	1	5,0	15,0
	3,50	2	10,0	25,0
	4,00	2	10,0	35,0
	5,00	5	25,0	60,0
	5,50	4	20,0	80,0
	6,00	3	15,0	95,0
	7,00	1	5,0	100,0
	Total	*20*	*100,0*	
Missing	System	7		
Total		27		

Table 14: Frequency table of the values that experts have given to the costs of Dutch bus-based P&R facilities, compared to the costs after passing the P&Rs (Own work).

Making a statement about the general expert assessment of the costs that travellers face after passing through the P&R is relatively more difficult due to this high variety. That is why the value of the median must be looked at again. This measure of tendency has a value of '5', which means that the costs of the P&R facility can be a 'slightly good' alternative to the costs that travellers encounter after passing the P&R with their car, according to the experts.



Graph 13: Box plot of the experts' assessment of the costs of Dutch bus-based P&R facilities, compared to the costs after passing the P&Rs (Own work).

Car information

Finally, only the sub-factor 'car information' remains to be discussed. This mainly concerns the information that travellers have before they are on the road (pre-trip) and the information they receive 'on-route', something that in today's time, with all kinds of travel apps that provide live information, a plays a greater role. However, this is not just about providing online information, static or dynamic signage along the road can also convince travellers to opt for a P&R facility instead of their own car trip to the centre.

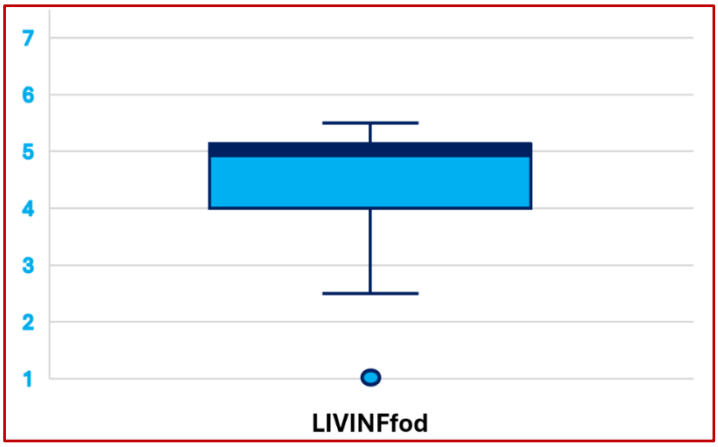
Table 15 shows that, compared to the previous two sub-factors discussed, there is less variety in the ratings for this sub-factor. However, it is clear in both this table and graph 14 that the values of the P&Rs do not exceed '5.5' and are all relatively low. However, the median again has a value of '5', meaning that the information that is shared regarding the P&R, both before and during the trip, is generally assessed as 'slightly good' by the experts.

One reason for this, according to the survey respondents, is that there is enough information available online about the P&R and that there is often communication via signage along the supply roads. However, in most cases this communication is static and not dynamic, meaning that travellers do not have a live update of the traffic situation during their journey. The lower scores, such as the outlier P&R Muiden (graph 14), were usually due to the absence of information communication along the roads.

In short, in the field of car information, the Dutch bus-based P&Rs score low, but with a median value of '5' it can be said that the information shared regarding the P&R is generally considered 'slightly good'.

LIVINFfod				
		Frequency	Valid Percent	Cum. Percent
Valid	1,00	1	5,0	5,0
	2,50	1	5,0	10,0
	3,50	2	10,0	20,0
	4,00	5	25,0	45,0
	5,00	6	30,0	75,0
	5,50	5	25,0	100,0
	Total	*20*	*100,0*	
Missing	System	7		
Total		27		

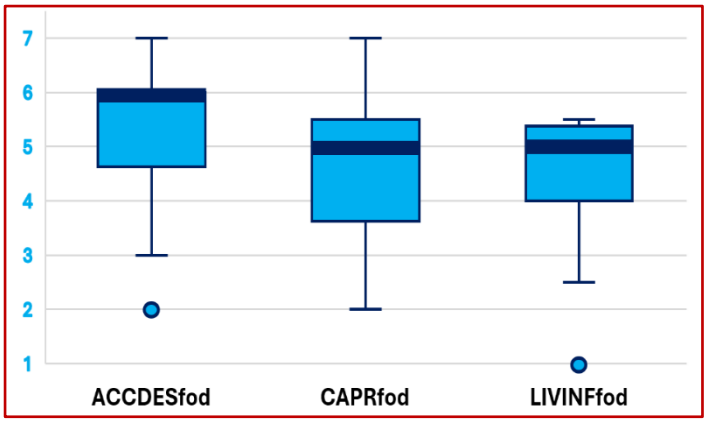
Table 15: Frequency table of the values that experts have given to the car information of Dutch bus-based P&R facilities (Own work).



Graph 14: Box plot of the experts' assessment of the car information of Dutch bus-based P&R facilities (Own work).

Overall Quality of the Features of the Destination

Now that all sub-factors of the Features of the Destination have been discussed, we can look at the overall assessment of this main factor. While the accessibility of the destination (i.e. the city centre) via the P&R facility still had a median value of '6', this was not the case for the other two sub-factors. These both had a value of '5' and the P&Rs generally scored lower in these two areas.



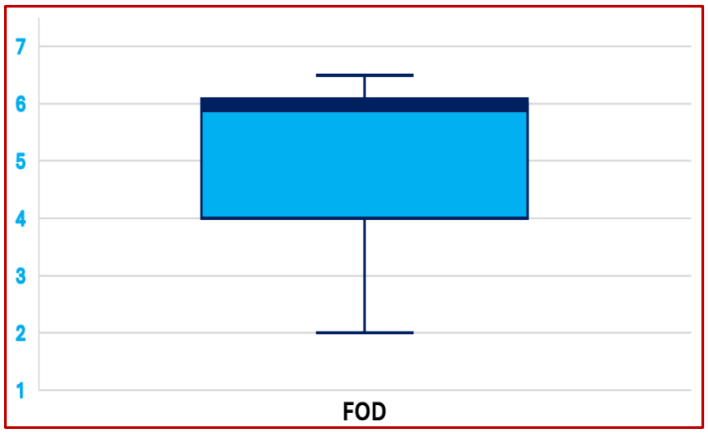
Graph 15: Box plot of the experts' assessment of all the subfactors belonging to the Quality of the Features of the Destination of Dutch bus-based P&R facilities (Own work).

In addition, two outliers have been identified, as can be seen in graph 15. In terms of accessibility of the final destination, the assessment showed that the connecting public transport to P&R Breda-West was no faster than using a car, making it a 'poorly' rated P&R facility in this area. In addition, P&R Muiden was assessed as an outlier in the field of car information, partly because it communicated neither static nor dynamic information to the car user (for example through signage).

If we then look at table 16, it is clear that more than 50% of the P&R reviews in the field of Features of the Destination have a value of '6', which means that this main factor is generally regarded as 'good' is assessed. However, there is also a large variety with a number of lower ratings, as can also be seen in graph 16. The median therefore gives a good general picture of the ratings of the features of the destination of Dutch bus-based P&Rs, but it should be noted that there are also worse ratings. This median may therefore give a distorted picture and that is why the table and the box plot show a more complete picture of the assessment of the features of the destination.

		FOD		
		Frequency	Valid Percent	Cum. Percent
Valid	2,00	1	5,0	5,0
	3,00	1	5,0	10,0
	3,50	1	5,0	15,0
	4,00	3	15,0	30,0
	4,50	1	5,0	35,0
	5,00	1	5,0	40,0
	6,00	11	55,0	95,0
	6,50	1	5,0	100,0
	Total	*20*	*100,0*	
Missing	System	7		
Total		27		

Table 16: Frequency table of the values that experts have given to the overall quality of the features of the destination of Dutch bus-based P&R facilities (Own work).

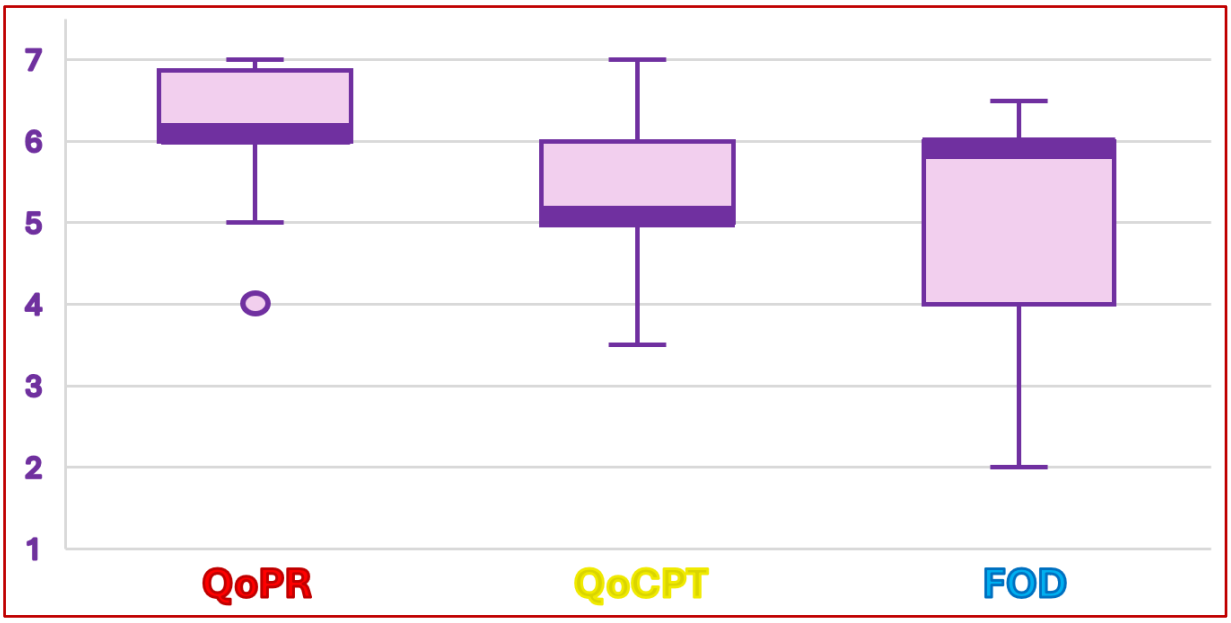


Graph 16: Box plot of the experts' assessment of the overall quality of the features of the destination of Dutch bus-based P&R facilities (Own work).

4.2.4 Answer to the Second Sub-Question

This entire explanation of all survey results belonged to research phase II, in which the current situation of Dutch bus-based P&Rs was determined on the basis of expert assessments. These assessments were made based on the evaluation criteria from the literature review, which served as the answer to the first sub-question. This section will now answer sub-question #2 through the expert assessments, after which we can continue to phase III of this research.

The second sub-question was as follows: “How do the contacted experts assess current the situation of Dutch bus-based P&R facilities based on the evaluation criteria outlined in the literature?”. Research phase I showed that there are three main factors, each with their own evaluation criteria (or sub-factors), that influence travellers’ choice. The evaluation of these sub-factors has been explained extensively in the section above, so we will now only look at the main factors to answer the question mentioned above.



Graph 17: Box plot of the experts’ assessment of the three main factors that influence Dutch bus-based P&R facilities (Own work).

Graph 17 shows the box plots of the three main factors. It clearly shows that the Quality of the P&R Facility (red) and the Features of the Destination (blue) are generally assessed slightly higher than the Quality of the Connecting Public Transport. These values can nevertheless all be ‘translated’ as positive, as the median values of ‘5’ and ‘6’, shown by the bold line in every boxplot, represent a ‘slightly good’ to ‘good’ rating for the current situation of bus-based P&R facilities in the Netherlands.

However, graph 17 also shows that for the Features of the Destination, which relates to the city centre’s characteristics that influence the use of the P&R, there is a large variation in ratings. This is confirmed by table 17, which shows that the middle 50% of given rating values for this factor are between ‘4’ and ‘6’. That is a relatively large range compared to the other two main factors. This means that these data provide a relatively less clear and less comprehensive picture of the overall situation of bus-based P&R facilities in the Netherlands. This is most likely due to the unique situation of each municipality and its traffic and parking policy, which of course also influences P&R use and therefore the P&R situation. The score for this main factor is therefore positive, but this fact must be kept in mind when drawing further conclusions from the survey results about the broader Dutch P&R situations.

Overall Statistics

		QoPR	QoCPT	FoD
N	Valid	20	20	20
	Missing	7	7	7
Median		6,000	5,000	6,000
Minimum		4,000	3,500	2,000
Maximum		7,000	7,000	6,500
Percentiles	25	6,000	5,000	4,000
	50	6,000	5,000	6,000
	75	6,875	6,000	6,000

Table 17: Frequency table of the values that experts have given to the three main factors that influence Dutch bus-based P&R facilities (Own work).

In short, the current situation of Dutch bus-based P&R facilities was assessed as 'good' by the experts contacted on the basis of the long-known established evaluation criteria from the literature review. The P&Rs meet most of the criteria and the survey results paint a positive picture of the facilities and the aspects surrounding them. However, it must be remembered that the bus-based P&R facilities do well *based on the evaluation criteria*. This does not necessarily mean that the P&Rs function as such in practice and are also widely used.

With the answer to the second sub-question, eight P&R municipalities will be examined in more depth in the next paragraph (4.3). The aim of this is to ultimately find out whether a good general assessment of the bus-based P&Rs based on the evaluation criteria (i.e. based on theory) also actually means that the P&R facilities function in practice or if there are other unknown factors that might play a role.

4.3 The Eight Chosen P&R Municipalities

In this third research phase, the analysis of the results obtained from the interviews with various mobility advisors, policy makers and researchers are presented. As mentioned earlier, eight P&R municipalities were chosen for this in-depth research into the factors that influence the situation of bus-based P&Rs in practice (see figure 26). These P&Rs and the interviewed experts will first be briefly illustrated one by one in this paragraph, before we can continue with presenting the results and answering the third sub-question in chapter 4.4.

4.3.1 Eindhoven

The first of the selected cases was already discussed in the introduction, in which it was presented as the initial reason for this research. This concerns P&R Genneper Parken, one of the two Park-and-Ride facilities in Eindhoven. This facility is located on the south side of Eindhoven, next to the A2 highway, and is therefore easily accessible for motorists. Travellers can comfortably and cheaply take the bus from this mobility hub to the centre of Eindhoven (Gemeente Eindhoven, n.d.-b). Parking at this facility costs only €4 per day and a combination ticket, consisting of a day ticket and return ticket to the centre, also costs only €0.50 per person (Gemeente Eindhoven, n.d.-c).

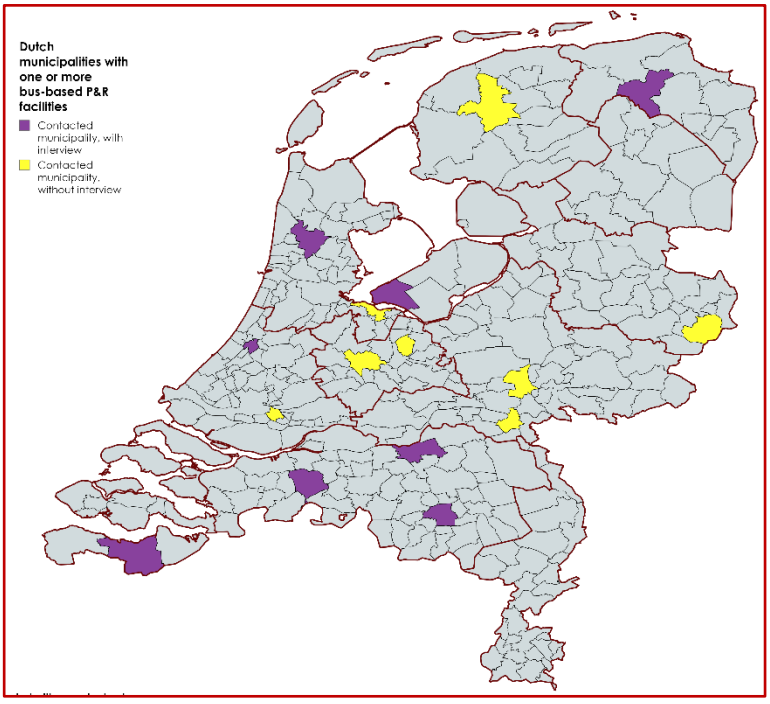


Figure 26: All established P&R municipalities in the Netherlands. An interview with an expert was only conducted for the purple municipalities. (Own work using MapChart, n.d.).

However, this P&R facility has not (yet) become a success since its opening in 2021 and only 4% of the parking capacity was used daily in the first six months after the opening (Omroep Brabant, 2021).

The expert who was interviewed for the deeper investigation of this case was Rogier Dijker. Since 2019, he has been a traffic policy developer at the Traffic, Environment and Sustainability Department of the Municipality of Eindhoven. In this position he focuses on the policy regarding parking and public transport, which also includes this P&R.

4.3.2 Groningen

The second example of a Dutch municipality with bus-based P&R facilities was also mentioned in the introduction, namely: Groningen. This city can also be seen as the 'P&R Capital' of the Netherlands, as it is surrounded by 6 bus-based facilities. This makes it possible to reach the city from any direction via a P&R, as shown in figure 27 (Groningen Bereikbaar, n.d.).

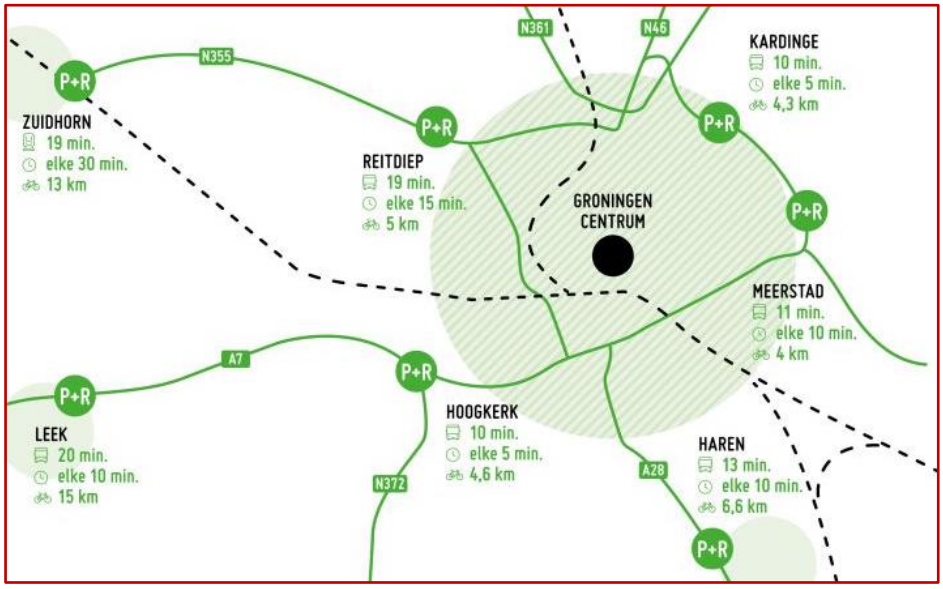


Figure 27: Map of Groningen, surrounded by P&R. In this image, every green "P+R" point is a bus-based P&R facility, except "P+R Zuidhorn" (top left).

In contrast to P&R Genneper Parken in Eindhoven, the P&Rs in Groningen are fairly simple facilities. These are 'normal' parking spaces at ground level, without a barrier, where travellers do not have to pay for parking (Groningen Bereikbaar, n.d.). In addition, there is a special 'P&R return ticket' deal for groups of travellers, which means that they only have to pay €6 to travel to the city centre by bus with a maximum of 5 people.

For this case, unlike all other cases, not one but two experts were interviewed, both of whom work at the Municipality of Groningen. This concerns Age Stinissen, a researcher from OIS Groningen, the Research Department of the municipality, who focuses, among other things, on statistics surrounding mobility in Groningen (e.g. car use and P&R counting figures). Jeroen Bosveld was the second expert who was interviewed. He is a parking policy advisor who focuses on the broader parking issue in Groningen.

4.3.3 Breda

This third P&R municipality has also been discussed previously in this study, namely as an outlier for various sub-factors in research phase II. This concerns the P&R facility Breda-West. This P&R is located on the west side of the A16 highway. This makes the facility easily accessible to motorists, but the precise location of the facility is not convenient according to the contacted expert's survey response. P&R Breda-West is located on the outside of the Breda ring road, which means that motorists, counter intuitively, first have to drive away from the city centre to get to the P&R and then take the bus back to the centre.

In addition, this P&R, just like the one in Groningen, is quite simple. It is actually a formal carpool place that has been 'upgraded' into a 'full-fledged' P&R facility with the addition of a bus stop. However, it was already mentioned in chapters 4.2.2 and 4.2.3 that the bus stop is quite far from the parking lot and the bus service is not a faster alternative to the car, which means that the attractiveness of the P&R is not very high. This was all explained in the survey by the expert who was also interviewed later. This concerns Gerben Geijsel, who works as a mobility advisor at the Municipality of Breda.

4.3.4 ‘s-Hertogenbosch

The three P&R facilities in ‘s-Hertogenbosch (or Den Bosch) ensure that this is the Dutch municipality that has the most P&Rs after Groningen. This concerns the facilities: Pettelaarpark, De Vliert and Deutersestraat. The first two mentioned are fairly simple P&Rs, where cars are parked on ground level. In contrast to the facilities in Groningen, there is a barrier here and visitors pay €5.10 to be taken to the centre by the connecting bus. This is also the price if you want to park at the facility on Deutersestraat. However, the difference between this P&R and the other two is that Deutersestraat is a built facility that is relatively larger. It should also be noted that all three facilities are located on the edges of the city, making them all easily accessible from the east, west and south. This good accessibility is supplemented by a frequent bus service that comes every 10 to 20 minutes, depending on the time of day (Zin in Den Bosch, n.d.).

One of the reasons that this P&R municipality was chosen as a case study is the success it has achieved in recent years. For example, it served as a ‘teacher’ for other municipalities, such as Eindhoven and Tilburg, the municipal P&R policy is seen as a success formula and P&R Deutersestraat is even the greenest P&R site in the Netherlands (Jongerius, 2019). In short, Den Bosch is a successful P&R municipality.

The expert interviewed for this is Robert Groenhof. He is a strategic mobility advisor for the Municipality of 's-Hertogenbosch and deals with all kinds of issues surrounding traffic, public transport and mobility.

4.3.5 Terneuzen

The unique situation around Terneuzen ensured that this was the fifth selected P&R municipality for this in-depth multiple case study. In 2003, the Western Scheldt Tunnel (WST) opened here, which today connects Dutch Flanders with Walcheren (figure 28). The bus-based P&R facility on the outskirts of Terneuzen turned out not to have a destination function, which was expected in advance, but rather an origin function. People from Terneuzen and the surrounding areas therefore make a relatively short trip to the P&R (pre-transport) and then travel a longer distance by bus. This origin function and the presence of the toll tunnel was therefore the reason that Terneuzen was also researched in more depth in this chapter.

Figure 28: The Western Scheldt tunnel, which connects Dutch Flanders with Walcheren, is indicated in red. (Own work made with Open Street Map (2024)).

After contact with both the Province of Zeeland, which manages the P&R, and the Municipality of Terneuzen, where the P&R is located, an interview was conducted with an expert, namely Peter van de Kerkhove. He is a policy officer in the field of traffic and transport at the Municipality of Terneuzen.

4.3.6 Leiden

In chapter 4.2.2, which relates to the quality of the connecting public transport, P&R Haagweg in Leiden was also identified as one of the outliers. This was due to the unique situation created in this city by the *Leiden Parking Plan Foundation*. This organization runs a P&R facility, with the connecting public transport only driving on request. The facility is located relatively close to the centre and, thanks to its high frequency, provides a constant ‘taxi-like service’ to and from various places in the city. Travellers park their car and then

decide where exactly they want to go, so there are no bus stops or fixed timetables. There is also no ‘direct’ combination ticket at this P&R facility. The parking rate is fixed and depends on the parking duration, but the taxi service is always included.

Due to the uniqueness of this ‘Park-and-Ride on request’, P&R Haagweg was chosen as one of the cases that were examined in more depth in this chapter. To do this, the director and co-founder of this foundation, Chris Verplancke, was interviewed. He was able to provide a detailed picture of the establishment and growth of this remarkable P&R facility and the factors required for it.

4.3.7 Almere

The seventh P&R municipality that will be discussed in this multiple case study is Almere. This relatively new city has an impressive bus station located on top of a viaduct on the A6 highway, on the edge of the city. It is again a relatively simple parking lot at ground level with few facilities. Despite the fact that the location gives rise to the expectation that this P&R would have a destination function for people who want to travel to the centre of Almere, it later turned out that it was mainly an origin-P&R. Almere is a commuter city, which means that many residents have to go to a location outside the city for work. P&R Almere 't Oor therefore mainly serves as a link for travellers who want to go to Amsterdam and can therefore be seen as a satellite P&R for the Dutch capital.

The contacted expert who assisted with both the survey and the in-depth research is Adriaan Keus. He works as a mobility advisor at the Municipality of Almere and provided a general picture of the success and failure factors of bus-based P&Rs.

Figure 29: Map of P&R Almere 't Oor compared to the locations of Amsterdam and Almere. The red line shows the expected travel pattern of P&R users, while the yellow line shows reality; a P&R on the outskirts of Almere that has an origin function and works as a satellite P&R for Amsterdam (Own work using Open Street Map (2024)).

4.3.8 Alkmaar

The eighth and last P&R municipality is Alkmaar. This city has two P&Rs, namely *P&R Oudorp* and *P&R Bergermeer*, both of which are located on the edge of the city. These facilities are free to enter, but do not have any extra facilities or a combination ticket option (Parkeren Alkmaar, n.d.).

What is special, however, is that Alkmaar is the only case, from the eight chosen, that was not included in the survey. This is because after contact with the expert interviewed later, it became known that the two P&R facilities no longer exist as such, as was already mentioned in chapter 4.2. The reason for this was that the P&Rs were hardly used, due to, among other things, too much parking space in the city centre, but more about this will be discussed later. Contact with the expert revealed that no active P&R policy has been in place for more than eight years, despite the fact that the P&Rs still exist according to the internet and the P&R

signage in and around Alkmaar is also still present. Due to this ‘implemented example’ of an unfortunately failed bus-based P&R facility, it was decided to complete the eight intriguing cases with this P&R municipality.

The expert who was contacted for this is Arjen van Heerde, policy advisor at the Municipality of Alkmaar. He is involved in parking and mobility policy in and around the city. His knowledge about the P&R facilities in Alkmaar showed, among other things, the factors that in practice have a negative influence on the situation of bus-based P&Rs.

4.4 Analysing Interesting Cases

The previous section explained that a combination of eight unique P&Rs, functioning both well and poorly, has been drawn up. This made it possible to provide a correct and clear picture of the factors that, in practice, can explain the situation of Dutch bus-based P&Rs. The results from the interviews revealed a number of both long-known and partly new factors, that were not clearly mentioned in the literature. These factors will be explained below, ultimately ending with an answer to the third sub-question: “What factors cause the situation of Dutch bus-based P&R facilities, and are there any additional unidentified factors that influenced this?”.

4.4.1 Preconditions for success

As mentioned in the previous paragraph, a total of nine semi-structured interviews were conducted to map the situation of the eight selected P&R municipalities. This allowed for the identification of a number of factors that are critical to the situation, i.e. the success or failure, of a bus-based P&R facility. This involved three preconditions that must be met before a P&R can function properly. These are briefly explained one by one below, in order of importance.

Accessibility of the City Centre

First of all, according to most interviewed experts, the accessibility of the city centre is the most important precondition that must be met before a P&R facility can work properly. This accessibility refers to ‘the ease of driving to the city centre’. For the benefit of the P&R facility, it must be inconvenient for travellers to drive to the centre and then park there. This poor accessibility creates both a physical and mental barrier for travellers to drive to the centre, causing them to opt for the faster and easier alternative, namely: bus-based Park-and-Ride facilities. If this threshold does not exist, there is no reason for motorists to use these facilities, which reduces P&R-use and thus negatively affects the overall P&R situation. It is therefore essential that this precondition is taken into account if one wants to create a successful bus-based P&R (Dijker, Geijsel, Groenhof, Stinissen, Van Heerde & Verplancke, Personal Communication, 2024).

This precondition was mentioned by many interviewees as one of the three keys to P&R success. According to Keus (Personal Communication, 2024), prior to any P&R implementation, the question must be asked: “How are you (i.e. the city centre visitor) discouraged from coming to the city centre?” This question also answers the question of whether the implementation will be necessary or successful at all. According to the Almere Mobility Advisor, “people will only consider bus-based P&Rs if their travel time loss increases significantly, when they have to be at a certain place in the centre by car” (Keus, Personal Communication, 2024). This loss of travel time increases by taking measures that influence these preconditions, such as reducing the accessibility of the city centre.

Groenhof (Personal Communication, 2024) also sees accessibility as an important factor for the success of bus-based P&Rs. He points to the example (mentioned earlier) of the poor P&R situation in Eindhoven, where few people use P&R Genneper Parken. The reason for this is that the preconditions are not met and therefore it is too easy to get to the city centre by car.

"And that is why it does not work in a city like Eindhoven, because (...) they have a nice inner ring, which easily gets you everywhere, even right up to the centre, with your car. Why would people then park on the edge of the city? That does not benefit the traveller enough..."

(Groenhof, Personal Communication, 2024).

This is confirmed by Dijker (Personal Communication, 2024), who sees a clear difference between the relatively car-friendly city of Eindhoven and the narrow streets of 's-Hertogenbosch' historical city centre. He describes how the street pattern in the latter, compared to 'his city', Eindhoven, is so tight that it is difficult for motorists to manoeuvre in those narrow streets and find a parking space there. According to Dijker (Personal Communication, 2024), this inconvenience, due to the poor accessibility of the city centre, can be a reason for motorists in 's-Hertogenbosch to choose one of the three bus-based P&Rs as an alternative.

On the other hand, this is not the case in Eindhoven, where motorists, as Groenhof's quote already described, can drive everywhere without encountering any accessibility-problems (Groenhof, Personal Communication, 2024). The threshold in Eindhoven (and other Dutch P&R municipalities) is therefore not high enough in terms of accessibility to the city centre, according to the experts.

Parking Capacity in the City Centre

Secondly, the parking capacity of the city centre was mentioned as one of the preconditions for P&R success. In addition to the accessibility, it must once again be made as difficult as possible for motorists to park their car in the centre. A reason must be created for them to park their car at a P&R site and then travel the last part of their journey by bus. This can partly be done by reducing the parking capacity in the city centre. Without a sufficient amount of parking spaces, these travellers are forced to look for an alternative and the bus-based P&R facility offers the solution to that problem (Dijker, Geijsel, Groenhof, Stinissen, Van Heerde & Verplancke, Personal Communication, 2024).

This precondition, just like the previous one, therefore serves as a so-called *push factor*. The aim of this is to keep a certain target group, in this case 'car users', out of the city centre. According to Dijker (Personal Communication, 2024), it must therefore also be made more difficult for travellers to park, so that car-users are 'pushed' from the city centre to the P&R and are therefore forced to make a modal shift. This 'outward pushing movement' must first be initiated before the *pull factor*, for example an attractive P&R facility, can 'work its magic'. This is easily summarized in one sentence by Stinissen (Personal Communication, 2024): "The worse it becomes to park in the city centre, the sooner people will switch to a P&R".

Verplancke, director of SSL, also indicates that for a P&R to be successful, there must be a certain degree of necessity for the motorist, which can only be created by removing other parking options.

"If there are sufficient other parking options closer to the centre, motorists may not feel a strong need to use a P&R facility and transfer to a bus for their onward journey. Setting up a P&R has little chance of success, if there are still enough other options (…)"

(Verplancke, Personal Communication, 2024).

A good practical example of this is the situation in Alkmaar, as was mentioned in chapter 4.3.8. Van Heerde (Personal Communication, 2024) described in his interview how after the construction of separate bus lanes in 2008, in anticipation of the arrival of the P&R sites, a parking lot was also constructed in the city centre. These parking spaces would be removed

once the P&Rs were completed. However, this parking lot was never removed and still stands today, which means that this precondition was not met, ultimately leading to the two P&Rs not being a good alternative, completely failing, and finally resulting in the termination of the city's P&R policy (Van Heerde, Personal Communication, 2024). This practical example confirms the view of the contacted experts that parking capacity in the city centre must be reduced to a certain point to achieve P&R success.

Parking costs in the City Centre

Finally, the parking cost in the city centre is mentioned as the last essential precondition for achieving P&R success. As with the previous two factors, the purpose of this measure is to create a barrier to prevent driving to, and parking in, the city centre. High parking costs discourage people from parking their cars in the city and bus-based P&R facilities are there offered as an alternative. It is unknown what the exact price of the parking fees is, which can convince travellers not to park in the city centre. The experts contacted do not agree on the amount of these fees, because each city differs in terms of size and attractiveness. For example, parking costs in a city like Groningen or Eindhoven will of course be higher than in Terneuzen, so the unique characteristics of a city also play a role in determining this fee (Personal Communication, 2024).

The experts also do not fully agree on the influence of these parking fees on reducing car users in the city centre. Geijsel (Personal Communication, 2024) states that the impact of increasing parking rates is relatively small compared to the other two preconditions that were mentioned. Many people who live (far) outside the city come to the city by car anyway, so the higher parking rates would make little difference to them. "When people stand at the parking meter, they always say: *"Look, what I have to pay now!"* And whether that is €5, €8 or €10, it doesn't really matter. People will complain anyway!".

Van Heerde and Dijker (Personal Communication, 2024) agree with this. They claim that the parking rate is of limited importance and that the other two factors mentioned mainly play a role in the success of a P&R. Verplancke (Personal Communication, 2024) agrees with this limited importance, but notes that the P&R fee must always be lower than that of other parking spaces closer to the centre.

In contrast to the other experts, the experts from Groningen, namely Stinissen and Bosveld (Personal Communication, 2024), consider parking rates to be of great importance. Bosveld claims that there must be a creation of a large enough contrast between the parking rates in the centre and the parking rates at the P&R facilities.

> *"(...), you have to be somewhat forced to do something as a consumer. If you can park for €1 in the centre, then free parking at the P&R makes little difference. So the contrast must be significant , which ultimately makes people actually want to consider it [using a P&R facility]"*
>
> *(Bosveld, Personal Communication, 2024)*

This view of the Groningen experts is partly due to their municipality's unique policy in the field of P&Rs. All P&Rs in Groningen offer free parking, which means there is a greater difference, compared to other cities, between P&R fees and the fees in the centre. As a result, this factor probably plays a greater role in this P&R municipality.

Another point that is often mentioned by experts and also relates to parking rates in the centre is the political and social interference. For example, Groenhof (Personal Communication, 2024) states that there is always a tension between 'how high the parking rates should be compared to other cities, to ensure that 'your' city is still attractive for the customer…'. Local entrepreneurs and residents always have different views on this matter, with the former wanting

to attract as many visitors as possible through low parking costs, while the latter often wants a parking space for themselves and a liveable environment, without too many cars. As a result, parking rates in the centre can sometimes be a thorn in the side of good and rapid policy implementation, as Dutch policymakers have the habit of always listening to everyone's wishes, which can cause consultations to take longer (= '*polderen*').

Keus (Personal Communication, 2024) understands this 'parking fee dilemma' that municipalities face and claims that the value of the visiting public cannot simply be pushed aside. He states that visitors are one of the most important drivers of the economic heart of the city, which means they also have a major influence on parking policy. According to him, entrepreneurs would not be happy with increased parking rates, because their visitors would no longer be able to come to the city in a convenient way, which would have negative economic consequences. It is therefore necessary to first look at creating an attractive alternative, in this case: a bus-based P&R, before there is an increase in parking costs in the centre. The two aforementioned preconditions must therefore first be met in order to create an attractive P&R facility, and only if this functions properly, an increase in parking rates in the city centre can be introduced to boost the P&R situation even more (Keus, Personal Communication, 2024).

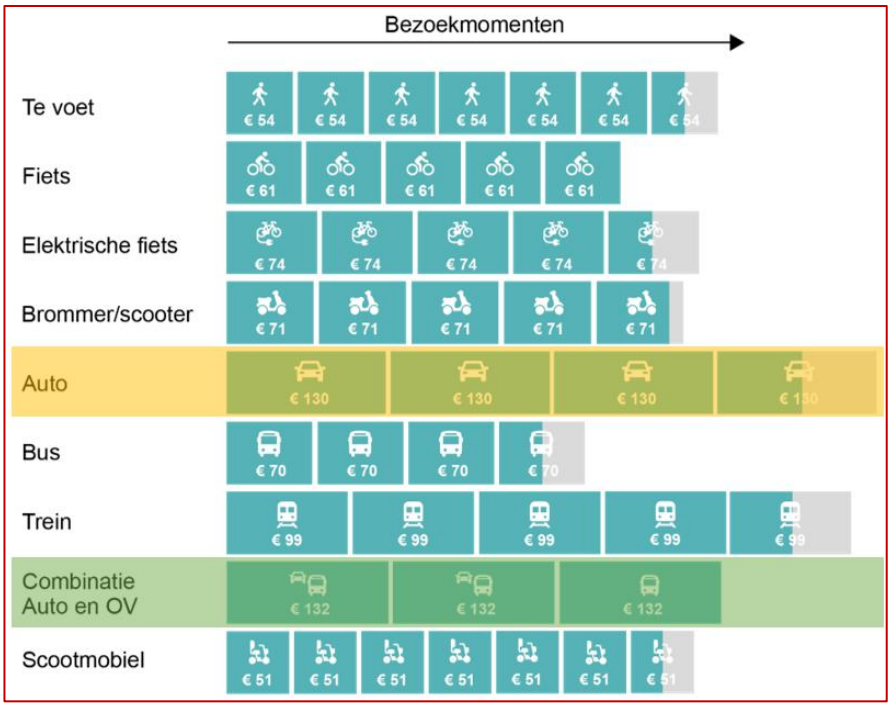


Figure 30: The expenditure of the city centre's visitors arranged by mobility. The visits and expenditure of the average P&R user are shown in green and those of the average car user are shown in yellow (Platform Binnenstadsmanagement, n.d.).

However, Geijsel only sees this 'visitor-dependency argument', which is often used by entrepreneurs in the municipal parking rate discussion, as a fallacy. He refers to a study by the "Platform Binnenstadsmanagement" (*Platform Inner City Management*), which shows the relationship between mobility and customer spending. This shows that P&R users and car users go to the city centre approximately equally often, but that P&R users spend more on average (Platform Binnenstadsmanagement, n.d.).

By naming this study, Geijsel (Personal Communication, 2024) wants to demonstrate that it has already been proven that P&Rs can serve as an alternative to parking spaces in the city centre, without affecting the number of visitors or the businesses that are located in the centre. According to him, this parking rate increase, which is so abhorred by local entrepreneurs, is therefore not dependent on first creating an attractive P&R environment, as Keus (Personal

Communication, 2024) claims, because the research by Platform Binnenstadsmanagement (n.d.) proves that the higher parking rates have no influence on visitor numbers and their undertakings.

Creating a threshold

In short, all three of these preconditions are so-called 'push factors'. Their aim is to keep a certain target group, in this case 'car users', out of the city centre. The first two involve a mobility barrier that should ensure that people divert to the P&R, while the third factor serves as a financial barrier. Although all experts see the latter as an important precondition, they do not fully agree on its influence on the P&R situation. In any case, it can be said that all three factors are considered essential for the success of a bus-based P&R facility.

4.4.2 Travellers' Feeling

In addition to the above-mentioned preconditions that play a major role in determining the success and failure of bus-based P&R facilities, the experts also indicated that the feeling that travellers have during a P&R action is also very important. The behaviour and travel motives of the car user must be fully understood to ensure that instead of making their entire journey by car, they transfer to the bus at a P&R facility.

Understanding the User

This is also evident from the views of Keus (Personal Communication, 2024), who claims in his interview that there should always be a *carrot-and-stick approach* when implementing P&R facilities. He states that the metaphorical stick, represented above by the three different *push factors*, must be combined with a thorough analysis of the potential user group, which in this case consists of car users. By thoroughly researching this group and understanding their travel feelings and motives, they can be enticed (= *carrot)* to use the P&R (Keus, Personal Communication, 2024).

> *"(...) People's behaviour! That is really what this is about… How do you change that? Who is that person in that car? What decisions is he making at the moment? Is he going out? Does he still have to pick up his children, does he still have to go shopping, or do something else? How about social safety at the facility? What is the lighting like? How do people feel about being there at night? Will they still use it [the P&R facility] if it's dark? All those things contribute to the attractiveness of hubs!"*
>
> *(Keus, Personal Communication, 2024)*

The original behaviour and travel motives of the car user, i.e. the potential P&R user, therefore largely determine how attractive he finds the P&R and whether he will use the facility. In other words, you have to replace the original trip feeling as best as possible by adapting the alternative to it (Keus, Personal Communication, 2024).

One way to replace the car trip is to keep the number of links in the chain journey as small as possible. These links refer, for example, to the number of bus stops that are passed on the journey from the P&R facility to the city centre. According to Groenhof (Personal Communication, 2024), there should be special P&R-buses that drive directly to the city centre and make relatively few stops in between. As a result, the original travel feeling, consisting of the speed and directness of the car, is almost perfectly reproduced.

Reducing the Mental Distance with Smoothness

According to Bosveld (Personal Communication, 2024) travellers want to get from A to B as quickly and comfortably as possible. To replace this seamless car journey, the alternative journey to and from the P&R must also be smooth. This is partly done by strategically placing the P&R facilities in easily accessible places and combining this with a high frequency of buses,

so that travellers do not have to wait long. This creates a smooth P&R action that makes them forget the car trip (Bosveld, Personal Communication, 2024).

Dijker (Personal Communication, 2024) agrees with this view and claims that a P&R must avoid 'travel hassle' at all times by keeping the P&R action as simple as possible. He refers to the P&Rs in Groningen, where users can quickly park for free and directly board a bus to the city centre, without any delay. According to him, simplicity and clarity make P&R facilities the perfect alternative to the car.

His colleague from Breda also sees simplicity as a valuable factor in influencing traveller feelings. However, Geijsel (Personal Communication, 2024), from his own case, points more to the *quality of the transfer* and specifically to the distance that travellers have to travel at the P&R facility itself. He states that the compactness of the facility improves the transition from car to bus. "As a traveller, you should not have the feeling that you park your car in one place and then have to walk a bit to the bus stop, because that creates so much resistance" (Geijsel, Personal Communication, 2024). He emphasizes that this is not about the physical distance, but rather about the mental distance. As an example, he gives his 'own' P&R facility in Breda:

> *"(...) in the case of Breda-West, you park your car on a windy piece of land… Then you have to walk a bit, then you have to cross, then you have to wait again for the traffic light, cars rushing past you, and then you cross... Then you have to walk a bit again and then, to make matters worse, you have to wait again at the bus stop until the bus comes. (...). Imagine, we build a second parking layer on top of the current parking lot, and it will be possible for travellers to simply walk over a footbridge from the parking lot to the bus stop, without all the stops, then it will be a completely different, and faster, feeling!"*
>
> *(Geijsel, Personal Communication, 2024)*

Travellers should thus get the feeling that it is a seamless transition and physical distance therefore plays a less important role. A smooth transition reduces the mental distance and makes the P&R more attractive.

No need for Extra Facilities

According to Geijsel (Personal Communication, 2024), it is better for a government to invest their money in the quality of the transfer than in improving the facilities at the P&R site. A practical example of this is tram-based P&R Ypenburg in The Hague, where the tram stop is also a far walk from the parking lot. Geijsel (Personal Communication, 2024) described how The Hague has also invested an enormous amount of money and effort in the facilities at the P&R site, but that this was actually like fighting a losing battle, as investments in the facilities could not reduce the mental distance and therefore did not improve the feeling of travellers.

This value of investments in the facilities at the P&R itself, such as waiting time softeners, is also doubted by other experts. For example, Dijker (Personal Communication, 2024) indicates that there is a kiosk at P&R Meerhoven, another facility in Eindhoven, but that it has not been a so-called 'game changer' in terms of P&R use or improving the travel feeling. So he is not sure whether the presence of a waiting time softener or a staffed facility makes such a big positive difference to the travel experience (Dijker, Personal Communication, 2024).

His colleagues from Groningen and 's-Hertogenbosch go one step further and conclude that there is no need for waiting time softeners at a P&R facility, but that a P&R only requires a form of social safety (Bosveld and Groenhof, Personal Communication, 2024). This can be done, for example, through good lighting or a very frequent bus service. In addition, Groenhof (Personal Communication, 2024) emphasizes that a P&R should serve as a transfer point and

not as a short stop in a trip to the city centre. That is why, according to the experts, waiting time softeners have little to no influence on the travellers' feeling and therefore there is no need for them at bus-based P&R facilities (Groenhof, Personal Communication, 2024).

Time is of the essence

Finally, the interviewed experts mentioned the importance of time and adhering to a consistent policy. The implementation of a bus-based P&R facility is a long-term process and most P&Rs are therefore not a huge success at first. According to Bosveld (Personal Communication, 2024), this is mainly due to the behavioural change that the P&R demands from its potential user. He states that this change in behaviour is accompanied by the creation of a 'P&R culture', in which people see the use of P&R as a natural order of things.

> *"It [the P&R use] has to seep in, so that the behaviour can change! I also think that at a certain point, there is no longer a barrier [to use a P&R]. It is just the way it goes, it works well, everyone is often positive about it, so then it also goes from word of mouth. Everyone just goes with the P&R, and it has just become very normal"*
>
> *(Bosveld, Personal Communication, 2024)*

The travellers' feeling towards bus-based P&R facilities must therefore change from 'P&R as a one-time car alternative' to a full-fledged 'P&R culture', in which the facilities serve as the best gateways to the city centre.

This culture is also mentioned by Groenhof (Personal Communication, 2024). He states that people have to get used to P&Rs and that P&R facilities certainly have a lead time of 5 years before the culture is really accepted. To achieve this, an active promotion policy is essential. 's-Hertogenbosch has done this by working with retailers, employees and residents to make the P&R facilities known to everyone. Ultimately, word of mouth advertising worked very well for creating the culture, but the influence of the municipality's promotional policy on this is limited.

In short, a lot of time and a consistent policy are needed to achieve a successful P&R facility and the associated behavioural change. The emergence of the so-called P&R culture requires a long-term process, in which potential users are encouraged in all kinds of ways to actively change their travel patterns. If the travellers' feeling fully accepts the P&R culture, the situation of these facilities will also improve. However, please note that to achieve P&R success, the preconditions must first be met before the travellers' feeling can 'work its magic'.

4.4.3 Answer to the Third Sub-Question

Finally, in this last part of this chapter 4.4, the third sub-question from this research can be answered, which was as follows: "What factors cause the situation of Dutch bus-based P&R facilities, and are there any additional unidentified factors that influenced this?". This question was addressed on the basis of the results from semi-structured interviews with experts from various P&R municipalities.

First of all, the experts clearly indicated that the situation of a bus-based P&R always depends on three preconditions. This concerns accessibility, or 'the ease of driving to the city centre by car', the parking capacity, and the parking costs in the centre. These three factors must first be addressed, for example by reducing car mobility, removing parking spaces and/or increasing parking rates in the centre, before the desired P&R success can be achieved. This approach, based on these push factors, ensures that car users are 'pushed out' of the city centre, leaving the P&R facilities as the best alternative and positively influencing the P&R situation.

Provided these preconditions are met, the other factors mentioned can then be examined, all of which are related to the travellers' feeling when making a P&R action. These four aspects mentioned can partly be seen as new factors, as they are not directly mentioned in the literature as evaluation criteria or a possible factor that influences the P&R situation.

However, some of these factors can, to a certain extent, be attributed to the aforementioned evaluation criteria from the literature study. For example, the discussed parts about user-understanding and creating a smooth transition can both be attributed to the main factor 'Quality of the Connecting Public Transport', as these two relate to, among other things, reproducing the 'directness' of the car feeling and improving transfer quality.

In addition, the 'no need for extra facilities', such as waiting time softeners, can also be attributed to a main factor, namely: the 'Quality of the P&R Facility'. The experts indicate that additional investments in waiting time softeners, for example, have virtually no positive influence on travellers' feelings towards the P&R facility and that it is therefore better to invest in other aspects. For example, guaranteeing social safety at the P&R facility is very important, but it must remain only a transfer point and not a short stop in a longer journey.

Finally, the importance of time was emphasized by the experts. This is something that has not yet emerged in the literature and can therefore be seen as a newly discovered factor. The incorporation of a P&R culture takes time and must go hand in hand with a consistent P&R policy.

In short, the situation of Dutch bus-based P&R facilities is mainly determined by the three preconditions, which are the key to P&R success. Provided these key factors are met, the opportunity is opened to look at other, partly newly discovered factors that in turn can also have a positive influence on the P&R situation. This is all illustrated in figure 31 below.

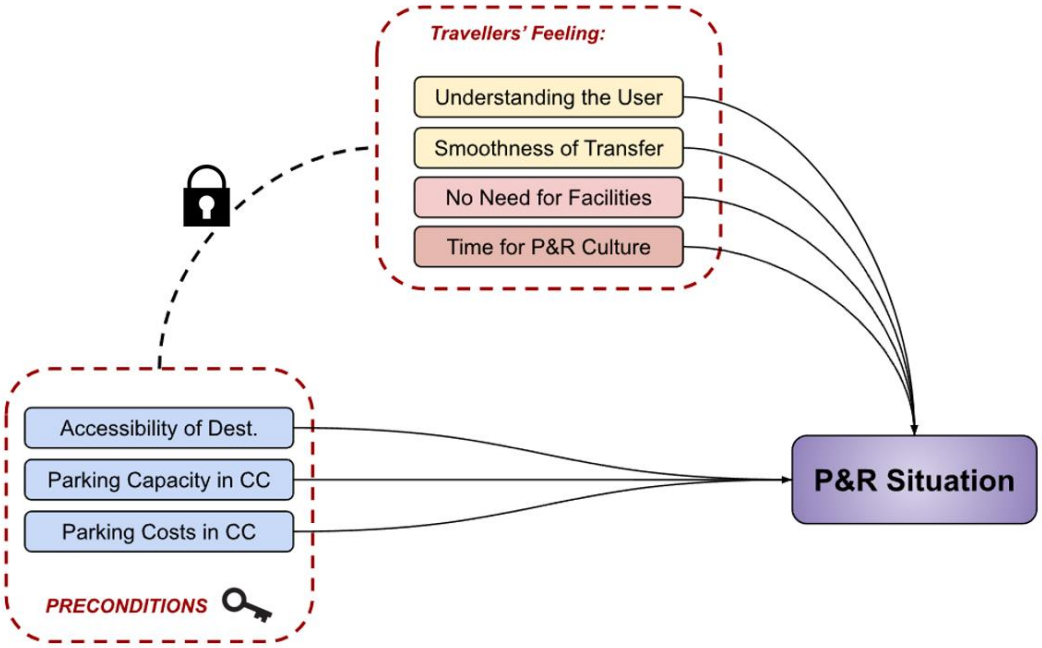


Figure 31: The answer to the third sub-question regarding the factors that cause the situation of Dutch bus-based P&R facilities. On the left, the preconditions are shown, forming the key to both the other factors that can influence the P&R and to a successful P&R (Own work).

5. Conclusion

Now that all results have been discussed and all sub-questions have been discussed, the main research question can finally be answered. Based on the historical context, personal experience and the problem statement from chapter 1, this main question was formulated: "What is the current situation of Dutch bus-based P&R facilities, based on existing evaluation criteria from the literature, and what factors influence this situation?"

In order to answer this question in a systematic, complete and correct manner, three sub-questions were asked, all of which were answered on the basis of the literature study and the results obtained. This concerned the following three questions:

1. *What are the evaluation criteria identified in the existing scientific literature that can be used to assess the situation of bus-based P&R facilities?*
2. *How do the contacted experts assess the current situation of Dutch bus-based P&R facilities based on the evaluation criteria outlined in the literature?*
3. *What factors cause the situation of Dutch bus-based P&R facilities, and are there any additional unidentified factors that influenced this?*

In response to the first sub-question, a conceptual model was drawn up based on the literature research, in which all evaluation criteria, i.e. the factors that influence the P&R situation, were divided into three main factors. To better demonstrate these evaluation criteria, the extensive conceptual model has been rotated, as can be seen below in Figure 32. This figure also directly answers the first sub-question, which then made it possible to look at sub-question #2.

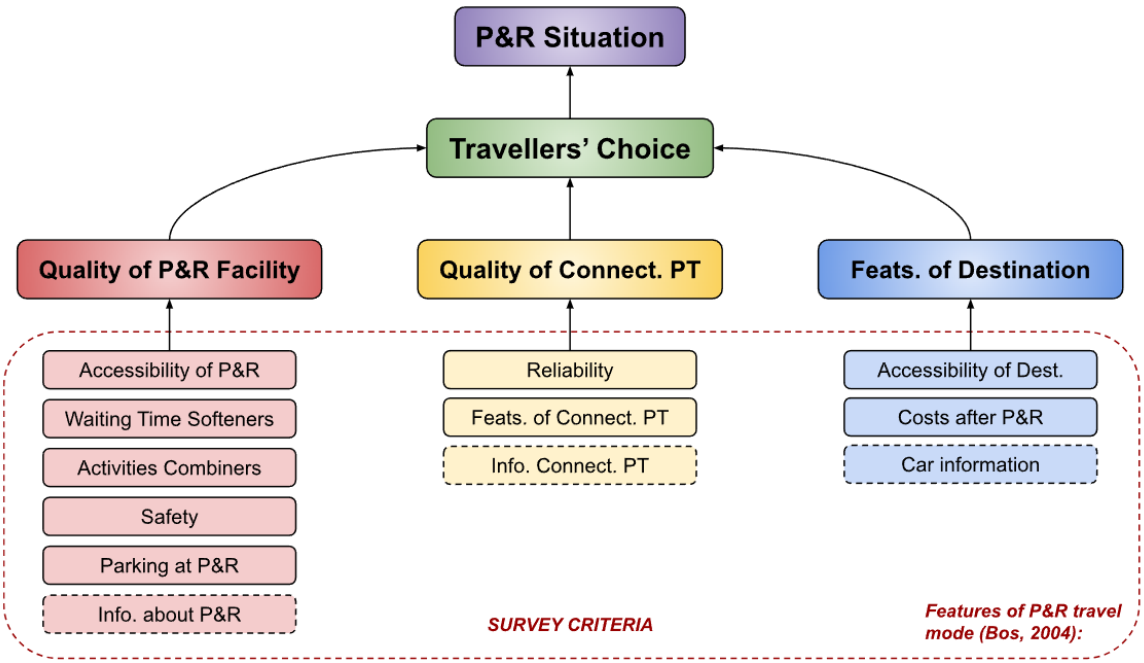


Figure 32: The rotated conceptual model, better showing the evaluation criteria (Own work).

It was then up to the experts to assess the current situation of bus-based P&R facilities in the Netherlands based on these evaluation criteria. From Chapter 4.2 we can conclude that the Dutch P&Rs generally score well on the main factors 'Quality of the P&R Facility' and 'Features of the Destination'. Besides, they score 'slightly good' in the area of connecting public transport. Table 18 has been drawn up for a comprehensive overview of the scores per assessed P&R facility. It can quickly be seen that the bus-based P&R facilities in the Netherlands are doing relatively well in three evaluated areas. Den Bosch and Groningen in particular score well,

while Breda is rated below average. It can also be seen that although the overall assessment of the Quality of the Connecting Public Transport is the lowest compared to the other two factors, the largest differences in assessments between P&R facilities can mainly be found in the Features of the Destination. In short, based on the evaluation criteria from the literature, it can be concluded that the Dutch bus-based P&R facilities are generally well assessed by the experts contacted. Please note that this is an assessment based on the criteria from the known literature and does not immediately mean that every P&R facility functions well and/or is widely used in practice.

			QoPR	QoCPT	FoD
P&R Facility	Utrecht	Papendorp-Noord	4,00	5,00	6,00
	Eindhoven	Genneper Parken	6,00	5,00	3,50
	Groningen	Kardinge	6,00	5,00	6,00
		Hoogkerk	6,00	5,00	6,00
		Haren/A28	6,00	5,00	6,00
		Reitdiep	6,00	5,00	6,00
		Meerstad	6,00	5,00	6,00
		Euroborg	7,00	6,00	6,00
		Leek	7,00	6,00	6,00
	Almere	Almere 't Oor	5,00	6,00	4,50
	Breda	Breda-West	4,00	3,50	2,00
	Nijmegen	Nijmegen-Noord	6,00	5,00	5,00
	's-Hertogenbosch	Pettelaarpark	7,00	7,00	6,00
		Deuteren	7,00	7,00	6,00
		De Vliert	7,00	7,00	6,00
	Enschede	Zuiderval	6,00	6,00	4,00
	Terneuzen	Busstation WST	6,50	6,00	3,00
	Leiden	Haagweg	6,00	5,00	4,00
	Muiden	Muiden	6,00	4,50	6,50
	Soest	Soesterberg	4,00	6,00	4,00
		Overall score	6,00	5,00	6,00

Very poor
Poor
Slightly poor
Neutral
Slightly good
Good
Very good

Table 18: All median scores of the assessed Dutch bus-based P&R facilities per main factor.

Finally, the specific factors that explain the situation of the bus-based P&R facilities had to be explained, in order to also determine whether there were any possible new, unknown factors. The interviews showed that the three preconditions, accessibility, parking capacity and parking costs in the city centre, are central as causes of the P&R situation. These factors are the key to P&R success and also serve as a prerequisite for the effect of the other identified factors. This concerns aspects that influence the travellers' feeling and therefore have an impact on the P&R situation. Three of these factors, shown in Figure 31 (see chapter 4.4.3), are only 'partly new', as they can also be attributed to the main factors 'Quality of the P&R Facility' and 'Quality of the Connecting Public Transport'. Only the 'time factor', which identifies the creation of a P&R culture through consistent policy, can be seen as a fully-fledged new factor, as this has not been mentioned in the literature.

Combining these sub-conclusions, consisting of the answers to the sub-questions, provides the opportunity to answer the main research question. So, what is the current situation of Dutch bus-based P&R facilities, based on existing evaluation criteria from the literature, and what factors influence this situation? Based on this research, it can be stated that the current situation of the Dutch bus-based P&R facilities is assessed as 'good' by the experts contacted on the basis of the assessment criteria from the literature. However, this does not mean that these P&R facilities function as such in practice. The P&R situation mainly depends on

accessibility, parking capacity and parking costs. These preconditions are all known in the literature and are supplemented with four factors related to the travellers' feeling. Of these last four factors, one new or unknown factor has been identified, namely: the time required to create a P&R culture.

In short, the Dutch bus-based P&Rs generally score well based on the long-known evaluation criteria. The situation of these P&R facilities mainly depends on the preconditions, which serve as the key to improving the travellers' feeling and ultimately achieving P&R success.

6. Discussion

Now that the conclusion has been completed and the main question has been answered, this discussion chapter can delve deeper into the meaning, importance and relevance of the research results. The connection between these results and the literature study will first be explained. Subsequently, several limitations and implications that arose in this study will be discussed. Finally, this chapter will end with some suggestions for further research.

6.1 Interpreting the Results

The primary aim of this research was to investigate whether there are unknown factors that influence the situation of bus-based P&R facilities in the Netherlands. This was done by first establishing the well-known evaluation criteria from the literature, then having the P&Rs assessed and ultimately, on the basis of a multiple case study, concluding which factors influence the success of P&R facilities. The results and the answer to the main research question were explained in the previous chapter and what immediately stood out were the three preconditions:

1. Accessibility of the City Centre;
2. Parking Capacity of the City Centre;
3. And the Parking Costs in the City Centre.

Almost every expert contacted identified these three factors as the key to P&R success. What is striking is that these preconditions are not 'newly identified' factors. If we look at the original conceptual model (figure 33), we see the 'Accessibility' and the 'Costs after the P&R' as sub-factors of the 'Features of the Destination'. However, the third precondition, Parking Capacity, which is not directly mentioned in the conceptual model, is also a feature of the destination and can therefore also be included under this main factor.

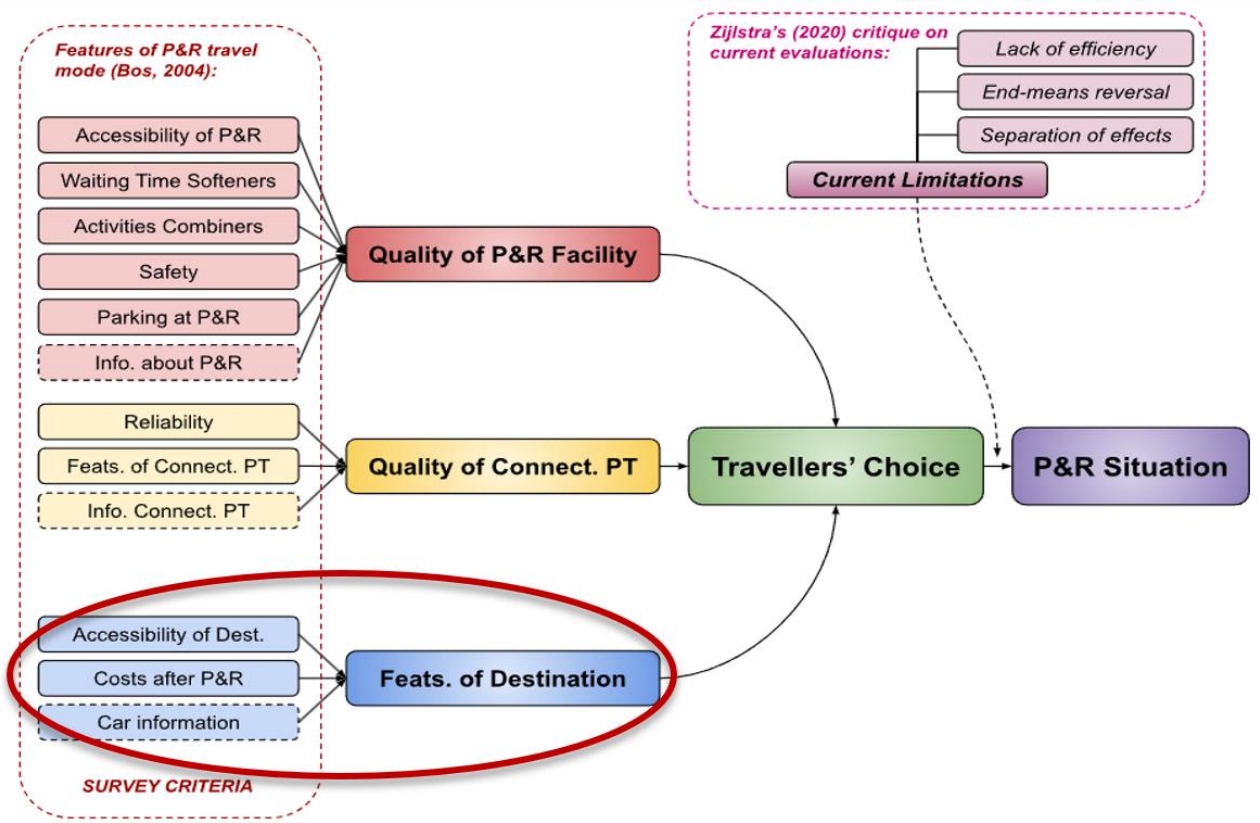


Figure 33: The extensive conceptual model, in which it becomes clear that all three preconditions belong to the main factor 'Features of the Destination' (Own work).

If a link is made between the results from this research and the previously drawn up conceptual model, we can say that the Features of the Destination, as a main factor, plays a bigger role than the other two main factors in determining the P&R situation. A municipality can therefore have the best P&R facility, with the best connecting public transport, but if these preconditions are not met, the bus-based facility will not or hardly be used, resulting in a negative P&R situation.

The criticism by Zijlstra (2020), which was mentioned in chapter 2.3.4, and related to the distinction between the P&R measure and the other supporting measures, is also in line with this. Zijlstra (2020) states in his article that the implementation of a P&R facility is always accompanied by other measures, so that this implementation is never solely responsible for a change in travel behaviour of potential P&R users. This is shown in figure 33 in the top right corner as 'separation of effects'.

By including not only the criteria of the P&R facility, but also those of other (non-facility-related) aspects, in the survey and mentioning them in the interviews, it was possible to determine that the facility and the connecting public transport have relatively little influence on the travellers' choice, and therefore the P&R situation. The supporting measures, on the other hand, play a greater role in the form of adjustments to the preconditions, which are among the features of the destination. Broadening the scope of the evaluations, arising from the criticism of Zijlstra (2020), has therefore led to this knowledge being found and this conclusion being drawn.

6.1.1 The New Customer-Wish Pyramid

It can thus be concluded that the Features of the Destination play a greater role in determining the P&R situation, i.e. its success or failure, compared to the other two main factors. In particular, these two factors, namely the Quality of the P&R Facility and the Connecting Public Transport, and their criteria are based on the layers of the customer-wish pyramid shown in figure 34.

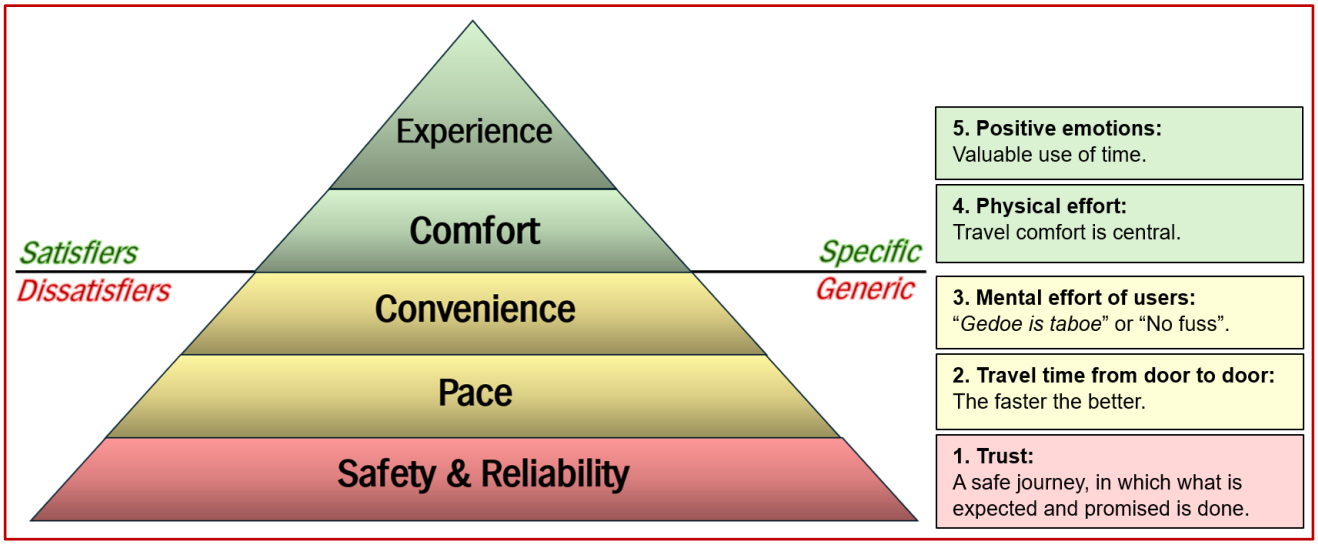


Figure 34: The original customer-wish pyramid (Own work based on CROW (2015)).

This pyramid is a conceptual framework that shows what potential P&R users want on their trip, in order of importance. Safety and reliability serve as the basis, followed by the layers 'pace' and 'convenience'. These three layers are seen as the dissatisfiers, the aspects that people expect during their journey. If these aspects are not present, the pyramid cannot be 'constructed', which means that travellers, or in this case potential P&R users, will not be likely to use the P&R facility and adjust their travel behaviour (CROW, 2015).

The top two layers, ‘Comfort’ and ‘Experience’, on the other hand, are the satisfiers. These are the layers that improve the travel experience and can serve as additional pull factors. However, these quality requirements of the higher layers on the pyramid can only be taken into account if the underlying requirements are of sufficient quality (CROW, 2015).

So the layers of this pyramid mainly relate to the criteria regarding the quality of the P&R facility and the connecting public transport. They serve as basic characteristics that must be met before an implementation of a bus-based P&R takes place (CROW, 2015). However, this research has shown that it is not these two main factors, but the Features of the Destination that are the basis of P&R success. Therefore, a layer must be added to this pyramid at the bottom, as ‘the base of the base’. This is shown in figure 35.

Figure 35: The New Customer-wish Pyramid (Own work).

In short, to achieve bus-based P&R success, it is important that the various layers in this pyramid are met, starting with the Features of the Destination. After reducing accessibility and parking capacity, and increasing parking costs in the city centre, it is possible to look at the other characteristics. But these preconditions, which serve as the basis of the new customer-wish pyramid, must first be met before moving up the pyramid.

6.2 Limitations

6.2.1 Expert-related Limitations

There were a number of limitations in this study, as in any study, that may have influenced or rendered the results incomplete in some way. One of these is the choice made at the start of this research to contact one expert per P&R municipality for the survey and interview during the case study, instead of several. Each expert was therefore given the opportunity to provide a one-sided and clear picture of the bus-based P&R facilities in their municipalities. However, there are a few limitations to this approach. For example, a single expert may give a distorted or incomplete picture of the situation in the P&R municipality, while several experts had broadened this picture.

In addition, the P&R facilities in the municipality were in most cases assessed by an expert who was in some way affiliated with the municipality or the P&R. These could, for example, have been mobility advisors or policy makers. There is a possibility that the experts completed the survey in a biased manner, in order to give their municipality a higher score. This is of course not the expectation, and it is assumed that the answers given were honest, but an independent assessment of these P&R facilities might have provided a more valid picture of the bus-based P&R situation in Dutch municipalities.

The somewhat skewed ratio of interviewees in the multiple case study may also slightly distort the results. For example, only one expert was interviewed for each P&R municipality, while two experts were interviewed for Groningen. The reason for this is that the first expert interviewed, Stinissen, mentioned that he did not have the best knowledge of municipal policy in the field of P&Rs. He therefore referred these questions to his colleague Bosveld, with whom an interview was subsequently conducted. In retrospect, this second interview contributed an enormous amount of knowledge about both the Groningen situation and the general P&R factors, so this is not something to regret. However, this somewhat skewed ratio of experts per municipality should be kept in mind when reading the results of this study.

6.2.2 'Ends-means reversal': Noted, but not possible

In addition to the expert-related limitations, 'missing the focus on the ends' was also a limitation in this study. This problem, which occurs more often in P&R evaluations, was also mentioned by Zijlstra (2020) in his article. Chapter 2.3.3 explains how many current P&R evaluations only focus on the means, but neglect the ends, such as emission reduction and reduced traffic pressure. To get a better picture of the P&R situation, it is therefore necessary to also analyse these ends (Zijlstra, 2020).

Although this criticism was taken into account by asking questions in the survey about various topics that show the impact of the P&R, such as parking pressure, emission reduction and the possible growth in the number of public transport users, many experts were unable to answer this. These questions were often answered with "N/A" or "neutral", and if the questions were answered at all, the experts indicated that this was only based on distant suspicions, making it not useful for this study.

After later contact, it turned out that the municipalities often did not have specific figures on these topics, and they could only share documents about the occupancy rate of the P&R facility itself for this research. In short, an attempt was made to include Zijlstra's (2020) criticism in this research, but the little knowledge about the ends ensured that this remained a limitation.

6.3 Implications & Recommendations

6.3.1 Recommendation for Policy and Practice

This study showed that the situation of bus-based P&R facilities mainly depends on the characteristics of the destination, which refers to the accessibility, parking capacity and parking costs of the city centre. These three factors are the preconditions for achieving P&R success and therefore form the basis for the new customer-wish pyramid (figure 35).

In practice, this conclusion can provide a solution for the current, incorrect and often passive bus-based P&R policy in various municipalities. Both Dutch and foreign municipalities that have a poorly functioning bus-based P&R facility can use the results from this study to pinpoint the sore spot in their municipality. In most cases it will appear that the features of the destination are not sufficiently addressed, so that travellers see no reason to use the P&R facility. Municipalities with a bus-based P&R would therefore do well to adapt their policy to a carrot-and-stick approach, where there is more 'stick' than 'carrot', in the form of reducing accessibility and parking capacity, and/or increasing parking costs in the city centre. A concrete

figure for, for example, the number of parking spaces that must be reduced or the increase in hourly parking costs in the city centre has not been investigated or determined in this study. This will be different in every municipality, depending on several factors and characteristics of the city and its surrounding area.

In any case, only after these preconditions have been met can policymakers look at the higher layers in the pyramid, such as 'convenience' and 'comfort'. This obviously also applies to P&R municipalities with an average or well-functioning bus-based facility, which want to further improve or expand their P&R policy. In these cases, they will most likely already broadly meet the presented preconditions, allowing the higher layers of the new customer-wish pyramid to be addressed.

On the other hand, the conclusion from this study not only offers a helping hand for P&R municipalities with a poorly functioning bus-based facility, but also for municipalities that do not yet have a facility, but are considering one. The research shows what the requirements are and what the municipality must do to achieve P&R success. However, there will also be policymakers who do not see such a 'stick approach' as a solution, but merely as an 'attack' on motorists. The conclusion therefore shows the threshold, and its severity, that policymakers must cross before opting for the implementation of a bus-based P&R facility. Based on this threshold, municipalities must determine whether or not they are open to P&R policy, because without meeting the preconditions, implementing a bus-based P&R facility will not be successful.

In short, the implication of this research is that P&R success depends on meeting the preconditions. This also indirectly offers a recommendation for both P&R municipalities and municipalities that are considering a P&R. For both cases, the threshold that must be crossed to ultimately achieve P&R success is shown and explained. This gives policymakers in practice the opportunity to adapt their approach to the conclusions from this research in order to optimally implement a successful bus-based P&R facility.

6.3.2 Recommendations for Follow-up Research

In addition to the fact that, according to this research, municipalities, as initiators of a P&R implementation, should primarily focus more on the preconditions presented, this research also provides a number of recommendations for possible follow-up research.

First of all, the aforementioned limitation surrounding the 'ends-means reversal' would be a reason to conduct research into the relationship between consequences and the actual goals of a bus-based P&R. In practice, a comparison should be made between the effect bus-based P&Rs have and their intended purpose. Does the implementation of a bus-based P&R facility actually reduce emissions? And what about the traffic pressure in the municipality? To return to the aforementioned metaphor of Zijlstra (2020) from chapter 2.3.3; *Is the patient still alive after the successful operation?*

However, this is a very extensive study, which requires examining certain factors that are relatively very complicated, such as emission quantities and traffic flows. Despite this, a breakthrough in such a study could provide a clearer picture of the impact of an implemented bus-based P&R facility and therefore better quantify its value for a municipality.

Secondly, an in-depth study into the potential bus-based P&R user and in particular the travel feeling of this user could contribute enormously to the improvement of the P&R service. It is important that not only the existing users of the P&R facility are questioned, for example in a survey, but also mainly the potential users, in other words: the motorist who visits the city centre. This is the target group that policymakers want to persuade to also use the P&R facility.

Once it is clear what their travel feelings are and what travellers want on their trip, it also becomes clear how and what a P&R facility must offer to achieve that modal shift.

Besides, this follow-up research could serve as a check for the conclusion reached in this study, in which the travellers' feeling was identified as one of the most important factors. For example, researchers could conduct quantitative research by approaching a large number of users via a survey at bus-based P&R locations. This creates a general picture of what P&R users do and do not want to experience during their trip. Of course, this has already been investigated many times, but this research provides grounds for a deeper investigation, in which a connection is made with the conclusions made here. A follow-up can thus serve as a check for the results found in this research, but also as additional advice for P&R municipalities, which can adapt their policy to their users.

Finally, a follow-up study could be conducted into the value of the two main factors that seemed less important in this study than previously described in the literature. This concerns the 'quality of the P&R facility' and the 'quality of the connecting public transport', which can also be seen in the conceptual model (figure 33). According to the literature, these two main factors, together with the features of the destination, have the greatest influence on travellers' choice, which also has a major influence on the situation of P&R facilities. However, this research has shown that the features of the destination mainly play a role and that the other two are only important at a later stage. The question is therefore to what extent these two 'main' factors, according to the literature, are actually important and therefore contribute to the success of a bus-based P&R facility. This could be investigated using both expert statements through interviews and survey studies among P&R users. In any case, this follow-up research would improve the inaccuracy of the three 'main' factors from the literature identified in this study by more deeply investigating and clarifying the value and contribution of the quality of the P&R facility and the connecting public transport.

In conclusion, the implications of this research, which mainly refers to the found preconditions and influence of travellers' feeling, provide a reason to conduct in-depth research into both the impact of bus-based P&R facilities in practice, the user's preferences, and the value of the quality of the P&R facility and its connecting public transport. These studies could better quantify the value of bus-based P&Rs and serve as a control for the results and the conclusion of this thesis.

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8. Appendix

8.1 Survey

This appendix shows the survey questionnaire that was used in this research to evaluate the various bus-based P&R facilities in the Netherlands. The questionnaire was originally formulated in Dutch, as all respondents from the P&R municipalities are Dutch-speaking. In this appendix, however, this questionnaire has been translated to English.

Introduction
Dear respondent,

Thank you for taking the time to participate in this survey about Dutch Park-and-Ride (P&R) facilities, which only have a bus line as a connecting means of public transport. These so-called 'bus-based P&Rs' are generally facilities on the outskirts of a city, where motorists can park their car and travel the last part of their journey by bus.

The aim of this research is to ultimately identify the factors that influence the situation of bus-based P&R facilities, to advance both academic knowledge and urban planning in practice. To do this, the current situation of the bus-based P&R facilities in the Netherlands must first be mapped out, and your experience and knowledge of the selected facility will help with this. This questionnaire therefore serves as an evaluation form.

The survey is completely anonymous, which means that you will not be mentioned by name in the research, if you do not want to, and your answers cannot therefore be traced back to you as a person. The collected data is only available to me and my thesis supervisors, and will be deleted upon completion of this research. After completing this thesis, the entire master's thesis will be published online in the Radboud Educational Repository (theses.ubn.ru.nl), and around the same time it will also be emailed to you, provided that you (at the last question in this survey) chooses this.

Completing the survey takes approximately 10 to 15 minutes. If you have any questions or comments about this survey and/or the research, you can always contact me (victor.frijns@ru.nl).

Thank you again for completing this questionnaire!

Yours sincerely,

Victor Frijns

P&R Selection
What P&R facility would you like to evaluate?

_____

Next page

Accessibility of the P&R Facility

What is your opinion on the following statements, regarding the selected P&R facility?

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree	N/A
The P&R facility is easily accessible for motorists.	○	○	○	○	○	○	○	○
No significant detours are required to reach the P&R.	○	○	○	○	○	○	○	○
The P&R is located on the road to the city centre.	○	○	○	○	○	○	○	○
The signage along the route to the P&R facility is clear.	○	○	○	○	○	○	○	○
The P&R facility is strategically located on one of the main roads.	○	○	○	○	○	○	○	○
Travellers can reach the P&R without significant delays.	○	○	○	○	○	○	○	○
The roads to the P&R facility are free of major traffic congestion.	○	○	○	○	○	○	○	○

Accessibility of the P&R Facility – Possible explanation space

If you would like to further explain your answers to the previous questions about the accessibility of the P&R facility, you can use this text space.

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Next page

Parking

What is your opinion on the following statements, regarding the selected P&R facility?

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree	N/A
Traffic circulation within the P&R facility is well organised.	○	○	○	○	○	○	○	○
There is no congestion within the P&R facility.	○	○	○	○	○	○	○	○
The P&R facility is well maintained and clean.	○	○	○	○	○	○	○	○
Signage and markings in the parking lot are clear and visible.	○	○	○	○	○	○	○	○
The parking rates at the P&R facility are considerably cheaper compared to parking options in the city centre.	○	○	○	○	○	○	○	○
The arrangement, where the parking ticket also serves as a public transport ticket, stimulates P&R use.	○	○	○	○	○	○	○	○
The P&R facility offers sufficient parking spaces.	○	○	○	○	○	○	○	○
There is a possibility for the P&R to expand in the short term.	○	○	○	○	○	○	○	○
The walking distance between the parking spaces and bus facilities at the P&R facility has been minimized.	○	○	○	○	○	○	○	○
The option to reserve a parking space online in advance is often used.	○	○	○	○	○	○	○	○
Sufficient accessibility features, such as ramps and lifts, are available to facilitate the mobility of persons with disabilities.	○	○	○	○	○	○	○	○
The P&R facility implements sufficient initiatives in the field of ecological sustainability.	○	○	○	○	○	○	○	○

Parking – Possible explanation space
If you would like to further explain your answers to the previous questions about parking at the P&R facility, you can use this text space.

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_____

_____

Next page

Waiting Time Softeners
What is your opinion on the following statements, regarding the selected P&R facility?

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree	N/A
The availability of covered shelters in the P&R facility improves the waiting experience of travellers.	○	○	○	○	○	○	○	○
The availability of kiosks in the P&R facility improves the waiting experience of travellers.	○	○	○	○	○	○	○	○
There are many other facilities near the P&R facility.	○	○	○	○	○	○	○	○
The environment around the P&R facility is attractive.	○	○	○	○	○	○	○	○
There are plenty of opportunities for recreation around the P&R facility.	○	○	○	○	○	○	○	○

Waiting Time Softeners – Possible explanation space
If you would like to further explain your answers to the previous questions about waiting time softeners at the P&R facility, you can use this text space.

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Safety

What is your opinion on the following statements, regarding the selected P&R facility?

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree	N/A
Safety considerations were paramount in the design and layout of the P&R facility.	○	○	○	○	○	○	○	○
The P&R facility provides a safe environment for both people and parked cars.	○	○	○	○	○	○	○	○
The P&R facility is well lit.	○	○	○	○	○	○	○	○
The presence of surveillance cameras at the P&R facility increases travellers' sense of security.	○	○	○	○	○	○	○	○
The presence of staff or security personnel at the P&R facility contributes to the sense of safety of travellers.	○	○	○	○	○	○	○	○
The lively environment around the P&R facility ensures a degree of social control and safety.	○	○	○	○	○	○	○	○
The number of reports of vandalism and theft is not significant.	○	○	○	○	○	○	○	○

Safety – Possible explanation space

If you would like to further explain your answers to the previous questions about the safety at the P&R facility, you can use this text space.

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Reliability of the Connecting Public Transport

What is your opinion on the following statements, regarding the selected P&R facility?

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree	N/A
There is a frequent bus connection to the P&R facility.	○	○	○	○	○	○	○	○
The frequency of the bus service generally matches the demand of users.	○	○	○	○	○	○	○	○
The PT schedule at the P&R facility is developed based on extensive assessments and considerations of transport planning.	○	○	○	○	○	○	○	○
The frequency of the bus service during peak hours at the P&R facility is well in line with demand.	○	○	○	○	○	○	○	○
Real-time information displays at the P&R facility provide accurate updates on the arrival and departure of the bus service.	○	○	○	○	○	○	○	○
The P&R facility offers seamless transfer options through a high bus service frequency.	○	○	○	○	○	○	○	○
Even during adverse weather conditions, the bus services demonstrate reliability and resilience.	○	○	○	○	○	○	○	○
The bus service at this P&R facility is reliable.	○	○	○	○	○	○	○	○

Reliability of the CPT – Possible explanation space

If you would like to further explain your answers to the previous questions about the reliability of the connecting public transport at the P&R facility, you can use this text space.

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Features of the Connecting Public Transport

What is your opinion on the following statements, regarding the selected P&R facility?

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree	N/A
The bus stops are conveniently located for users of the P&R facility.	○	○	○	○	○	○	○	○
The bus stops are easy to find for users of the P&R facility.	○	○	○	○	○	○	○	○
The buses that serve the P&R facility are well maintained and in good condition.	○	○	○	○	○	○	○	○
The services and information provided on board during the bus journey, such as a current timetable, are clear and helpful.	○	○	○	○	○	○	○	○
The buses that serve the P&R site adhere to the published timetable.	○	○	○	○	○	○	○	○
The design of the buses ensures comfort for passengers, in the form of sufficient seats.	○	○	○	○	○	○	○	○

Features of the CPT – Possible explanation space

If you would like to further explain your answers to the previous questions about the features of the connecting public transport at the P&R facility, you can use this text space.

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Available Information about the Connecting Public Transport

What is your opinion on the following statements, regarding the selected P&R facility?

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree	N/A
The signage at the P&R facility is clear.	○	○	○	○	○	○	○	○
There is sufficient information at the P&R site about the routes and timetables.	○	○	○	○	○	○	○	○
There is an accurate representation of the current timetable of the connecting public transport.	○	○	○	○	○	○	○	○
The P&R facility provides clear and extensive information about available route options and destinations.	○	○	○	○	○	○	○	○
Some information about the number of available parking spaces has already been indicated on the main access roads.	○	○	○	○	○	○	○	○
Some information about possible time reductions (through the use of the P&R) has already been provided on the main roads.	○	○	○	○	○	○	○	○

Available Information about the CPT – Possible explanation space

If you would like to further explain your answers to the previous questions about the available information about the connecting public transport at the P&R facility, you can use this text space.

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Accessibility of the Destination

What is your opinion on the following statements, regarding the selected P&R facility?

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree	N/A
The travel time from the P&R facility to the final destination is significantly shorter by public transport than by car.	○	○	○	○	○	○	○	○
It is simple to find a parking space at your final destination (the city centre).	○	○	○	○	○	○	○	○
It takes travellers more time to drive to the destination and park by car than to use a P&R to reach the destination.	○	○	○	○	○	○	○	○
It is simple to find a parking space at the P&R facility.	○	○	○	○	○	○	○	○
If there were no P&R facility, the hypothetical travel time for motorists to the final destination would be considerably longer.	○	○	○	○	○	○	○	○
The time needed to find a parking space at the P&R facility is relatively shorter than at the final destination.	○	○	○	○	○	○	○	○
The P&R facility helps reduce the total travel time to the final destination compared to other transport options.	○	○	○	○	○	○	○	○
The final destination is easily accessible from the P&R facility.	○	○	○	○	○	○	○	○
The P&R facility offers a seamless transition to the final destination.	○	○	○	○	○	○	○	○
The P&R facility is relatively more accessible for motorists than the final destination.	○	○	○	○	○	○	○	○

Accessibility of the Destination – Possible explanation space
If you would like to further explain your answers to the previous questions about the accessibility of the destination, you can use this text space.

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Costs after passing the P&R Facility
What is your opinion on the following statements, regarding the selected P&R facility?

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree	N/A
The parking costs in the city centre are relatively higher than those of the P&R facility.	○	○	○	○	○	○	○	○
Parking costs in the city centre are a financial barrier to traveling by car.	○	○	○	○	○	○	○	○
The affordability of parking at the P&R facility, compared to parking in the city centre, influences travellers' travel choices.	○	○	○	○	○	○	○	○
The travel time from the P&R facility to the city centre is considerably shorter compared to the car.	○	○	○	○	○	○	○	○
Using the P&R facility saves time compared to a car journey to the city centre.	○	○	○	○	○	○	○	○
The combi ticket (parking space + public transport ticket) encourages travel via the P&R facility.	○	○	○	○	○	○	○	○
Without a combi ticket travelers would not use the P&R facility.	○	○	○	○	○	○	○	○
The parking cost savings is generally the main reason for travelers to use the P&R facility.	○	○	○	○	○	○	○	○

Costs after passing the P&R Facility

What is your opinion on the following statements, regarding the selected P&R facility?

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree	N/A
The time savings is generally the main reason for travellers to use the P&R facility.	○	○	○	○	○	○	○	○
The combination ticket is generally the main reason for travellers to use the P&R facility.	○	○	○	○	○	○	○	○

Costs after passing the P&R Facility – Possible explanation space

If you would like to further explain your answers to the previous questions about the costs after passing the P&R facility, you can use this text space.

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Car information

What is your opinion on the following statements, regarding the selected P&R facility?

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree	N/A
The (online) information provided regarding travel times from the P&R facility versus direct driving influences the traveller's mode of transport.	○	○	○	○	○	○	○	○
There is sufficient information available for travellers to plan their trip as time-efficiently as possible.	○	○	○	○	○	○	○	○
There is sufficient proactive communication along main roads about road works or incidents (e.g. by means of dynamic signage).	○	○	○	○	○	○	○	○

Car information

What is your opinion on the following statements, regarding the selected P&R facility?

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree	N/A
The information about the estimated travel times from the P&R facility to various destinations is clear and accurate.	○	○	○	○	○	○	○	○
The availability of live travel time information ensures a more efficient way of traveling.	○	○	○	○	○	○	○	○
Without the available travel time information, the P&R facility would be used less.	○	○	○	○	○	○	○	○

Car information – Possible explanation space

If you would like to further explain your answers to the previous questions about the car information, you can use this text space.

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Future contact

Thank you very much for completing this survey! Your input is greatly appreciated and is very valuable for the further development of this research!

If you are open to being contacted again about this topic in the coming weeks, please leave your contact details below.

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Thesis publication
Would you like to receive the entire master's thesis after completing this research? If so, please write your contact details below.

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Thank you very much for completing this survey!
You can now close this window.

8.2 Interview Guide

Below is the interview guide that was used in this study during the interviews with the various experts.

For each interview, a number of questions were drawn up in advance that specifically addressed the experts' answers from the previously completed surveys. This allowed for more targeted questions to be asked about certain topics that had previously been highlighted by the experts. However, these specific targeted questions are not shown in this interview guide, because it only shows the general version that served as the basis for each interview.

All interviews were conducted in Dutch, but as with the questionnaire from chapter 8.1, this interview guide has been translated from Dutch to English.

Interview Guide – P&R Facility '…'	
Introduction	Good morning Sir/Madam, My name is Victor Frijns, I am 22 years old, and I am a Spatial Planning student at Radboud University Nijmegen. For my master's thesis, I am investigating the current situation of Dutch Park-and-Ride (P&R) facilities, which only have a bus line as a connecting means of public transport. These so-called 'bus-based P&Rs' are generally facilities on the outskirts of a city, where motorists park their car and travel the last part of their journey by bus. Over the next hour I will be asking you a number of questions on topics related to my topic. This will mainly include: 1. The quality of the P&R facility; 2. The quality of the connecting public transport; 3. The features of the final destination; 4. And the impact (or consequences) of the P&R facility are discussed. Everything you say about these topics will only be seen by me and possibly my research supervisors. Do you agree with your name appearing in the thesis or would you prefer to remain anonymous in this research? In the second case (of desired anonymity) I will give you a different name in the thesis. - *I don't mind appearing in the survey with my name.* - *I would prefer to remain anonymous in this research*.

	To make the later analysis of your information easier, I would like to record the interview and listen to it again at another time. These recordings will never be published and will only be used by me during the analysis. These will be deleted after completion of the investigation. So are you okay with me recording this interview? - *Yes, I'm okay with you recording the interview.* - *No, I'd rather you not record it.* Before the interview starts, I would like to say that you can always interrupt me if you have any questions or if something is unclear. And if there is something you cannot or do not want to answer, you can just say so, that will not be a problem. Do you have any questions before we start?
Personal information	I will start with a number of introductory questions about you as a person, and then move on to the deeper/more specific topics relating to 'your' P&R facility(s). *---- Start interview (start recording) ----* *Could you first briefly introduce yourself?* - *What is your name?* - *How old are you?* - *What do you do in daily life?* *Do you ever use the P&R facilities in and around [P&R Municipality]?* - *Do you have a preference for a certain type of P&R facility? Train, tram, metro or bus based?* - *What is your position regarding the use and implementation of P&R facilities?*
Questions by topic:	
Quality of the P&R Facility	Let us first talk about the quality of the P&R facility(s) themselves. **Accessibility:** - *How would you assess the accessibility of the P&R facility(s) for motorists? Are detours necessary to reach the P&R? Is there good signage?* - *Is the P&R facility(s) strategically located (on one of the main roads)? How is this location compared to the city centre?* - *Are the roads to the P&R facility generally free of major traffic congestion? Is there still significant delay?* **Parking:** - *Is there good traffic circulation within the P&R facility, which prevents congestion/delays within the P&R facility? Good signage?* - *Are there sufficient parking spaces available at the P&R facility? Is there a possibility for the P&R to expand in the short term?* - *What is your opinion about the maintenance of the P&R facility? Are accessibility features (ramps and lifts) available to facilitate the mobility of persons with disabilities?* - *Can you say something about the parking rates at the P&R facility compared to the parking options in the city centre? Do you think that a combination ticket scheme, if available, would have an incentive effect?*

	- *What is the approximate walking distance between the parking lots and bus facilities? Is the option to reserve a parking space online in advance often used?* **Waiting time softeners:** - *To what extent does the availability of waiting time softeners (e.g. covered shelters or kiosks) improve the waiting experience and increase traveller usage?* - *Are there any other facilities near the P&R facility(s) that could improve the user experience? Restaurants? Shopping centres? Recreation area?* **Safety:** - *Is the P&R facility designed/equipped in such a way that the safety of both people and parked cars is guaranteed? Well lit? Cameras? Security personnel? Lively environment (social control)?* - *Has there been a significant number of reports of vandalism and/or theft at the P&R facility(s)?*
Quality of the Connecting Public Transport	Now we will discuss the quality of the connecting public transport. **Reliability of public transport:** - *Is there a frequent bus service that meets user demand? Correct final destinations and seamless transfer options?* - *Will this frequency of the bus service be adjusted/increased during peak hours? And is this bus service also reliable during adverse weather conditions?* - *Are the real-time information displays at the P&R facility accurate and do they provide updates on arrivals and departures of the bus service?* **Features of public transport:** - *How would you assess the location of the bus stops in terms of convenience for users of the P&R facility(s)? Easy to find? Long walking distance?* - *What is your opinion about the condition/maintenance of the buses? Comfort? Enough seats for the current demand?* - *Are the services provided on board, such as a current timetable, clear and helpful? Is this timetable generally adhered to by the buses that serve the P&R site?* **Available information:** - *How would you assess the clarity of the signage at the P&R facility(s)? Clarity about rates? Sufficient information about the timetable?* - *Is there any information provided on the main access roads about the number of available parking spaces and/or the possible time reduction through the use of the P&R?*

Features of the Destination	Third, I want to talk about the characteristics of the final destination. **Accessibility of the Destination:** - *What is generally the final destination for motorists who use these P&R facility(s)?* - *Is the P&R facility relatively more accessible for motorists than the final destination? Does the P&R facility offer a seamless public transport transfer to the final destination?* - *If you compare the travel time with public transport and the car (from the P&R facility to the final destination), which option is faster?* - *Is it easy for travellers to find a parking space at the final destination (e.g. city centre)? Is the difference in 'parking time' a reason to use the P&R facility?* **Costs after P&R:** - *How do the parking costs in the city centre compare to those of the P&R facility? Do parking costs in the city centre constitute a financial barrier to traveling by car?* - *What do you think is generally the most important reason for travellers to use the P&R facility(s): saving parking costs, saving time, or something else? Do you think that the presence of a combination ticket influences travellers' travel choices?* **Live information on P&R:** - *Is there sufficient information available along the way for travellers to plan their trip as time-efficiently as possible? Is there communication about road works or incidents along main roads (e.g. by means of dynamic signage)?* - *How does the availability of live travel time information ensure a more efficient way of traveling? Do you think that the P&R facility would be used less without the available travel time information?* - *To what extent do you think that the (online) information provided about travel times from the P&R facility versus direct driving affects the traveller's mode of transport?*
Impact of the P&R Facility	Finally, we will discuss the impact and/or consequences of the implementation of the P&R facility. **Parking pressure:** - *To what extent has the P&R facility(s) contributed to a significant decrease in parking pressure (and/or demand for parking spaces) in the city centre?* **Emissions:** - *Has the implementation of the P&R facility(s) led to a significant decrease in traffic-related emissions?* - *Have the predetermined environmental objectives (e.g. air quality) been achieved with the implementation of the P&R facility(s)?* **Other:** - *Do you think a bus-based P&R facility(s) is a cost-efficient solution to the intended problems (parking pressure in the city centre, traffic pressure, emissions, etc.)?* - *Has the implementation of the P&R facility(s) led to a shift towards sustainable transport options (modal shift)? Number of public transport users increased? Number of "single occupancy trips" decreased?* - *Is there still an active policy in the field of bus-based P&R facilities? Investments? Future plans?*

Ending	I would like to thank you very much for answering my questions and contributing to my research. Do you have any comments or questions for me about these topics and/or my research that have not yet been discussed during the conversation? **Ending questions:** 1. *Could I contact you at a later time if I have any questions about certain topics?* 2. *Would you like to receive the final version of my thesis when I have completed the entire research? If so, which email address should I send it to?* 3. *And do you know any mobility advisors, councillors or others, who have knowledge of certain bus-based P&Rs and could contribute to my research?* Thank you again for your cooperation and for your time, and have a nice day!