PARKING SPOORZONE DELFT

Addressing expected parking challenges 2015-2017

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PREFACE

This report is the end product of the course TIL 5050 “Interdisciplinary Design Project” that is part of the MSc programme Transport Infrastructure & Logistics (TIL) provided at the Delft University of Technology. This course consists of a large group project realized by a team of five students. This project contains both a research and a design phase. The research phase allows students to analyse the problem before focusing on the design. The current report presents the outcomes of an interdisciplinary design project carried out November 2013 until January 2014.

The problem studied in this report concerns both a transport and infrastructure problem. It concerns the temporal loss of parking capacity expected in the period 2015-2017 in the neighbourhoods Olofsbuurt and Westerkwartier in the city of Delft. The project was initiated by the residents association Belangenvereniging Olofsbuurt-Westerkwartier (BVOW). During the project, not only the point of view of the BVOW has been considered, but also the points of views of the other key involved actors, such as CCL, ProRail, and the municipality of Delft.

This project has been carried out by 5 MSc students, under supervision of 4 senior TUDelft staff members with expertise in the domains of transport and logistics.

For more information regarding this project, feel free to contact Dr. Rudy Negenborn (TUDelft), r.r.negenborn@tudelft.nl.

Delft, 2014

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Disclaimer

This project has been carried out by MSc TIL students at TUDelft in partial fulfilment of their course requirements. This report presents the insights and views developed by the students within the available time, the best of their knowledge, publicly available information and interviews. This report is open for discussion and not meant as direct investment advice.

SUMMARY

This project is carried out on request of the BVOW, the interest group of the neighbourhoods Olofsbuurt and Westerkwartier in Delft, in order to propose solutions for the parking issue of Spoorzone Delft expected between 2015 and 2017. They are worried that parking disturbances will emerge in their neighbourhoods when the parking places of Spoorzone Delft will be removed.

Indeed, in 2015 the parking places that are currently situated below the viaduct will disappear due to the removal of the viaduct and will be replaced in 2017 by an underground parking. Thus, between 2015 and 2017 a shortage in parking places might occur. In addition, the current parking capacity of the nearby neighbourhoods Olofsbuurt-Westerkwartier cannot compensate the temporal loss of parking places, as it already now regularly suffers from a lack of parking capacity itself.

The goal of this report is to find solutions in order to prevent or solve this parking problem and to provide an answer to the main research question:

"How can the expected parking problems, due to construction works in the Spoorzone Delft, be prevented and/or solved in a feasible way, concerning technical, socio-political, and economic aspects?"

More information about the Spoorzone Project is explained in order to better understand the background of the problem. The actors that are involved in the removal of the parking places are the contractors that are directly involved in the construction of the project Spoorzone Delft, the users of the parking places and other actors such as the municipality, the BVOW and the shops located in parking area C (neighbourhood Olofsbuurt-Westerkwartier). The main stakeholders are the people that park in the Spoorzone area and the problem owners are CCL, ProRail and the Municipality of Delft.

Literature research has shown that walking time, distance to destination and safety are important factors that influence the parking preferences of inhabitants. People are willing to park their car further away from their house when there is some sort of compensation. A survey was conducted to investigate which people park under the viaduct. It was shown that most of the users live in areas B (city centre) and C (neighbourhoods). In order to determine the number of parking places that has to be replaced, counting of the municipality and results of the survey were used. It was concluded that 300 parking places need to be replaced.

The design objectives are clarified by doing a requirement analysis. It was decided that two rounds of evaluation will be done in order to answer the research question. Criteria based on the requirements analysis are made in order to evaluate the generated solutions.

A total number of 54 means has been generated from ideas submitted by the respondents of the survey and the actors interviewed, as from ideas coming from a brainstorm session. A means-end diagram has been constructed to organise the means. These means have been combined in twelve solutions.

A multiple-criteria decision analysis (MCDA) is used to answer the final research question. This analysis is based on the criteria derived from the requirement analysis. The MCDA was realised based on the points of view of the main stakeholder and the problem owner on four criteria: functionality, costs, environement and feasibility. Each actor assigning specific weights to each of this criterion. The rankings obtained with the MCDA are nevertheless really sensitive to the solution costs, meaning that additional studies to determine those costs more precisely should be realised in order to have a more robust ranking. It should also be observed that most of the solution having a good ranking are situated at the South of the Station, it might be necesery to combine several solutions in order to have a more equally distribution of the parking places around the neighborhoods Olofsbuurt-Westerkwartier.

From the MCDA, three solutions may be regarded as positive from the points of view of both main stakeholder and problem owner:

- Solution 7. Improve attractiveness P+R Nijverheidsplein at night with bicycle
- Solution 6. Improve attractiveness P+R Nijverheidsplein at night
- Solution 5. Free parking Phoenix garage for license holders

Because of the sensitivity of the MCDA for the solution costs, two solutions might be feasible when more detailed information is known about these costs:

- Solution 10 (Room at Ambachtsstraat with bicycle) becomes more attractive when a cheap (i.e. gravel) or partial solution (i.e. less than 300 parking places) could be executed
- Solution 12 (Limit access of visitors to Phoenix garage) could be attractive if the problem owner could initiate a good cooperation with Parking Delft B.V.

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1. INTRODUCTION

This chapter gives an overview of the report. The introduction starts with the description of the problem under study. Based on this description the main research question and objectives of the report are presented. The research question will be answered by the use of sub-questions. The methodology will give insights in the foundation of the report and where the answers of the sub-questions can be found.

1.1 BACKGROUND INFORMATION SPOORZONE DELFT

The railway between Rotterdam and The Hague is one of the busiest tracks in the Netherlands. This track goes straight through the city of Delft and results in a lot of nuisance. It is desirable to increase the train frequency on this track in the coming years. Current infrastructure makes this impossible (the two tracks form a bottleneck for the 350 trains that pass Delft every day) and must be expanded to have enough capacity for future train traffic (Rijksoverheid, 2013). The actual train station of Delft also faces several limitations; most notably the capacity of the station is limited and does not meet the current demand. In addition, the railway tracks create a barrier between the east and west side of the city, disfigure the historical city centre, generate safety risks, and are the source of noise nuisance experienced by inhabitants.

As there is no space in the Spoorzone to increase the number of tracks above ground, it has been decided to build two underground tunnels (both with space for two train tracks). As important construction works were necessary to build the two tunnels, it has been decided to redevelop the whole Spoorzone area by building a new underground train station and to realize an urban transformation of the whole area. The area Spoorzone Delft thus is currently being reconstructed in order to achieve these goals.

1.2 PROBLEM STATEMENT, RESEARCH QUESTIONS AND RESEARCH OBJECTIVE

Below the Spoorzone viaduct there are currently around 500 parking places. To build the second tunnel of the Spoorzone the viaduct must be demolished in 2015. The 500 parking places will be removed and later replaced in an underground parking in 2017. This means that between 2015 and 2017 a shortage of parking capacity could occur. Currently, there are no concrete plans to solve this problem. The municipality and/or the contractors are planning to solve it, but as no strict agreements in the contract are made, it is still unclear how (Ten Haaf et al., 2013). The current parking capacity of the nearby neighbourhoods Olofsbuurt-Westerkwartier cannot compensate the temporal loss of parking places, as it regularly suffers from a lack of parking capacity itself (Grontmij, 2000). Since it is not clear yet how the loss of these places will be accommodated the **main research question** of this report is:

"How can the expected parking problems, due to construction works in the Spoorzone Delft, be prevented and/or solved in a feasible way, concerning technical, socio-political, and economic aspects?"

In order to answer this main question, this question has been subdivided in the following **sub-questions** (Table 1). In Section 1.3 these sub-questions are linked to the different phases of the methodology.

TABLE 1: SUB QUESTIONS RELATED TO THE METHODOLOGY

Sub-questions		Chapter
1.	Which actors are involved in the removal of the parking places?	Ch. 2 Background
2.	What is the capacity of current parking facilities in and around the Spoorzone Delft and which parking policy is currently practiced?	Ch. 2 Background
3.	Which factors influence the parking preferences of car users?	Ch. 2 Background
4.	What are the power and interests of the actors?	Ch. 3 Analysis
5.	How and when will the Spoorzone area be developed and is there room available for temporary use?	Ch. 3 Analysis
6.	Who are the current users of the Spoorzone parking area and for what purposes do they park there?	Ch.3 Analysis
7.	How many parking places need to be replaced after the removal of the Spoorzone viaduct?	Ch.3 Analysis
8.	What are the requirements of all stakeholders that need to be taken into account when generating solutions?	Ch. 4 Requirements and criteria
9.	On which criteria can the proposed alternatives be evaluated?	Ch. 4 Requirements and criteria
10.	Which are the possible means to resolve the problem?	Ch. 5 Means and solutions
11.	Which are the possible solutions to resolve the problem?	Ch. 5 Means and solutions
12.	Which solution(s) suit(s) best for the problem?	Ch. 6 MCDA

The **objectives** of this project are as follows:

- To propose a solution for the current users of the parking places situated below and next to the Spoorzone viaduct between 2015 and 2017;
- To propose a solution that causes as little inconvenience as possible to the inhabitants of the nearby neighbourhoods;
- To propose a solution that is economically viable for implementation.

This project has been initiated by the BVOW (Belangenvereniging Olofsbuurt-Westerkwartier), an interest group of the neighbourhoods Olofsbuurt-Westerkwartier. The main concern of the BVOW is that huge disturbances will emerge when the parking places will be removed, since the neighbourhoods are hardly able to provide enough extra capacity for cars that are currently parked below the viaduct. This report is thus written for the BVOW.

1.3 METHODOLOGY

To be able to come with a clear and structured report to resolve the problem, a plan of approach has been developed. In this approach several phases can be distinguished. Figure 1 shows the methods that have been used during each phase.

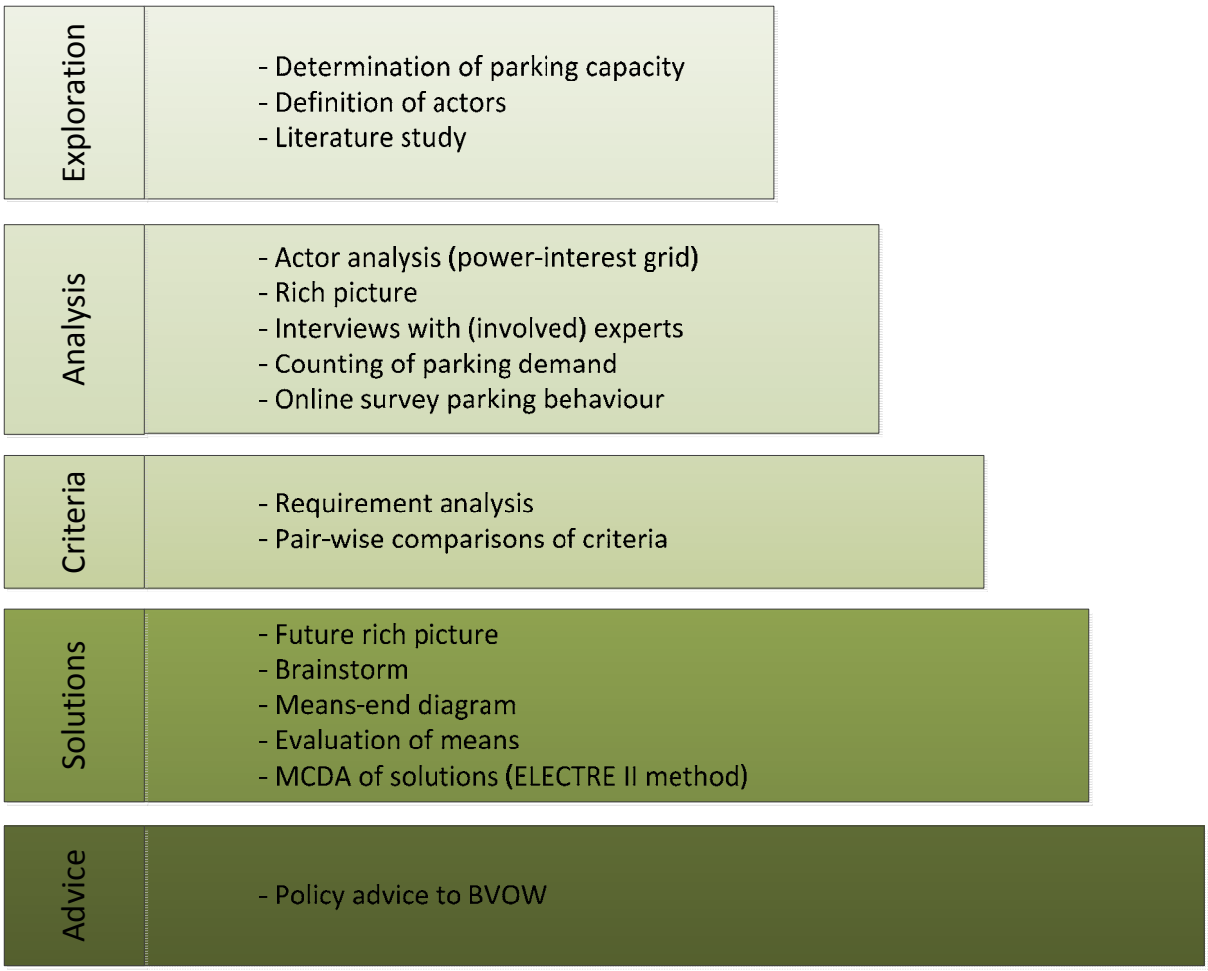

FIGURE 1: VISUAL REPRESENTATION OF THE METHODS WITH THE ASSOCIATED PHASES

The main goal of the **exploration phase** has been to get a clear overview of the current situation. Nearby parking facilities, current parking policies, related payment methods, and prices have been examined. The Spoorzone project itself and its planning also have been explored. Furthermore an initial stakeholder overview and a list of (scientific) literature on parking issues and policies have been established during the exploration.

During the **analysis phase**, several methods have been used to investigate how many parking places should be compensated. A stakeholder analysis has been used to attach the interests and power to the actors found in the exploration phase. A rich picture then has been made to visualize the current situation with all relevant factors and aspects. Interviews with experts and involved stakeholders have been done, in order to sharpen the problem, and to take into account the various points of view. An online survey for users of the parking places below the Spoorzone viaduct has been used to collect information on the actual demand and the parking motives. This information has been merged with counting results, provided by the municipality.

In the **criteria phase**, criteria have been derived, which can be used for evaluation. The criteria are based on a requirement analysis, in which the requirements of the most important stakeholders have been listed.

In the **solutions phase** various methods have been used. A future rich picture has been sketched to indicate a realistic future solution. A brainstorm has been performed to generate means to compensate the temporal loss of parking capacity. The list of means has been complemented with ideas generated during the interviews with experts and ideas from respondents of the online survey. The resulting list of solutions has been structured with a means-end diagram. Then the list of means has been evaluated by looking at the feasibility. The remaining means then were combined in feasible solutions and evaluated with a multiple-criteria decision analysis (MCDA). For this analysis, the ELECTRE II method has been chosen. Two sets of weights have been derived by pair-wise comparison of all criteria for two actor points of view, namely the problem owner and the main stakeholder. The evaluations for these two visions have been compared to see which solutions score the best.

In the last phase a **policy advice** has been written, in which conclusions on the MCDA as well as the weaknesses of the research have been taking into account. The policy advice should give direction for future steps to prevent and/or resolve the temporal loss of parking places in the Spoorzone area.

1.4 REPORT OUTLINE

The report is structured as follows. In Chapter 2 background information about the project and current situation at the Spoorzone area is given, such as general information about the parking policy in Delft. Sub-questions 1 to 3 will be answered in this chapter. In Chapter 3 an analysis of the problem will be realized allowing determining the users of the parking area, the different stakeholders involved in the project and the demand for the parking places and garage. This chapter will answer the sub questions 4 to 7. In Chapter 4 the requirements and criteria for the design and evaluation of the solutions will be determined, answering sub questions 8 and 9. In Chapter 5 the different means to resolve the problem will be developed, and after a first round of evaluation twelve solutions will be selected. This chapter thus deal with the sub questions 10 and 11. In Chapter 6 the twelve solutions will be classified thanks to a Multiple Criteria Decision Analysis, allowing answering sub question 12. Finally, a general conclusion is given in Chapter 7 followed by a policy advice to the concern actors. The chart showing the report outline can be seen in Figure 2.

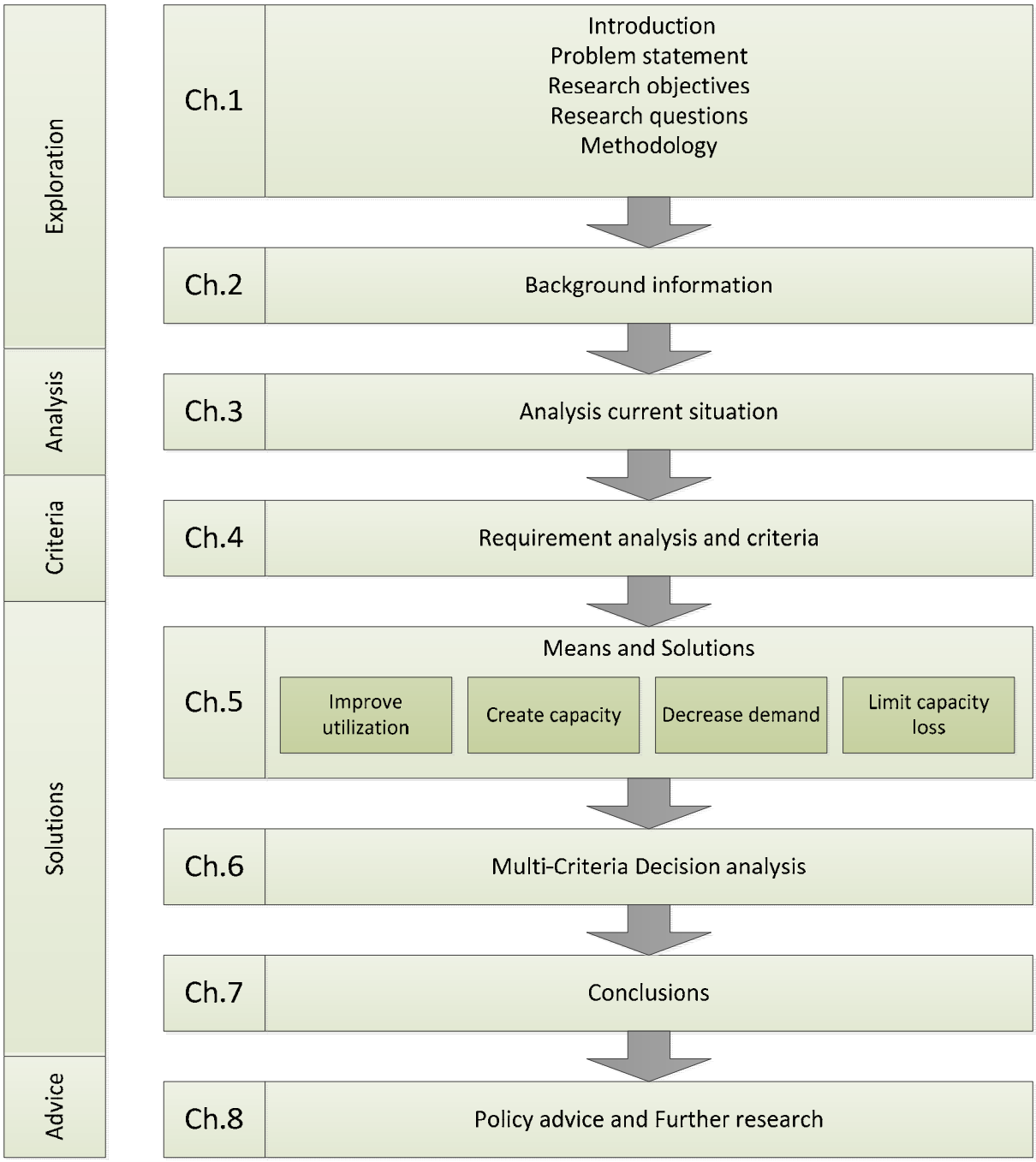

FIGURE 2: REPORT OUTLINE

2. BACKGROUND

This chapter provides background information on the Spoorzone project and current circumstances in Delft that concern this project. The sub-questions that will be answered in this chapter:

1. *Which actors are involved in the removal of the parking places?*
2. *What is the capacity of current parking facilities in and around the Spoorzone Delft and which parking policy is currently practiced?*
3. *Which factors influence the parking preferences of car users?*

In the first section there will be an elaboration on the Spoorzone project. Here, information can be found on the plans and planning of the project. In section 2.2 the actors that are involved in the removal of the parking places are explored. After this the current parking policies are presented. In section 2.4 a literature study on parking can be found. This chapter will end with a conclusion where the sub-questions will be answered.

In this report there will be references to the terms neighbourhoods and Spoorzone area. Figure 3 shows how these areas are defined. The neighbourhoods concern the area Olofsbuurt-Westerkwartier. The area is situated at the west side of the city centre and is restricted between the Ruys de Beerenbrouckstraat, the Phoenixstraat, the Westlandseweg and the Provincialeweg. The Spoorzone area is situated from the DSM/Gist terrain in the north to the Abtswoudseweg in the south (Spoorzone Delft, 2013g).

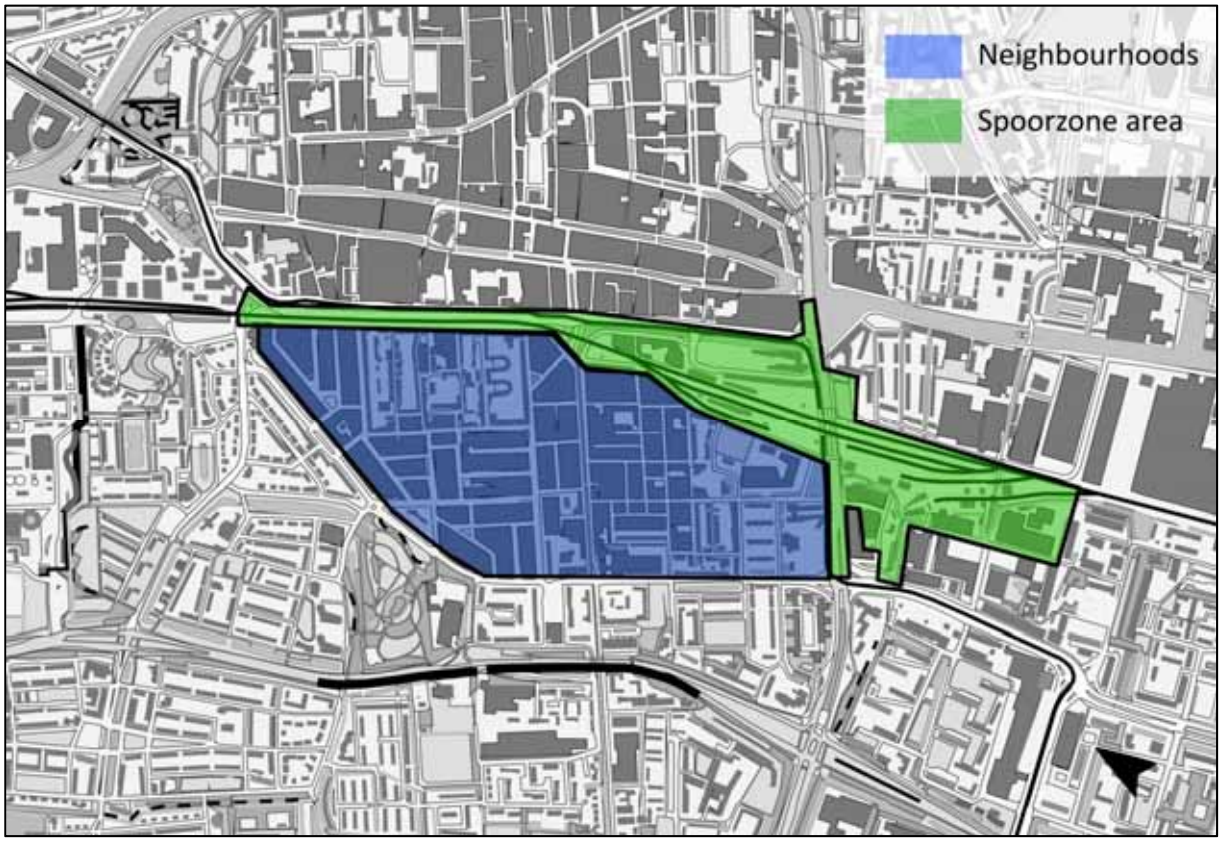

FIGURE 3: DEFINITION OF THE AREAS

2.1 THE SPOORZONE DELFT PROJECT

As explained in the introduction of the report, the Spoorzone Delft area is being reconstructed for several reasons. This section will elaborate on the exact plans that have been developed for this project.

2.1.1 THE PROJECT IN GENERAL

Two tunnels with in total four tracks will be developed below the city of Delft which will provide a better living environment for the residents (Spoorzone Delft, 2013a). The tunnel will be 2.3 kilometres long and will run from DSM/Gist to the Abtswoudseweg. The tracks will no longer be a barrier between the different areas of the city. A new underground station will be built and combined with a new office for the municipality. Before the tunnel can be built, the viaduct will be removed. This is needed in order to build the second tunnel (Ten Haaf et al., 2013).

FIGURE 4: DETAILED PLAN SPOORZONE DELFT (GEMEENTE DELFT, 2013D, P. 44)

Below the Spoorsingel, a parking garage will be built with 600-650 places. This garage will be for inhabitants, commuters and travellers who transfer from car to train or the other way around (P+R) (Ten Haaf et al., 2013). Travellers, who come by bike to the station, will use the bicycle stands beneath the station. There will be 5.000 bicycle stands at the front side of the station and 2.700 stands at the backside of the station (De Koning, 2013). It can be expected that approximately 10.000 – 12.000 spaces for bicycles are needed; so the developers of the Spoorzone Delft are currently looking for an additional 3.000 places (Nederveen, 2013). Also, a garage below the municipality office will be realised. The purpose and size of this garage is not yet known. On top of the southern part of the tunnel a city park will be created with lots of green and water. New dwelling will be developed in the middle and southern part (Spoorzone Delft, 2013c, 2013g).

2.1.2 PROJECT ORGANISATION AND EXECUTION

The main clients of the project are the Ministry of Infrastructure and Environment and the municipality of Delft. They finance the project together with the province of South-Holland and both municipalities of The Hague and Rotterdam (Spoorzone Delft, 2013a). More information on the project organization and execution can be found in section 2.2.

2.1.3 PLANNING

The execution of the entire project will take approximately ten years. The preparation phase was harder than expected and has therefore taken more time than originally was planned. Also, shifting cables and pipes has taken longer. In June 2010, it was announced that the delay would be longer than one year. In the table below the new planning can be found.

TABLE 2: PLANNING PROJECT SPOORZONE DELFT (SPOORZONE DELFT, 2013E)

Year	Tasks
2009	Preparation ▪ Shifting cables and pipes ▪ Demolishing houses ▪ Moving tram Phoenixstraat ▪ Replanting trees
Winter 2009 – 2014	Building eastern tunnel Phoenixstraat and area south of Irenetunnel Building eastern and western tunnel in station area and Engelsestraat Building underground station
2013	Start building city office and station hall
2014 – 2015	Finishing tracks and station Start building dwelling
2015	Trains drive underground
2015 – 2017	Demolishing of tracks (viaduct) Building western tunnel Phoenixstraat and Engelsestraat Building parking garage Spoorsingel Public space ready Phoenixstraat/Spoorsingel
2017	Second tunnel ready
2025 – 2035	Urban development ready

A more detailed planning for 2015-2017 is provided in Figure 5 . Indeed, it is useful to have a more precise planning during this period in order to define the exact problem and have an indication for a possible solution, as the parking places below the viaduct will be removed during these two years. Available literature only includes the detailed planning without any additional information (Gemeente Delft, 2013c). More precise information about the planning is not available because the contractors have a Design and Construct contract (Ten Haaf et al., 2013). This means that there is a lot of freedom and the exact planning is not yet known. However, the more detailed planning can be used to have better insight in what is happening at the Spoorzone area between 2015 and 2017.

FIGURE 5: DETAILED PLANNING 2015-2017 (GEMEENTE DELFT, 2013C)

2.2 LIST OF INVOLVED ACTORS

This section will define the actors that are important within the boundaries of this project. For description, the actors have been subdivided in different groups. More information of the actors can be found in section 3.1 and in Appendix B.

- The first defined group are the **contractors.** These are the actors that are directly involved in the construction of the project Spoorzone Delft.
- The second defined group are the **users of the parking spots** that will be removed. These people will be affected by the removal of parking spots and will have to search for another location to park their vehicle.
- The last group are the **other actors** that cannot directly be placed in one of the other two groups. These are the municipality of Delft, the BVOW and the shops located in parking area C.

2.2.1 CONTRACTORS OF SPOORZONE PROJECT

The organization of the Spoorzone Project is quite complex, it has several clients and is developed by several contractors. As stated before, the main clients of this project are the Ministry of Infrastructure and Environment and the municipality of Delft. They finance the project together with the province of South Holland, The Hague and Rotterdam (Spoorzone Delft, 2013a). Ontwikkelingsbedrijf Spoorzone Delft (OBS) was founded by the municipality of Delft. Its main task is to execute the agreements from the contract between the different parties. It is the overarching organization that manages the municipality of Delft, Combinatie CrommeLijn VOF (CCL), ProRail and Spoorzone Delft, and is thus responsible for the preparation and execution of the development.

The construction work is divided in above ground and underground construction. ProRail is the formal principal client for the construction of the 2.3 kilometres long tunnel and underground station. Commissioned by the OBS, ProRail is also responsible for building the parking garage and a part of the public space (Spoorzone Delft, 2013f). ProRail has tendered the construction work to CCL, a consortium that consists of the companies: Mobilis BV, Dura Verkeer Groep NV and contractor company CFE NV.

CCL on their turn also hires various subcontractors for specialized work regarding the realization of the underground construction work. CCL is responsible of constructing the tunnel, the underground station, the parking garage along the Spoorsingel, they are in charge of the site preparation of the planning area, and of a large part of the design of the public space (Spoorzone Delft, 2013h).

The above ground constructor is responsible for constructing the houses and offices. This actor has not a lot to deal with the removal of parking spots and thus will not be taken into account further in this report. Figure 6 shows a graphical overview of the organization of the Spoorzone Delft.

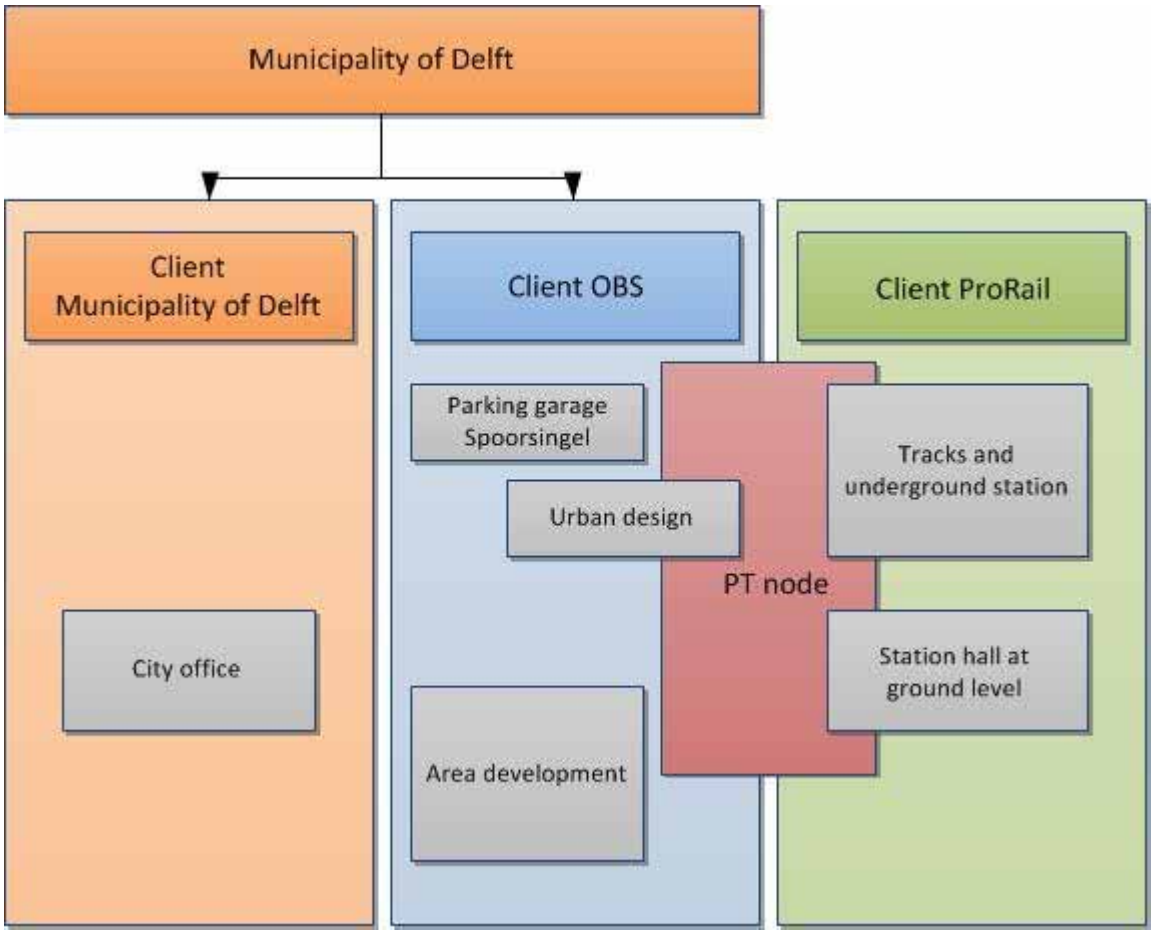

FIGURE 6: ORGANIZATION SPOORZONE DELFT (LEEFBAAR DELFT, 2011)

Therefore, the main actors that can be found between the contractors are:

- OBS
- ProRail
- CCL

2.2.2 USERS OF PARKING PLACES SPOORZONE AREA

There are a lot of people that currently make use of the parking places below the viaduct and on the Spoorsingel. Based on research from interviews and the survey (section 3.6 and Appendix C) the following users of the Spoorzone parking places that will be taken into account as actor are:

- Residents of parking area C
- Residents of parking area B
- Commuters (both area B and C)
- Irregularly visitors

Residents have usually a parking licence for the whole week. They can park under the viaduct and in the neighbourhoods where most of the parking spots are only available for licence holders or visitors with a visitor's card. With these residents groups only the residents that make use of the Spoorzone parking area and thus live closely to the Spoorzone are considered.

Commuters are travelling towards Delft every weekday in order to work there. They can have a parking licence for five or seven days when their company is located in area B (city centre), and a licence for seven days when the company is located in area C (neighbourhoods). Companies in area B are allowed to have a maximum of two licences; companies in area C are allowed to have a maximum of two licences and one visitor's card or two visitors' cards and one licence for the concerned area. Other commuters have to pay at the ticket machine or via calling to e.g. Parkline.

Irregularly visitors are visitors that park at the Spoorzone by paying a ticket at the ticket machine, that have a visitor's card or that pay by park-line parking. For parking with park-line one should have a subscription, with this subscription one can call a number (stated at the parking area) and log-in and also log-out at the moments that the vehicle is parked here. By this, car users will pay by second which leads to lower parking costs.

2.2.3 OTHER INVOLVED ACTORS

Actors that cannot be directly dedicated to the two other groups above are:

- The municipality of Delft
- BVOW
- Shops in parking area C

Other actors that must be taken into account are the municipality of Delft, the BVOW and the shops owners in parking area C. The **municipality of Delft** is one of the main actors of this project as it is part of the group that represents the problem owner, as it will be seen below. It is responsible for the parking policy of Delft and is involved in the project Spoorzone Delft.

The **BVOW** is an interest group associated with the neighbourhoods Olofsbuurt-Westerkwartier. The BVOW has some overlap with the residents of parking area C that use the Spoorzone parking places, but also has other interest. The BVOW is also committed to other people from the neighbourhoods that do not park in at the Spoorzone. This is why the BVOW and the residents of parking area C are taken as two separate actors.

The **shops owners in area C** can see their sales influenced by a changing in parking strategies of the area. The shops in area B are not taken into account, since there are enough parking places, mainly garages, in the city centre for people with the reason to shop over there. This is confirmed by the fact that there were not a lot of users of the parking area Spoorzone and Spoorsingel with the reason to shop in the city centre, based on the results of the survey (section 3.6 and appendix C).

2.3 PARKING POLICIES

The design of the city centre of Delft and its surrounding neighbourhoods makes it unsuitable to facilitate a high parking demand. In these areas there the demand for parking places comes from both residents and people visiting the city. In recent years, a few big parking garages emerged around the city centre. These parking garages were created to accommodate this parking demand and were in general destined for people visiting the city centre. Table 3 below gives an overview of the existing garages.

TABLE 3: PARKING GARAGES IN THE CITY OF DELFT

Garage	Capacity	Location
Phoenixgarage	202	West side city centre
Marktgarage	332	East side city centre
Zuidpoortgarage	810	South city centre
Kampveld garage	19 (reserved particular vehicles)	North east side city centre
Hovengarage	550	Voorhof

To make these garages profitable, paid parking has been introduced in recent years in an increasing large radius around the city centre of Delft. Separate payments can be done for a period up to one day. For frequent parking requests a licence for one year is available. Mostly those are bought by inhabitants of the respective neighbourhoods but it is also possible for companies to buy licences for their employees for the area they are located in. Licences are only valid in a single area, in total seven different areas in Delft are recorded. Figure 7 below shows an overview of these different areas. The price of a first licence for inhabitants is the same in six of the seven areas: €68.40 per year. Only for area B (city centre) a different tariff of €149.40 per year is maintained.

For each of the areas a detailed map is available where for each street it is indicated if parking is allowed for licence holders' only or mixed parking is possible (Gemeente Delft, 2013b). When mixed parking is allowed, licence holders can park there and non-licence holders can park there by buying a parking ticket. Appendix A describes in more detailed the way parking in and around the Spoorzone area is organised.

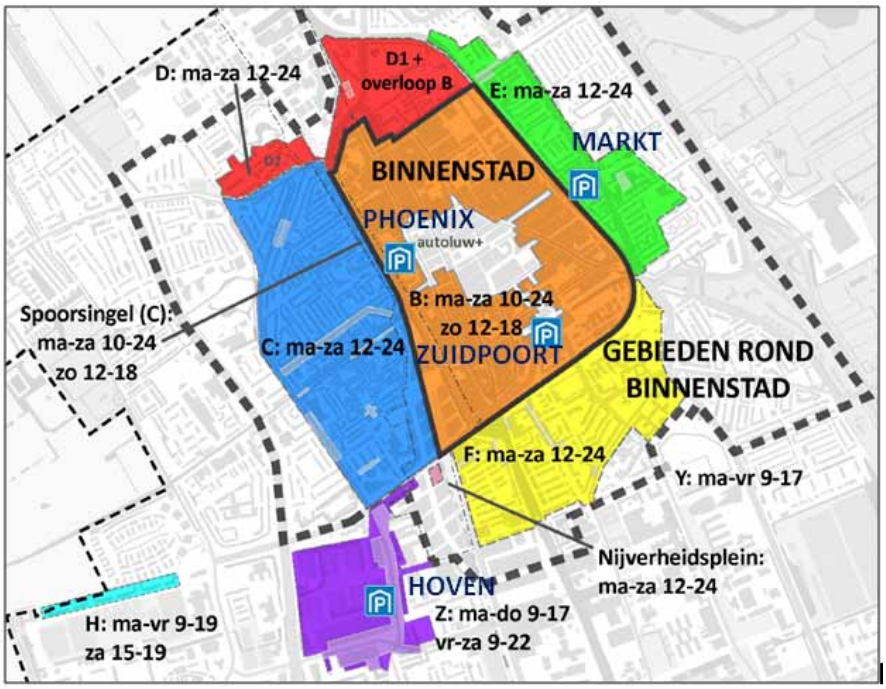

FIGURE 7: DIFFERENT PARKING ZONES IN THE CITY OF DELFT (GEMEENTE DELFT, 2013B)

2.4 LITERATURE RESEARCH

A literature study has been used to have a better understanding of the problem. The literature research in particular becomes useful when parking preferences of car users should be taken into account (during generation and evaluation of possible solutions).

2.4.1 INFLUENCE OF THE CAR

The car is the most used means of transportation in the Netherlands (Ministerie van Verkeer en Waterstaat, 2008). Although the population is increasing, the number of cars is increasing even more rapidly. The CBS (Statistics Netherlands) expects that the number of cars per household will keep growing but will flatten in 2030.

Although car possession is in general lower than in dense urban areas, the household density still results in high pressure on parking facilities in these areas (Ministerie van Verkeer en Waterstaat, 2008). Because public space is limited, more parking problems occur such as; lack of parking places, lots of cars in the streets, and traffic searching for a parking place.

Owning a car does not only allow people to travel, it also gives them a feeling of having a higher status. Having a nice car gives people more status than a second handed car. Also, driving fast can give people a good feeling. Being able to park your car in front of your house feels like expanding your territory (Steg, Brand, Rooijers, & Vlek, 1998). According to Marsden (2006) parking should be considered as a part of the living environment. Parking facilities influence the liveability of the neighbourhood (Bonaiuto, Fornara, & Bonnes, 2003).

2.4.2 PARKING CHOICES

People have different preferences when it comes to parking. Residents prefer parking their car in front of their house than parking on a collective parking lot. However, when they are being compensated the aversion to park at a distance decreases. This could be done by providing good alternatives like a public transport connection or the presence of walking and cycle paths (Borgers et al., 2008).

Different factors have an influence on the parking choice of an inhabitant. Walking time and the distance to the destination are important aspects (Van der Goot, 1982; Westin & Gillen, 1978). Car safety is also of great importance in order to prevent the car from getting damaged or even stolen. The type of location of the parking place, e.g. on the street or at a parking lot is not that important (Stubbs, 2002).

Value of time is equivalent to the appreciation of time that people have when parking their car (Axhausen & Polak, 1991; Lam, Li, Huang, & Wong, 2006; Westin & Gillen, 1978). However, this variable is dependent on specific situations and context and therefore not easy to determine. The willingness to walk a certain distance between a parking place and a destination is also not given (Borgers et al., 2008).

Van Eeuwijk, Borgers, and Kemperman (2010) have conducted research to parking preferences of inhabitants of a neighbourhood in Tilburg. It was found that the relation between the distance and the appreciation of the living environment was non-linear. The larger the distance to the parking place, the stronger the decrease of appreciation. The research has also shown that surveillance has a high influence on the appreciation of the neighbourhood, which was confirmed by other sources (Stubbs, 2002; Van Eeuwijk et al., 2010; Westin & Gillen, 1978). Most preferred was direct sight on the parked car but a good alternative is a clustered parking lot with camera surveillance.

2.5 CONCLUSION

Actors involved in the removal of the parking places are contractors involved with the construction of the project, users of parking places, and other actors such as the municipality, residents from the residents association BVOW, and shops located in parking area C. A more detailed stakeholder analysis is required to clarify what the stakeholders´ interrelations, power, and interests are. This will be done in chapter 3.

The capacity of the current parking facilities can be found in Table 3. In order to pay for parking there is the possibility to pay for temporary stay for up to one day. For more frequent parking a licence can be bought by inhabitants and companies. These licences are only valid in one specific area (Figure 7), for example area B for the city centre or area C for the neighbourhoods Olofsbuurt-Westerkwartier.

A literature study has been done to find out which factors influence the parking preferences of inhabitants. Walking time, distance to destination and safety of the car are important aspects when it comes to the parking choice (Stubbs, 2002; Van der Goot, 1982; Westin & Gillen, 1978). In literature it was shown that people are willing to park their car further away from their house when there is some sort of compensation (Borgers et al., 2008). When generating possible solutions, these factors should be taken into account.

3. ANALYSIS OF CURRENT SITUATION

This chapter has the goal to provide a more in depth insight in the current situation. The sub questions that will be answered in this chapter are as follows:

4. *What are the power and interests of the actors?*
5. *How and when will the Spoorzone area be developed and is there room available for temporary use?*
6. *Who are the current users of the Spoorzone parking area and for what purpose do they park there?*
7. *How many parking places need to be replaced after the removal of the Spoorzone viaduct?*

In the first section an actor analysis is executed to determine the power and interest of each of the actors. This will also give insight on who are the main actors influenced by the removal of the parking places. Subsequently a rich picture will visualise the problem and the relation between the different actors. In the third section the occupation rate of the different garages will be evaluated. In the following section the planning of the temporary use of the Spoorzone will be analysed to determine if there exist locations that could be used for temporary parking solutions. Finally, in the fifth and sixth sections the counting and survey highlight who are the current users of the parking places, for which purposes they park there, and how they pay. The main conclusions are used in section seven for the determination of the number of parking places that need to be replaced between 2015 and 2017.

3.1 ACTOR ANALYSIS

In Appendix B the actor analysis can be found, this section is a conclusion from the results of this analysis. In this section the different actors involved in the project are determined and their relations revealed.

3.1.1 POWERS AND INTERESTS OF ACTORS

To be able to implement an effective policy to resolve the parking problem at the Spoorzone area it is important to incorporate the point of views of the stakeholders towards the problem and policy (Enserink et al., 2010). In Table 25 of Appendix B the characteristics of each actor are given by describing their interest, position, resources, current and wanted situations and solutions. These characteristics allow investigating the interest and power of each of these stakeholders which resulted in a power-interest grid (Figure 8). The interest and power of the actor can be high, neutral or low. In this case almost all actors have a high interest. From the grid it becomes clear how to deal with these actors, which actors are important and which are less important. The actors that have a high interest and power should be closely managed, since these are the most important ones. But one must not forget that the other actors also can influence the policy that will be implemented.

From the power-interest grid it can also be concluded that the municipality, CCL and commuters should be closely managed. The commuters themselves do not have high power, but they can lobby via their company that has more power. All concerned actors are included in this grid.

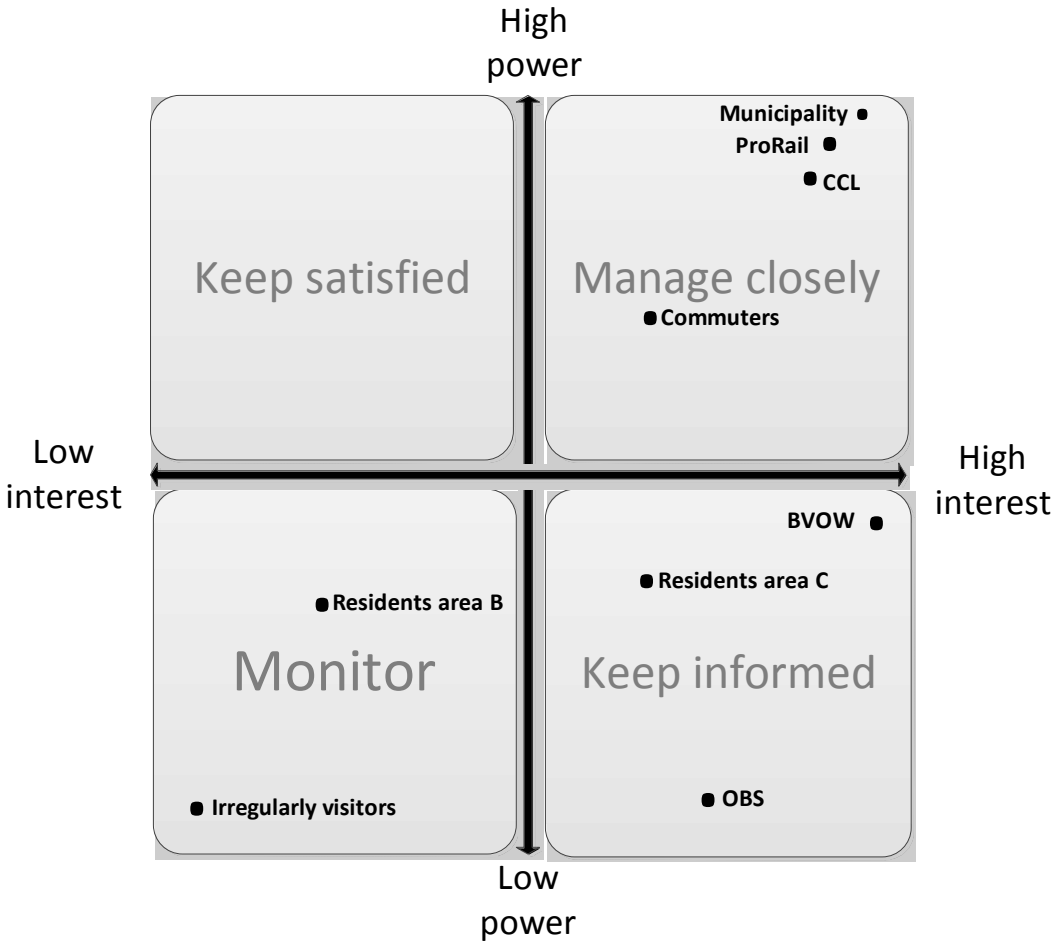

FIGURE 8: POWER-INTEREST GRID STAKEHOLDERS

The key-actors are the municipality, ProRail, CCL and the commuters, since they can lobby via their companies. The residents of area B have a lower interest than those of area C, since they have more parking facilities in the city centre to park their car. Residents of area C do not have a lot of other options to park their car somewhere else as there is already a lack of parking places in their area.

3.1.2 MAIN ACTORS

The problem in this report is complex, many parties are involved and many activities are realized in parallel concerning the construction of the Spoorzone area, which affects different stakeholders. Based on the actor analysis, three different main actors that have interest in the problem of removing the parking places have been identified. These are:

- The research customer
- The main stakeholder
- The problem owner

As the residents association BVOW has asked for this research, they are regarded as **research customer**. The association represents a large share of inhabitants of the neighbourhoods Olofsbuurt-Westerkwartier.

In this research we have chosen to make a distinction between the research customer and the **main stakeholder**. The main stakeholder is defined as the actual users of the parking places in the Spoorzone area. It is reckoned that in order to be successful, a solution for the temporal loss of parking places should fit the demands of the actual users. These users now have been indicated as the main stakeholder. After comparing the results from counting (Section 3.5) and survey (Section 3.6), the exact user will be determined. Groups that could be counted among possible users are residents of parking areas B and C, commuters that travel to areas B or C, and irregularly visitors.

Finally it has been concluded that there is a difference between the main stakeholder and the **problem owner**. According to its definition, the problem owner is the one "that can stop or change the nature of a transformation" (Veeke, 2013, p. 10). As OBS, ProRail, CCL and the municipality of Delft work together in the Spoorzone project, therefore parties could be considered as possible problem owner. From interview it was reckoned that CCL, ProRail, and the municipality of Delft together (want to) share the responsibility of seeking compensation of parking places, with no clear power structure between the three. In addition OBS coordinates the agreements made during the Spoorzone project, but it does not regards itself as having any power (Ten Haaf et al., 2013). Therefore, it was chosen to regard CCL, ProRail, and the municipality of Delft together as problem owner and leave OBS out.

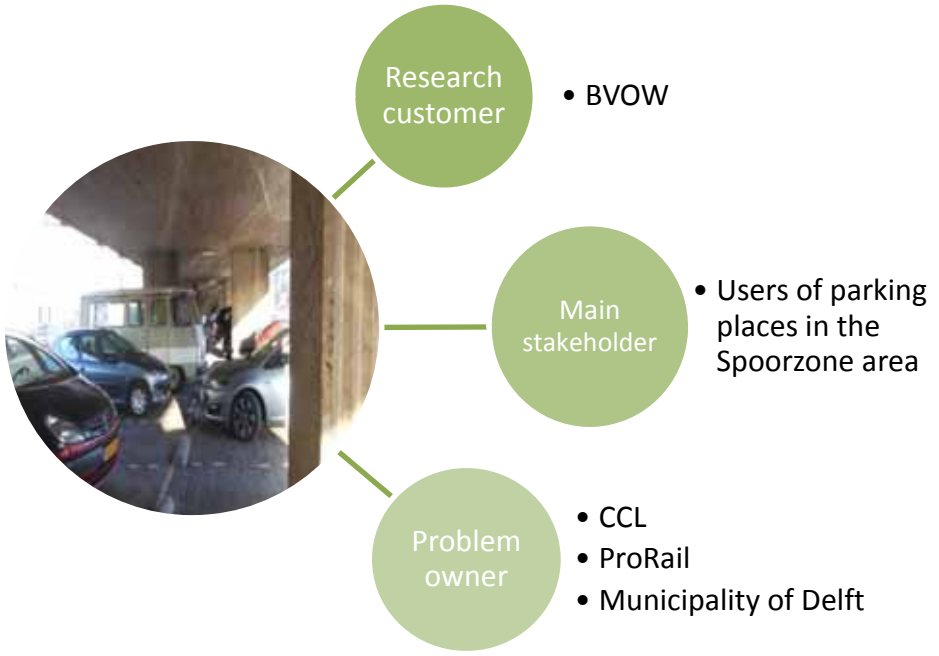

FIGURE 9: MAIN ACTORS

3.2 RICH PICTURE

The rich picture below (Figure 10) reflects the problem by highlighting issues, interests, actors, problems, processes, possible relationships, uncertainties, conflicts, and motivations. This rich picture is a visual representation of the current situation.

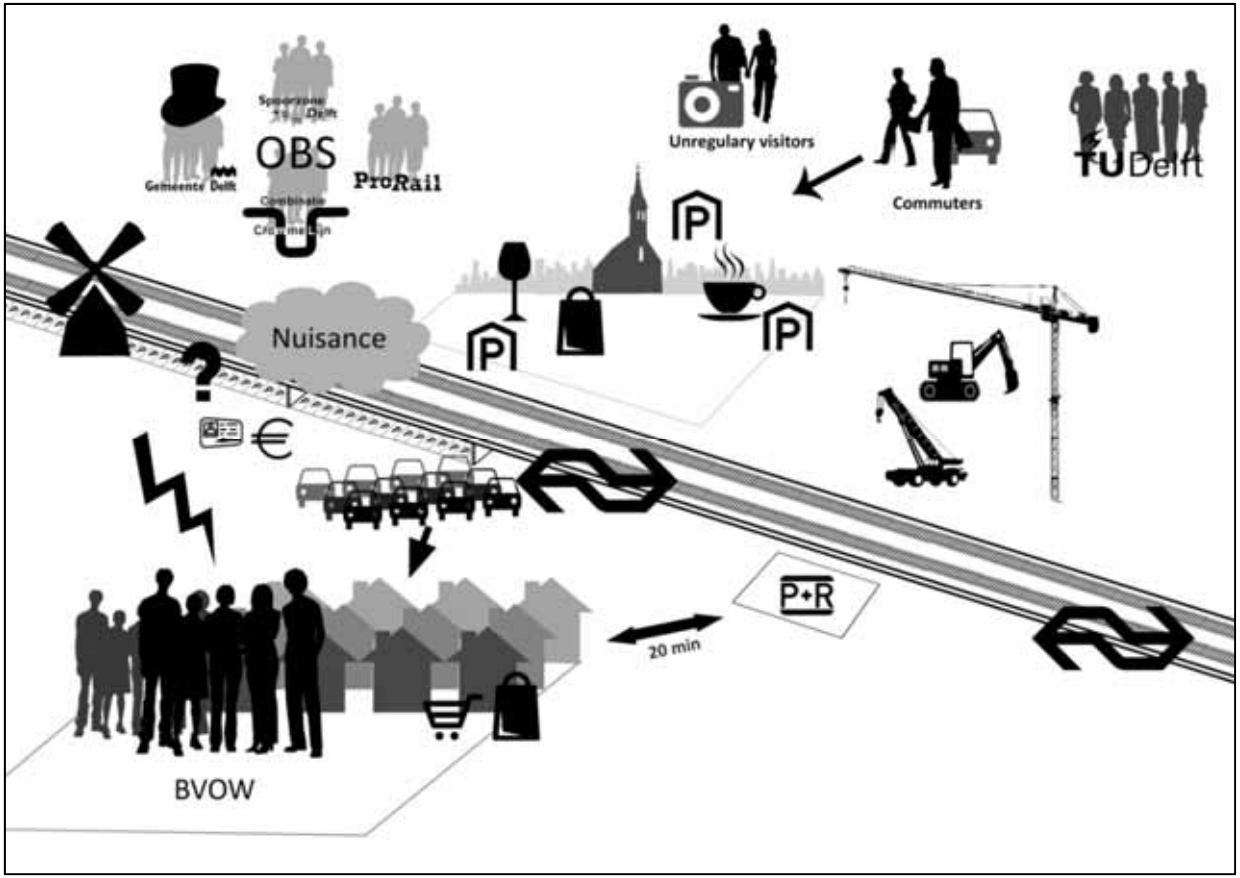

FIGURE 10: RICH PICTURE PARKING SPOORZONE DELFT

3.3 MEASUREMENTS OF CURRENT PARKING FACILITIES

As described in Chapter 2, three large parking garages are located on the edge of the city centre; the Phoenixgarage, the Zuidpoortgarage and the Marktgarage. Somewhat further from the city centre the Hovengarage is situated. These garages might take over some parking demand when the parking places under the viaduct will be removed. For this reason it is useful to see to which extend this is possible. To get more insight in this, it is necessary to see what the utilisation of these garages is at different time of the day. For three of the garages (Phoenix, Zuidpoort and Markt) it was possible to track the utilisation rate during the day. On a total of five days each hour the utilisation rates were registered. It was chosen to analyse a normal weekday (Wednesday), the market day (Thursday) and the busiest day in the weekend (Saturday). Figure 11 below shows an example of the analysis done for Saturday 7 December 2013. In Appendix A the figures are presented for four other analysed days.

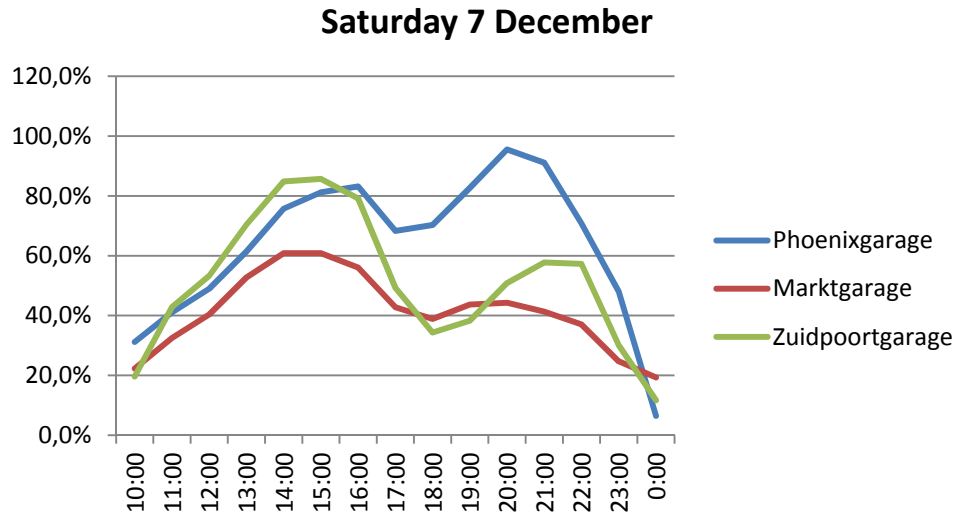

FIGURE 11: UTILISATION RATES PARKING GARAGES 7 DECEMBER 2013

Four conclusions can be extracted from this analysis of the occupation rates of the garages.

- In all garages on all days two peaks can be identified: one around 15:00 and one around 20:00.
- The Phoenixgarage has on weekdays a far higher utilisation than the other two garages, in the weekend this difference is smaller.
- All garages are nearly empty during the night.
- The utilisation rates of the Markt- and Zuidpoortgarage are quite low during weekdays (never above 50%).

3.4 AREA DEVELOPMENTS IN THE SPOORZONE

The Spoorzone area will be developed in different phases (Gemeente Delft, 2013d) and by different contractors. In 2013, the entire area is still used by several contractors. At the end of 2014, the areas will become slowly available in order that in 2015 the area development can start.

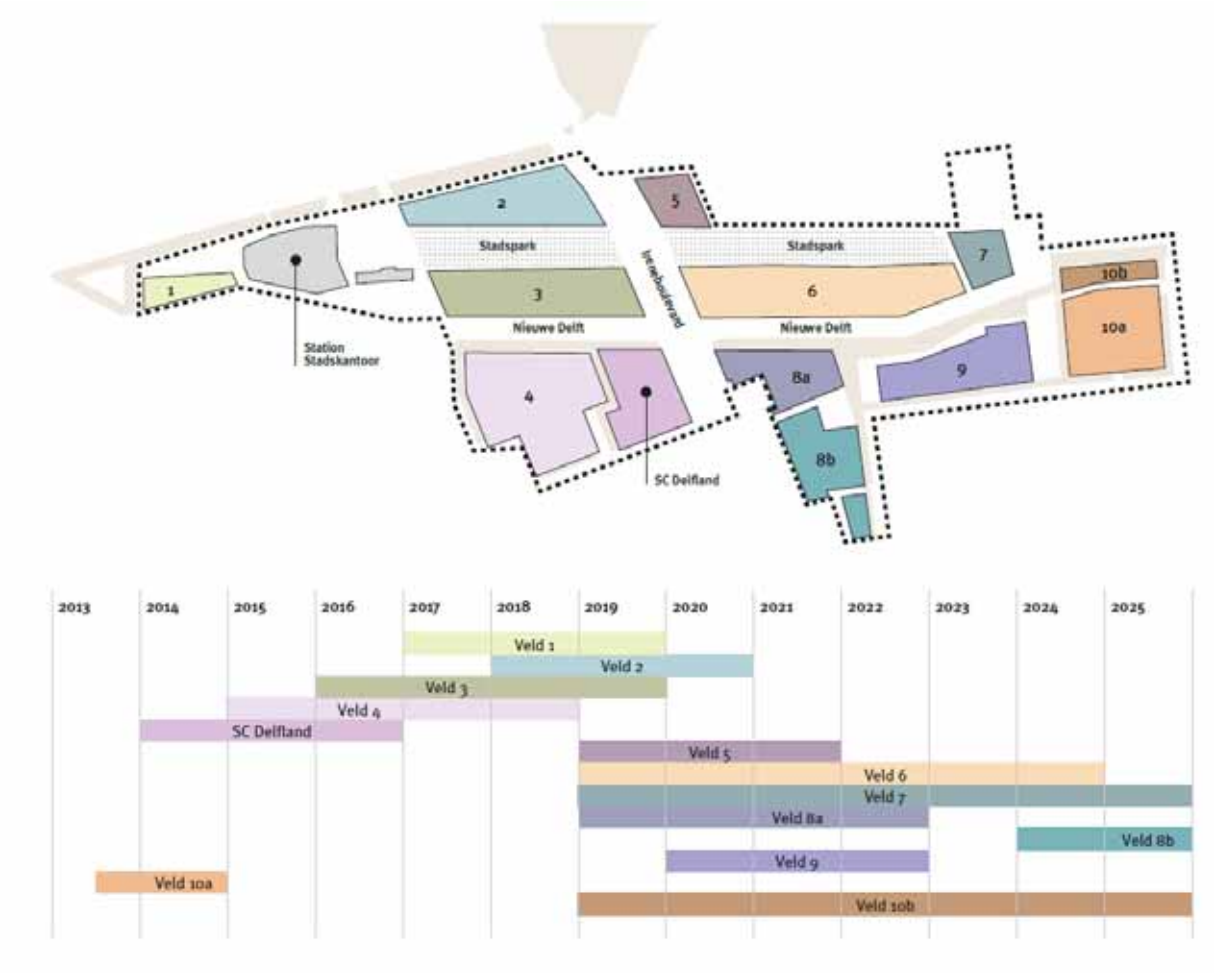

FIGURE 12: PHASING SCENARIO (GEMEENTE DELFT, 2013D, P. 111)

The phasing scenario above shows which areas will be developed in which time frame (Figure 12). The development will start at field 10a and SC Delfland. These developments are quickly followed by other areas. In general, the area around the station will be developed earlier than the area in the south.

For the generation of means and solutions later in this report, it is useful to know which areas are available when (Figure 13). *Gebruik de lege ruimte* is an initiative where people could present ideas and plans for the temporary use of the available space in the Spoorzone area (Gebruik de lege ruimte, 2013). In the end of 2012, the plans have been presented to the municipality and Spoorzone Delft. Currently, several ideas are being further developed (Spoorzone Delft, 2013i).

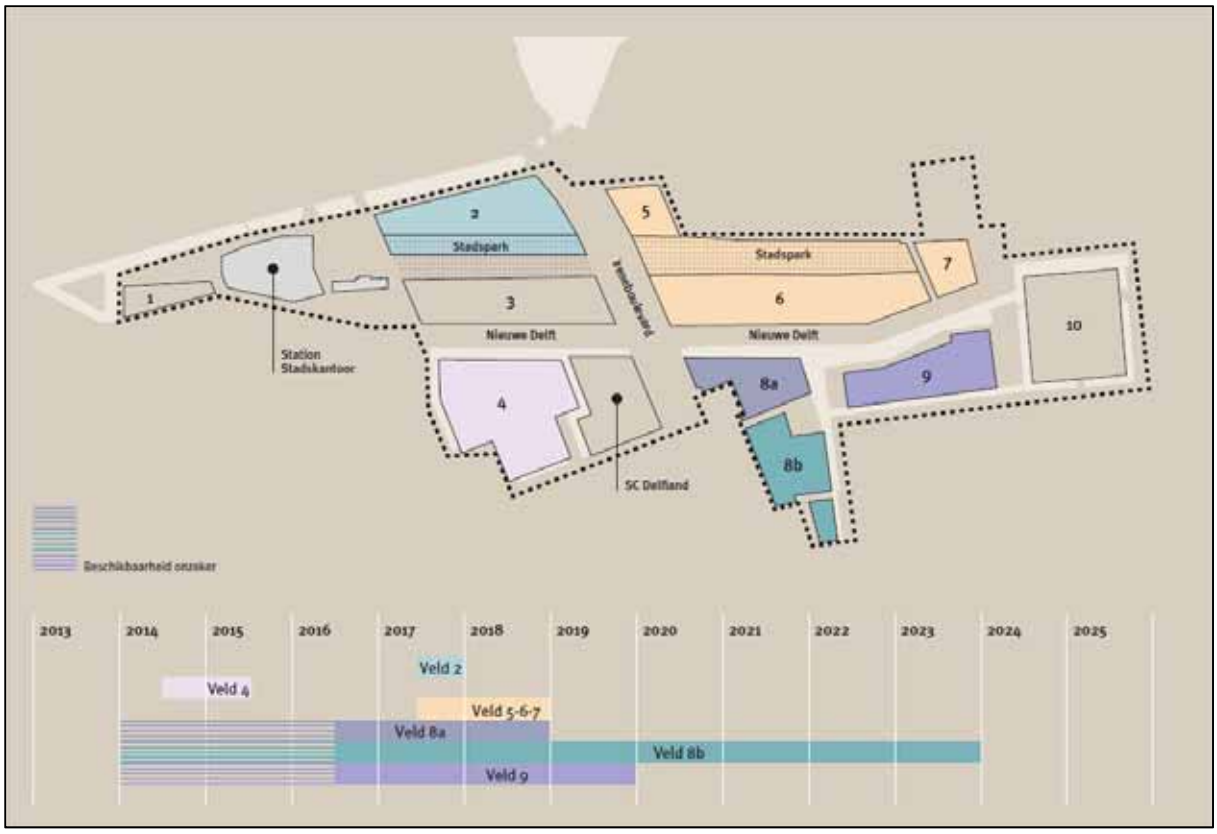

FIGURE 13: TEMPORARY USE (GEMEENTE DELFT, 2013D, P. 114)

Most areas are not available for temporary use, but others are available for quite some time. Areas 8, 9 and 10 will become available in 2014 (Gebruik de lege ruimte, 2013). In these areas it will take the longest before development starts. Projects with a length of 5 until 10 years can be realized here. Areas 2 and 3 will become available between 2015 and 2017. Areas 5, 6 and 7 will become available after 2017 and are available for 3-7 years. Areas 1, 4 and SC Delfland will become available after 2015, but developments will start soon which means only short projects are possible.

For future reference, it can be assumed that between 2015 and 2017 a few areas are available for temporary use. Areas 8a, 8b and 9 can be used for the entire period. Area 4 is only available for the first half of 2015 whereas areas 2, 5, 6 and 7 are only available the second part of 2017.

3.5 COUNTING PARKING DEMAND

The municipality executed counting on the parking places situated below the viaduct. Last counting has been realized in November and December 2012. In Table 4 the information can be found. In 2012 the total number of parking places was of 505. During an interview with the problem owner it was stated that this number is still accurate (Ten Haaf et al., 2013). The counts under *licence + visitors card* include all licence holders (residents and companies) and visitors cards of area B and C and companies C. It can be seen than the ratio of licence holders and visitors cards is really high; 81.5% on average.

TABLE 4: COUNTINGS MUNICIPALITY (VERREST, 2013)

Date (year 2012)	Time	Licence + visitors card	Other visitors	Total	Occupation rate
Wednesday November 28th	Morning	247	14	261	51.7%
	Afternoon	252	41	293	58.0%
	Evening	277	65	342	67.7%
Friday November 30th	Evening	233	140	373	73.9%
Saturday December 1st	Afternoon	258	48	306	60.6%
Sunday December 2nd	Afternoon	246	34	280	55.4%

Striking is the number of other visitors on Friday evening. On Friday the shops are open until 21:00 instead of 18:00. It can be expected that this is the reason for the high number of irregular visitors, combined with the fact that people go out more often on Friday evenings than during the other weekdays; these assumptions however cannot be verified. This Friday evening has the highest occupation rate 73.9% (373 occupied places). The average occupation rate is around 61%, which means 309 occupied places.

From this table it can be stated that the biggest user group are the licence holders. In Table 4 no information is given on if these licence holders are residents or commuters. The survey will give more specific information whether this group mainly exists of residents or commuters from the neighbourhoods Olofsbuurt-Westerkwartier.

Finally, it should be noticed that we received the information of the counting after having done the survey, leading to some redundancy between the two

3.6 SURVEY ON PARKING BEHAVIOUR

The previous sections of this chapter provided information about the actors involved in the project and garage capacities. To come up with a suitable solution for the future parking problem more information related to the users of the Spoorsingel and Spoorzone parking zone is needed. To obtain this information a survey has been initiated by the project team by use of an online interface. This section will discuss the results from the survey. The actual behaviour of people is collected in this survey; it is thus a revealed preference survey. This section gives a small conclusion retrieved from the survey, more insights about the organization of the survey and the results are shown in appendix F.

The people that are surveyed are people parking below the viaduct (former place below the viaduct and additional temporary places situated on the former Phoenixstraat) and along the Spoorsingel. Notes have been distributed at the window screen of the cars parked at the concerned parking places. In the note people are asked to answer the survey via an online interface. The total number of respondents is 116. It has shown that the biggest user group are the residents from the neighbourhoods Olofsbuurt-Westerkwartier: 70% (Figure 14).

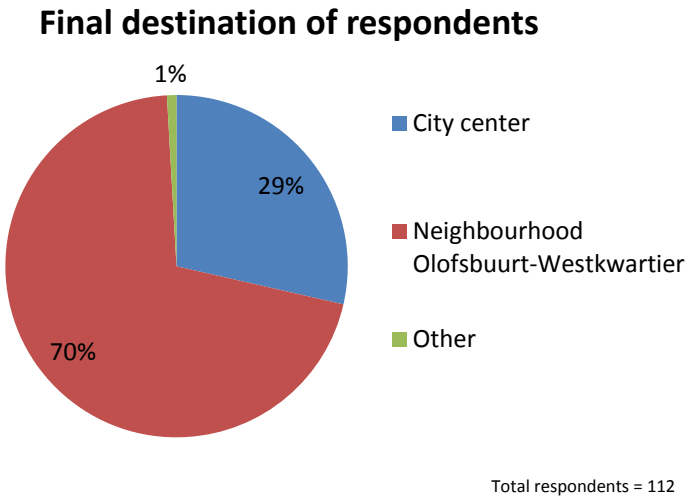

FIGURE 14: GRAPH OF FINAL DESTINATIONS OF RESPONDENTS

Of all respondents, 82% have an inhabitant licence for the city centre (65%) or neighbourhoods (17%) (Figure 15). From this it can be concluded that most of the users of the concerned parking area live nearby. It must be noted that residents from the neighbourhoods might be more willing to fill in the During the distribution of the survey notes, it was noticed that many cars have parking licences. This observation was confirmed by the results of the survey.

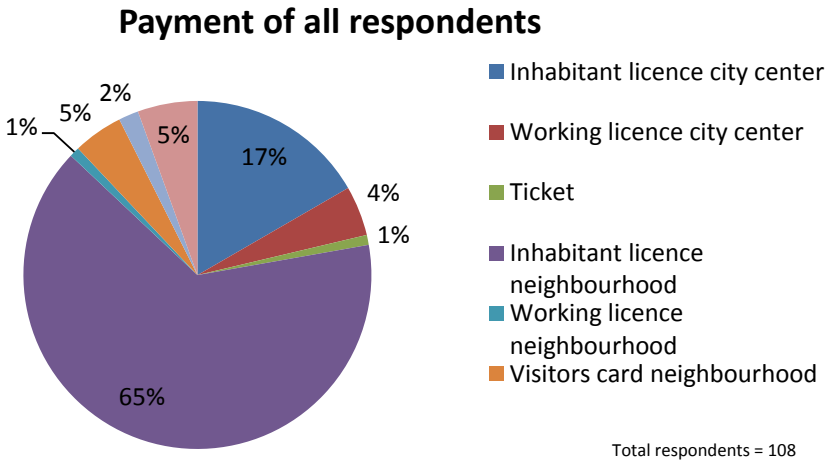

FIGURE 15: GRAPH OF PAYMENT OF ALL RESPONDENTS

For the arrival and departure time of the car a small pattern can be seen. In the morning a lot of residents depart from the area and arrive in the late afternoon/evening. Also some respondents indicate they park from 0:00 till 24:00; it is possible that the question was misunderstood since the day starts at 0:00. It could also be that that people do not use the car to travel to their work and only use it for other purposes. No real conclusions can be drawn from this.

3.7 CONCLUSION

The analysis has indicated a complex field of actors, where the BVOW is regarded as research customer, the combination of CCL, ProRail and the municipality of Delft as problem owner, and the main stakeholder as the people parking in the Spoorzone area. Comparing the counts from the municipality with the outcomes of the survey it can be stated it is considered very likely that the biggest user group is formed by residents of the nearby neighbourhoods. Therefore the main stakeholder is defined as residents of the neighbourhoods Olofsbuurt-Westerkwartier that park in the Spoorzone area. For this group a solution should be sought for the temporal loss of parking places as a result of the Spoorzone viaduct removal.

The amount of parking places that needs to be replaced can be based on the current number of parking places and the occupation rate (Section 3.5). As occupation rates differ from time to time, the motif of the user (the main stakeholder) should be kept in mind. At the beginning of 2012 a total 505 parking places was available. Even though the maximum occupation rate is found 73.9% (measured on a Friday evening), an occupation rate of 67.7% (measured on a Wednesday evening) is used for calculating the necessary amount of parking capacity (Table 4). This is because the latter percentage is assumed more representative; the share of licence holders at Wednesday evening is the highest (on Friday evening the share of other visitors, i.e. non-licence holders, is relatively high). This leads to the calculation of 67.7% of 505 = 342 parking places. In Table 4 it can be found that of these 342 occupied parking places, only 277 parking places are occupied by licence holders and users with visitors cards (who together form a 277/342 = 81% share). Assuming other visitors have (compared to inhabitants) the least problems with switching from parking places towards a parking garage, the approximation of the parking capacity that needs to be replaced is determined as 277 parking places (Table 4). Taking into account an error of uncertainties in counting and survey results, this number is rounded to 300 parking places.

Possible locations for relocation of parking capacity have been investigated. Within the Spoorzone area between 2015 and 2017 a few areas have been found available for temporary use. When looking at the occupation of the three big parking garages around the city centre, it can be concluded that the utilisation rates are in general rather low, making these facilities interesting for (temporal) use, in particular for visitors.

4. REQUIREMENT ANALYSIS AND CRITERIA

This chapter will look at the requirements and criteria that will be used for the comparison of the different solutions that are found. The first part of this chapter will give insights in how the requirements have been derived and how the criteria are based on these requirements. These criteria will be used for the evaluation of the solutions in the Multiple-Criteria Decision Analysis (MCDA). The sub-questions that will be answered are:

8. *What are the requirements of all stakeholders that need to be taken into account when generating solutions?*
9. *On which criteria can the proposed alternatives be evaluated?*

4.1 REQUIREMENT ANALYSIS

In order to develop a solution for the parking issues in the Spoorzone Delft, a requirement analysis must be realized to clarify what the design objectives are. This section explains how the requirement analysis is realized. It then provides a summary of the requirements classified by design aspects. Finally different kinds of requirements are distinguished; functional, non-functional and interface requirements.

4.1.1 METHODOLOGY REQUIREMENT ANALYSIS

Important information for the requirements analysis is provided by interviews with experts, the survey, and the stakeholder analysis. Interviews with experts gave a rough idea on the solutions space and its constraints; some experts gave specific tips for solution directions. From the survey a user profile (the main stakeholder) has been derived, together with a clear description on the (highly influential) problem owner. The points of view of these actors are used for assessing the significance of requirements. Finally, requirements are selected that could be used as criteria for evaluation of possible solutions.

4.1.2 TYPES OF REQUIREMENTS

As can be found in the right column of Table 5 all requirements have been sorted in three types. This distinction will provide a direction for working out the solution, which means this becomes relevant for working out the solutions that are left after the brainstorm evaluation. The types of requirements are:

- Functional requirements;
- Non-functional or performance requirements;
- Interface requirements.

Functional requirements indicate what the system must do; they can be quantified (how many, how good, how far, when and how long, how often). **Non-functional (performance) requirements** indicate what attributes or quality the solution system must have, i.e. what the performance of the system should be (security, usability, maintainability etc.). **Interface requirements** refer to the conditions of interactions between the system and the environments in which it functions. These conditions can have various forms, such as functional, physical, and logical (Ludema, 2013, p. 35).

4.1.3 LIST OF REQUIREMENTS SORTED PER DESIGN ASPECT

Five design aspects for the solution have been chosen that cover all relevant aspects of the design problem. These are:

1. Environment
2. Functionality
3. Maintenance
4. Technology
5. Construction and implementation

By working out each of the chosen design aspects, relevant requirements for the solution have been found. In the third column, the requirement type is indicated, and in the last one the significance is indicated (i.e. if the requirement is considered important for the problem owner, for the main stakeholder, or for both). This significance is where possible based on interviews with experts and literature.

TABLE 5: REQUIREMENTS ANALYSIS

Nr.	Design Aspects		Type of requirement	Important for
1.	**Environment**			
	1.1	The solution is not allowed to cause delays in the Spoorzone project, neither change in the current planned layout	Interface	Problem owner
	1.2	The solution should be sustainable; preferentially only renewable material will be used	Non-functional	Both
	1.3	The solution must use land that is or has already been used instead of green areas	Non-functional	Both
	1.4	The solution may not cause demolishing of buildings in the neighbourhoods	Interface	Both
	1.5	The solution may not harm the visual conditions of the environment; huge parking garages above the ground are not desired	Interface	Main stakeholder
	1.6	The solution may not impact street furniture and children playgrounds in the neighbourhoods	Interface	Main stakeholder
	1.7	Additional emissions should be avoided	Non-functional	Both
	1.8	Additional noise hindrance should be avoided	Non-functional	Main stakeholder
	1.9	Additional odour hindrance should be avoided	Non-functional	Main stakeholder
	1.10	The solution must be designed in such a way that social support is likely	Interface	Problem owner
	1.11	The solution must be designed in such a way that political support is likely	Interface	Problem owner
2.	**Functionality**			
	2.1	The solution should provide a parking capacity of 300 parking places (based on section 3.7)	Functional	Main stakeholder

	2.2	The solution should suit the parking motives of users from the neighbourhoods Olofsbuurt-Westerkwartier, as of visitors of the city centre	Non-functional	Main stakeholder
	2.3	The solution should not increase in an non manageable way pressure on existing parking places in Delft	Interface	Main stakeholder
	2.4	The solution should be reliable; no breakdowns of the solution are allowed	Non-functional	Both
	2.5	The solution should prevent long search for a parking place	Functional	Main stakeholder
	2.6	The solution should be easily accessible for its users; travel time between parking facilities and final destination should be minimized	Functional	Main stakeholder
	2.7	The solution should be affordable for its users; increase in parking costs is undesired	Functional	Main stakeholder
	2.8	The solution should be safe from a traffic point of view	Non-functional	Both
	2.9	The solution should provide accessibility for emergency services	Interface	Both
	2.10	Operational costs should not be too high	Non-functional	Problem owner
3.	**Maintenance**			
	3.1	Preventive maintenance should be minimal	Non-functional	Problem owner
	3.2	Curative and repair maintenance activities should be kept at a minimum	Non-functional	Problem owner
4.	**Technology**			
	4.1	The solution should be safe from a constructive point of view	Non-functional	Problem owner
	4.2	The location of the solution should be chosen in such way that relocation of the solution location during the 2 years should be prevented	Functional	Problem owner
	4.3	The solution should be understandable for its users (how and where to park)	Non-functional	Problem owner
	4.4	The technologic lifetime should last at least for the period 2015-2017 (approximately 2 years)	Functional	Problem owner
	4.5	The economic lifetime should last at least for the period 2015-2017 (approximately 2 years)	Functional	Problem owner
5.	**Construction and implementation**			
	5.1	The solution should be implemented within one year (start 2015); a long construction period should be prevented	Functional	Problem owner
	5.2	Manufacture of the solution should not increase the costs too much	Non-functional	Problem owner
	5.3	Implementation of the solution should not increase the costs too much	Non-functional	Problem owner
	5.4	Implementation of the solution must be feasible from a logistic point of view	Non-functional	Problem owner

4.2 CRITERIA

While the requirements in the previous section describe the demands for the solution for different design aspects and from different actor point of views, the criteria help to assess the differences in the successfulness of the proposed solutions. The criteria will determine how the proposed solutions can be evaluated. Two rounds of evaluation will be realized:

1. **Brainstorm evaluation**: the list of generated means is shortened by assessing the feasibility of the means. If a means is deemed unfeasible it is eliminated from the list;
2. **MCDA evaluation**: multiple criteria are used to determine which solutions are expected to perform the best. This evaluation has been performed from the point of view of the problem owner and the main stakeholder.

4.2.1 CRITERIA FOR BRAINSTORM EVALUATION

In order to estimate if means are feasible or not they will be evaluated based on the four criteria state below, which assess the feasibility of the solutions. Elaborations on the brainstorm evaluation can be found in Section 5.3. From the requirement analysis, four criteria have been distilled that are considered non-negotiable for the successfulness of the solutions. These will be used to evaluate the feasibility of the means solutions during the brainstorm evaluation. The derived criteria are:

A. Suitability construction works and planning (requirement 1.1);
B. Implementation time (requirement 5.1);
C. Socio-political support (distilled from requirements 1.4, 1.5, 1.6, 1.10 and 1.11);
D. Effectiveness of solution (amount of expected parking places divided by the amount of needed parking place), in combination with non-exclusion of other solutions and sub-solutions.

As stated in requirement 1.1, a solution should fit the **construction works and planning** of the Spoorzone project. Solutions that do not satisfy this requirement are considered as infeasible. This interface requirement (requirement 1.1) is crucial for the context in which the solution will be placed.

Functional requirement 5.1 is considered crucial for the construction and implementation aspects of the design. The solution should be operational from the start of the Spoorzone viaduct removal, which is scheduled from 2015 till 2017. If a means from the list cannot be **implemented before 2015** (e.g. because it takes two years to construct), it will lead to an infeasible solution.

According to requirements 1.10 and 1.11, the sought solution requires **support from social groups** (such as the users of the parking place below the Spoorzone viaduct) **and politicians**. It is considered that without this support, a solution becomes infeasible. A lack of support can arise when one or more requirements are not fulfilled by the design. Especially interface requirements dealing with the environmental aspect are important, such as requirements 1.4, 1.5, 1.6, 1.10 and 1.11, but also relevant are interface requirements 2.3 and 2.9. Finally, all non-functional requirements that are left unfulfilled by the design are a likely cause for protests.

Providing **sufficient parking capacity** is a functional requirement (requirement 2.1). It could be fulfilled by one means, but it is more likely that a set of means is necessary to solve the entire problem. Means that do not offer the total amount of needed parking capacity and at the same time exclude other (sub-)solutions, are eliminated from the long list. The required amount of parking capacity is based on the amount of lost parking places and the occupation rate. For the brainstorm evaluation however, it was chosen to use a threshold of 20 parking places.

4.2.2 CRITERIA FOR MULTIPLE-CRITERIA DECISION ANALYSIS

After the brainstorm evaluation the left means are combined to form (feasible) solutions. The criteria which are used for evaluation of these solutions are also based on the requirements analysis. The effects of the solutions will be looked upon in more detail than the brainstorm evaluation, because the MCDA implicitly assumes that its criteria are fulfilled to a certain extent instead of a 100%. The difference in successfulness of fulfilling the criteria, creates the possibility to compare (i.e. evaluate) the solutions. From the chosen requirements, four main criteria (and their specified sub-criteria and units) can be distinguished with their specific units, see Table 6.

TABLE 6: CRITERIA AND UNITS

Criteria	Sub criteria	Units	Requirements based on
Functionality	N° Parking Places	N° Parking Places	Requirement 2.1
	Parking costs users	€	Requirement 2.7
	Travel time	Min	Requirement 2.7
Solution costs		€	Requirements 5.2 & 5.3
Environment impacts	Pollution	Km Drive	Requirements 1.7, 1.8, 1.9 & 2.5
	Sustainability	m² used	Requirements 1.2 & 1.3
	Liveability	"Visual quality"	Requirement 1.5
Technical Feasibility	Implementation time	Months	Requirement 5.1
	Life time of solution	Years	Requirements 4.2, 4.4 & 4.5

The functionality criterion concerns the effectiveness and usefulness of the solution. The number of parking places indicates to what extent the solution solves the problem. Parking costs and walking distance indicate the generalised costs for users of the parking places.

Solution costs forms the second main criterion. It integrates all the following components of costs: the implementation costs related to the integration of the solution in the environment, construction costs related to the manufacture of the solution (if necessary), and operating costs (i.e. maintenance costs, inspection costs, employee costs etc.).

The third criterion is the environmental impact, this also relates to the design aspect. This considers all effects of the solution on the environment in general, but also on the surrounding area. To measure the pollution (including air, noise and odour pollution) the amount of kilometres to search for a parking place is taken. This distance is compared with a base situation, namely the distance from the heart of the neighbourhoods Olofsbuurt-Westerkwartier to the heart of the Spoorzone area. Sustainability takes into account the amount of used land (in particular green areas), but also the material used for manufacturing the solution. The liveability of the neighbourhoods refers to the destruction of street furniture, the loss of children's playgrounds, and visual hindrance for the neighbourhoods due to the construction of huge parking garage in front of houses.

Technical feasibility is the final criterion; this takes the ease of implementation into account. Implementation time indicates the number of months needed to become technically operational. Lifetime of the solution indicates if the solution must be relocated during the period of the Spoorzone viaduct removal. This criterion does not involve costs (as they are taken into account by the solution costs criterion) and socio-political support (because these are assumed to be strongly related with the functionality criterion) in order avoid correlation between the criteria.

These criteria will be used for the MCDA evaluation. In Chapter 6 related weights will be elaborated on, as well as the sub-criteria and sub-weights.

4.3 CONCLUSION ON REQUIREMENTS AND CRITERIA

For designing possible solutions, requirements have been listed for five design aspects. These can be found in Table 5. Requirements that demand 100% fulfilling, can be used as criteria for evaluation of the brainstorm outcome, in order to get rid of infeasible means/solutions. Requirements that do not demand 100% fulfilling, can be used for multiple-criteria decision analysis. A list of criteria for MCDA evaluation can be found in Table 6.

When looking at the significance of requirements for problem owner and main stakeholder (Table 5), it can be concluded that requirements dealing with maintenance, technology, construction and implementation aspects are in particular important for the problem owner, while the functionality aspect is especially important for the main stakeholder. Both problem owner and main stakeholder are considered to have interests in environmental aspects. This difference in significance should be taken into account while determining weights for MCDA evaluation.

5. MEANS AND SOLUTIONS

This chapter provides the generation, synthesis and evaluation of means which form the input for the construction of feasible solutions. The two sub-questions that will be answered in this chapter are:

10. *Which are the possible means to resolve the problem?*
11. *Which are the possible solutions to resolve the problem?*

The resulting solutions will form the input of a Multiple-Criteria Decision Analysis (MCDA) in the next chapter.

5.1 FUTURE RICH PICTURE

In order to come up with a good solution, first it is considered what an ideal future situation would be. Therefore a rich picture has been used (Figure 16). While the rich picture concerns an imagination of an ideal situation, it also takes into account design requirements as derived in Section 4.1 and choices during the analysis (Section 3.7).

It can be noticed that the Spoorzone viaduct is removed and that construction works are going on. Cars that were previously parked under the viaduct are now parked at different parking facilities in the city of Delft. Where necessary, inhabitants of the neighbourhoods travel to their houses by public transport or bicycle. The city centre is accessible for all visitors (including irregular visitors). All actors are happy with the situation.

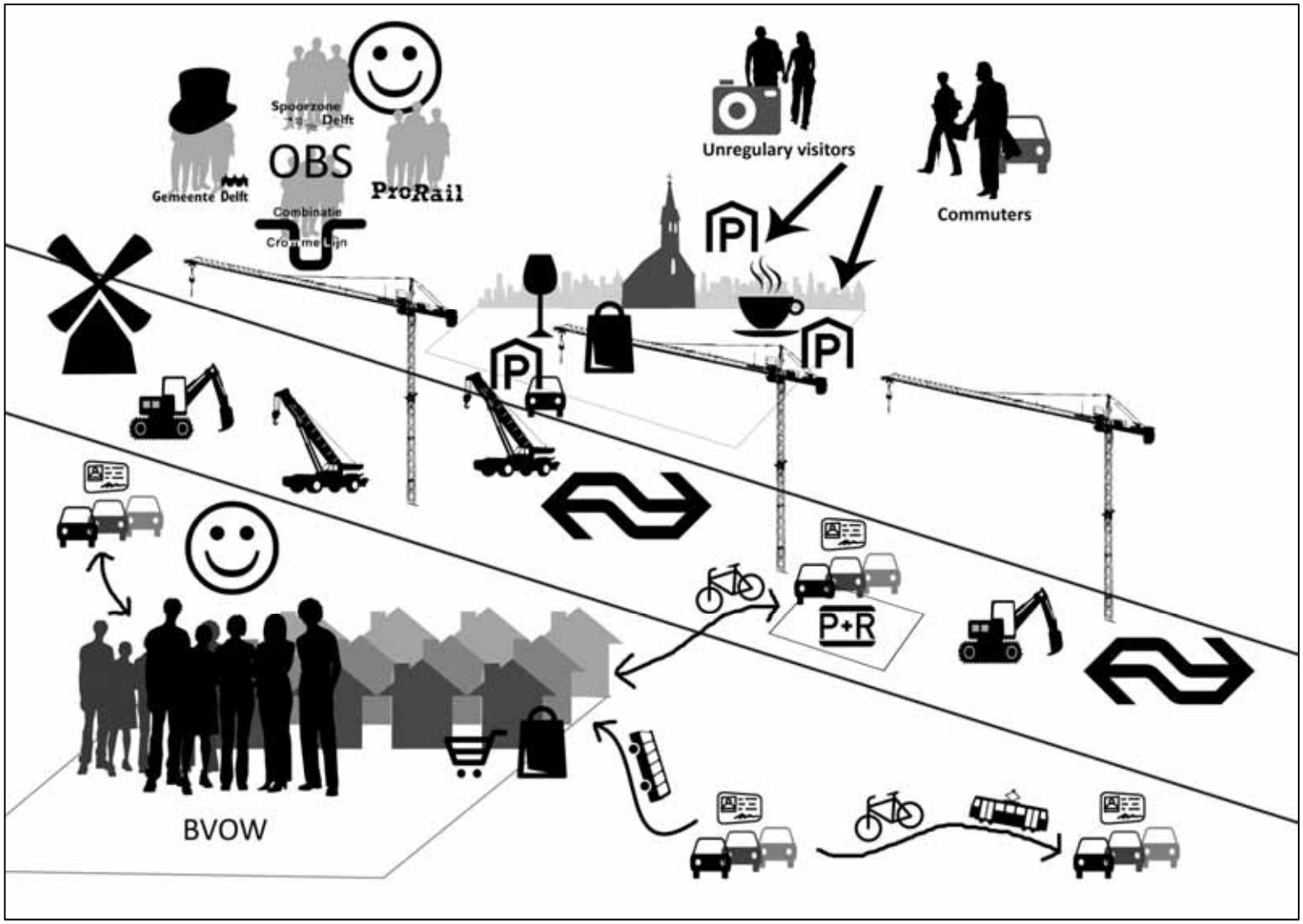

FIGURE 16: FUTURE RICH PICTURE

5.2 GENERATION AND STRUCTURING OF MEANS

5.2.1 GENERATION OF MEANS

Triggered by the ideal description of the, a brainstorm session has been executed by the project team in order to find solutions for the temporal loss of parking places in the Spoorzone area. During the brainstorm all ideas, whether technically highly developed or not, providing few or many parking places, costly or cheap, idealistic or practical have been allowed. These ideas have been complemented by ideas generated by survey respondents (who were asked for ideas in the survey). Finally, also ideas from experts have been added, which arose during the interview sessions. In Appendix D an overview of all the means is presented, with also the origin of each solution. In addition, the frequency of the solutions proposed by the survey is stated.

5.2.2 MEANS-END DIAGRAM FOR STRUCTURING

In order to organise the means, a means-end diagram has been constructed. In this means-end diagram the main goal of the analysis (‘*Overcome temporary loss of parking places between 2015-2017*’) has been subdivided in various levels of concrete means that could solve the problem. The use of this diagram even resulted in some ideas that were not yet generated during the brainstorm, survey, and interviews.

The use of the means-end diagram has resulted in four main categories of means:

1. Improve utilization of current parking places nearby the Spoorzone area
2. Create additional parking places
3. Decrease willingness to park
4. Limit the loss parking places in the Spoorzone area

The means-end diagram is displayed Figure 17. In order to have more insight on the description of each means can be referred to appendix D. The sole requirement for an idea to be written down was that the generated means somehow could contribute to solving the problem of the temporal loss of parking places in the Spoorzone Delft. All means have been described solely, i.e. it is tried to prevent describing means that in essence are combinations of several means.

Most of the categories are further classified in a few more sub-levels. Figure 17 shows these categories and their further deviation. All means from the fourth category: ‘*Limit the loss parking places in the Spoorzone area*’ (indicated in red) have been found infeasible (Appendix D). Some of the means (indicated orange) related to improving the utilisation: ‘*Decrease travel time from nearby parking facilities’* need to be combined with other means in order to solve the problem.

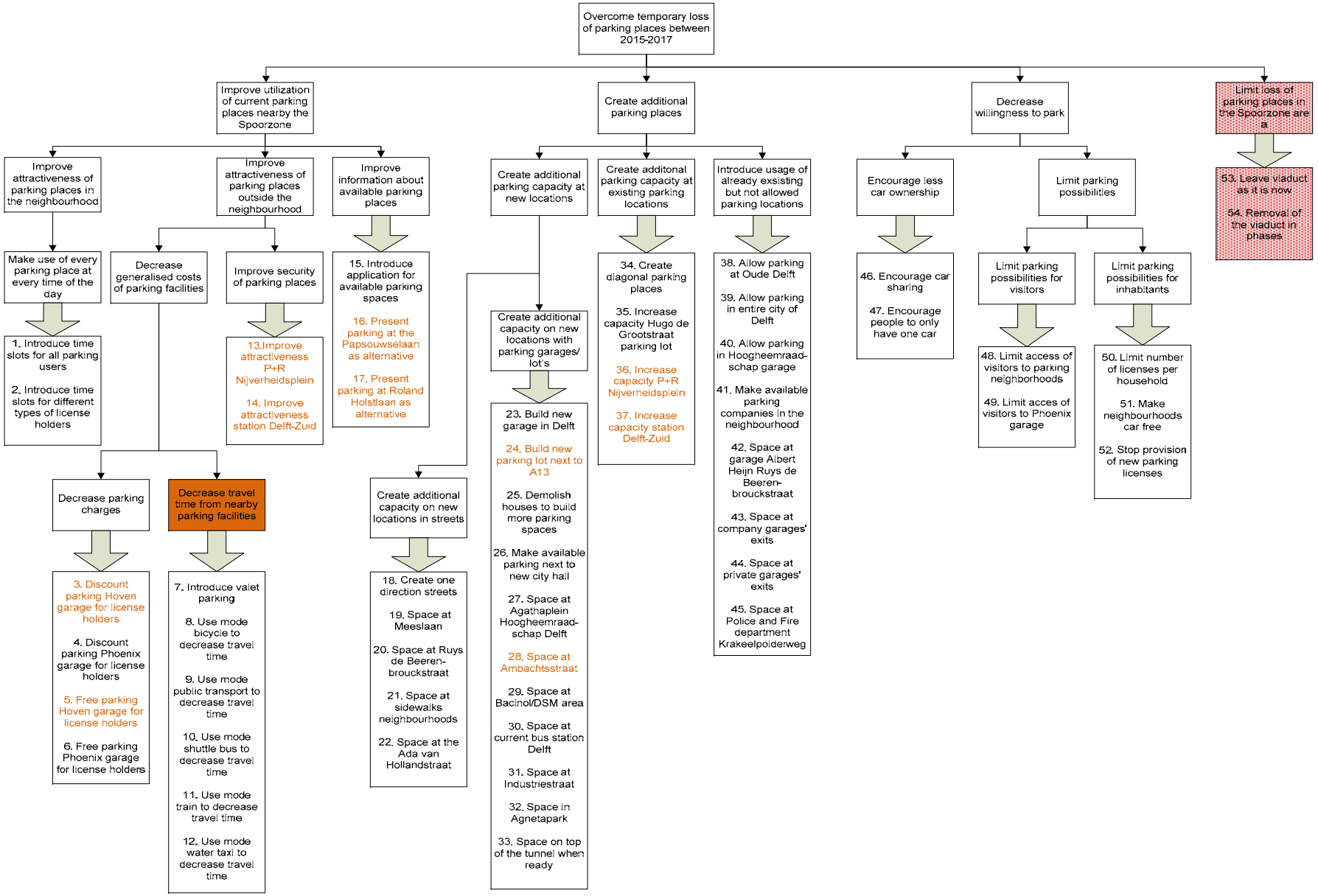

FIGURE 17: MEANS-END DIAGRAM

The location of the means of categories 1 and 2 are visualized below (Figure 18 and Figure 19).

FIGURE 18: LOCATION OF THE MEANS REGARDING THE IMPROVEMENT OF THE UTILIZATION OF CURRENT PARKING PLACES

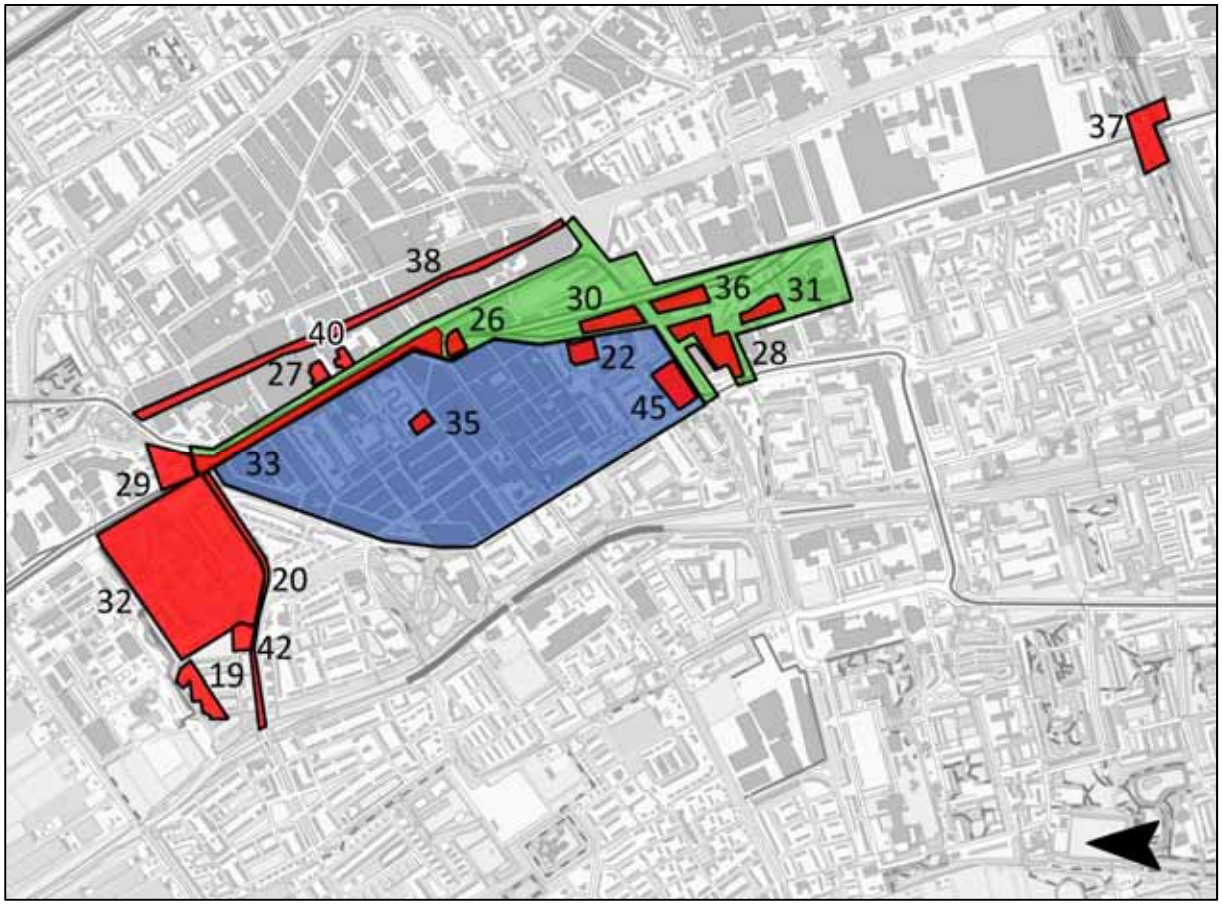

FIGURE 19: LOCATION OF THE MEANS REGARDING THE CREATION OF ADDITIONAL PARKING PLACES

5.3 BRAINSTORM EVALUATION

5.3.1 EVALUATION OF MEANS

As indicated in chapter 4, the entire list of generated means is reduced by evaluating their feasibility. This way, solutions that are deemed infeasible are eliminated from the list. As stated in Chapter 4, the following feasibility criteria have been chosen:

A. Suitability construction works and planning
B. Implementation time
C. Socio-political support
D. Effectiveness of means (amount of expected parking places divided by the amount of needed parking place), in combination with non-exclusion of other (sub) solutions

For each of the means, a score of 0, 1 or 2 has been assigned to each criterion. A score of 2 means that the means fulfils this criterion for sure, a score of 1 indicates that the means might fulfil the criterion but without certitude and a score of 0 indicates that the means does not fulfil the criterion. For each means the criteria scores are summed. The means that passes through this first round of evaluation are the ones with a score of 7 or 8 (it can be noted that no sums of 8 are there), which means that if a means scores 0 on one criterion, or scores 1 more than once, it is eliminated from the list. Below the evaluation table can be found.

TABLE 7: ALL INVESTIGATED MEANS WITH FEASIBILITY EVALUATION

Nr.	Description	A	B	C	D	Total
Category 1. Improve utilization of current parking places nearby the Spoorzone area						
1	Introduce time slots for all parking users	2	1	2	1	6
2	Introduce time slots for different types of licence holders	2	1	2	1	6
3	Discount parking Hovengarage for licence holders	2	2	1	2	7
4	Discount parking Phoenixgarage for licence holders	2	2	1	2	7
5	Free parking Hovengarage for licence holders	2	2	0	2	6
6	Free parking Phoenixgarage for licence holders	2	2	1	2	7
7	Introduce valet parking	2	1	0	2	5
8	Use mode bicycle to decrease travel time	2	2	1	2	7
9	Use mode public transport to decrease travel time	2	2	1	2	7
10	Use mode shuttle bus to decrease travel time	2	2	1	1	6
11	Use mode train to decrease travel time	2	2	1	1	6
12	Use mode water taxi to decrease travel time	2	1	1	1	5
13	Improve attractiveness P+R Nijverheidsplein at night	2	1	2	2	7
14	Improve attractiveness station Delft-South	2	1	1	2	6
15	Introduce application for available parking places	2	1	2	1	6
16	Present parking at the Papsouwselaan as alternative	2	2	1	1	6
17	Present parking at Roland Holstlaan as alternative	2	2	1	1	6
Category 2. Create additional parking places						
18	Create one direction streets	2	1	1	0	4
19	Space at Meeslaan	2	1	0	2	5
20	Space at Ruys de Beerenbrouckstraat	2	1	0	2	5
21	Space at sidewalks neighbourhoodss	2	2	0	1	5

22	Space at the Ada van Hollandstraat	0	2	2	2	6
23	Build new garage in Delft	2	0	0	2	4
24	Build new parking lot next to A13	2	1	1	2	6
25	Demolish houses to build more parking places	2	0	0	2	4
26	Make available parking next to new city hall	1	1	1	2	5
27	Space at Sint Agathaplein Prinsenhof	2	1	0	2	5
28	Space at Ambachtsstraat	2	2	1	2	7
29	Space at Bacinol/DSM area	0	2	1	2	5
30	Space at current bus station Delft	0	1	2	2	5
31	Space at Industriestraat	2	1	1	2	6
32	Space in Agnetapark	2	1	0	2	5
33	Space on top of the tunnel when ready	0	1	2	2	5
34	Create diagonal parking places	2	1	2	1	6
35	Increase capacity Hugo de Grootstraat parking lot	2	2	1	2	7
36	Increase capacity P+R Nijverheidsplein	2	1	1	2	6
Category 3. Decrease willingness to park						
37	Increase capacity station Delft-South	2	2	0	2	6
38	Allow parking at Oude Delft	2	2	0	1	5
39	Allow parking in entire city of Delft	2	2	0	1	5
40	Allow parking in Hoogheemraadschap garage	2	2	0	1	5
41	Make available parking companies in the neighbourhoods	2	2	0	2	6
42	Space at garage Albert Heijn Ruys de Beerenbrouckstraat	2	2	1	1	6
43	Space at company garages' exits	2	2	1	1	6
44	Space at private garages' exits	2	2	1	1	6
45	Space at Police and Fire department Krakeelpolderweg	2	1	0	2	5
46	Encourage car sharing	2	1	2	0	5
47	Encourage people to use only one car	2	1	1	1	5
48	Limit access of visitors to parking neighbourhoods	2	2	1	1	6
49	Limit access of visitors to Phoenixgarage	2	2	1	2	7
50	Limit number of licences per household	2	1	1	2	6
51	Make neighbourhoods car-free	2	1	1	0	4
52	Stop provision of new parking licences	2	0	1	2	5
Category 4. Limit loss of parking places in the Spoorzone area						
53	Leave the viaduct as it is	0	2	1	2	5
54	Removal of viaduct in phases	0	2	1	2	5

5.3.2 Remaining feasible means

The following means survived the brainstorm evaluation. An elaboration on their scores can be found in Appendix D.

- Category 1. Improve utilization of current parking places nearby the Spoorzone area
  - Means 3. Discount parking the Hovengarage for licence holders
  - Means 4. Discount parking Phoenixgarage for licence holders
  - Means 6. Free parking Phoenixgarage for licence holders
  - Means 8. Use mode bicycle to decrease travel time
  - Means 9. Use mode public transport to decrease travel time
  - Means 13. Improve attractiveness P+R Nijverheidsplein at night

- Category 2. Create additional parking places
  - Means 28. Space at Ambachtsstraat
  - Means 35. Increase capacity Hugo de Grootstraat parking lot
- Category 3. Decrease willingness to park
  - Means 49. Limit access of visitors to Phoenixgarage

5.4 SOLUTIONS

Not every means on its own is a solution for the problem. Some of the means should be combined in order to create the necessary capacity (requirement 2.1). The means 8 and 9 for instance need to be combined with other means to create a solution. In the case the use of the bicycle or public transport is able to significantly reduce the travel time compared to walking, the combination is made. Means 4 and 49 are also combined, because means 49 is seen as a too costly and therefore unrealistic solution for users. This process has led to twelve solutions, which will be evaluated in a MCDA. The solutions are worked out below where Figure 20 provides an overview of the location of the solutions. An elaboration on how the number of provided parking places that are mentioned below is determined can be found in appendix E.

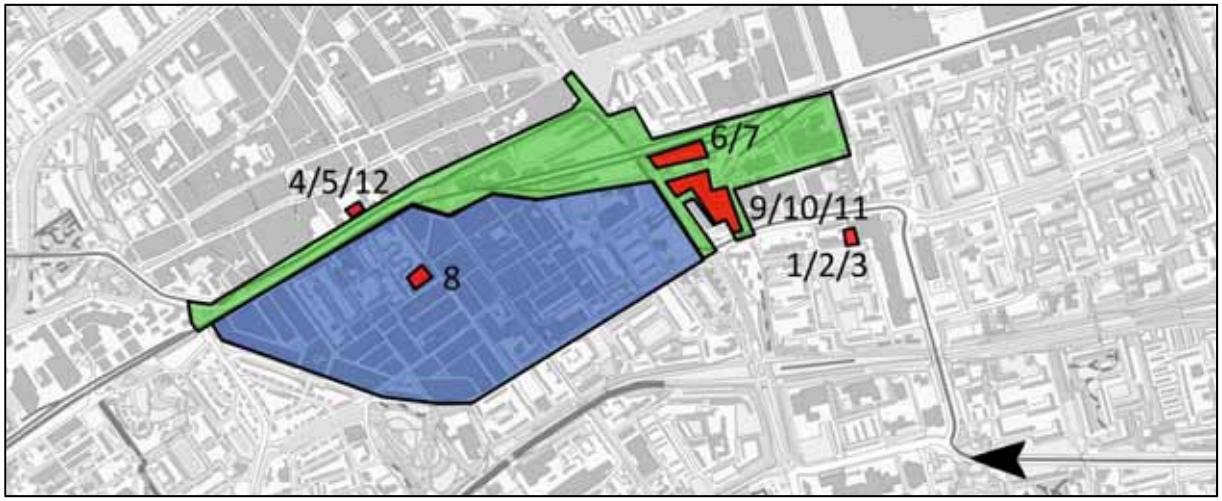

FIGURE 20: LOCATION REMAINING FEASBILE SOLUTIONS

SOLUTION 1. DISCOUNT PARKING THE HOVENGARAGE FOR LICENCE HOLDERS (M3)

The Hoven shopping area is situated at a distance of less than 1 kilometre from the neighbourhoods Olofsbuurt-Westerkwartier. It has a parking garage with a capacity of 550 parking places of which it is assumed 200 are available for usage. A discount for licence holders from area B and C could turn this garage into an interesting alternative for residents of the neighbourhoods Olofsbuurt-Westerkwartier. Nevertheless, it should be notices that this parking garage is only open during the day with the following opening hours: from 7h30 to 20h from Monday to Saturday and from 10:30 to 18:00 on Sunday (Parkeerlijn, 2014b).

SOLUTION 2. DISCOUNT PARKING THE HOVENGARAGE FOR LICENCE HOLDERS WITH BICYCLE (M3+M8)

The Hoven shopping area is situated at a distance of less than 1 kilometre from the neighbourhoods Olofsbuurt-Westerkwartier. It has a parking garage with a capacity of 550 parking places of which it is assumed 200 are available for usage. A discount for licence holders from area B and C could turn this garage into an interesting alternative for residents of the neighbourhoods Olofsbuurt-Westerkwartier.

An additional solution to cover the distance from the Hovengarage to the neighbourhoods is to bike instead of walk. The garage which is out of an accepted walking range of the neighbourhoods could become more attractive when the bicycle is used. Promotion of the mode bicycle could be done by providing bicycles (for example in a similar way to the PT-bicycle), but good information and bicycle parking places might also suffice.

SOLUTION 3. DISCOUNT PARKING THE HOVENGARAGE FOR LICENCE HOLDERS WITH PUBLIC TRANSPORT (M3+M9)

This solution looks a lot like the solution 2 above. Only now with a different additional solution to cover the distance from the Hovengarage to the neighbourhoods, namely by using public transport. In front of the garage a tram stop of tramline 1 is situated. This tramline connects the Hovengarage with the Phoenixstraat in 6 minutes. Providing free tickets to licence holders or specifically to users of the parking facilities could turn the Hovengarage as a great alternative during the removal of the Spoorzone viaduct.

SOLUTION 4. DISCOUNT PARKING PHOENIXGARAGE FOR LICENCE HOLDERS (M4)

The Phoenixgarage is situated next to the Spoorzone, less than 100 meters away from the neighbourhoods Olofsbuurt-Westerkwartier. The garage has a capacity of 202 places. This solution is available for 24 hours a day, but based on the average occupation rate of the garage it is assumed that this solution can provide 110 parking places. Allowing residents to park in the garage for a lower price than the normal tariff would improve the attractiveness of the garage. This way, residents might consider the nearby garage as an alternative for parking places in the Spoorzone. Both licence holders B and C could be provided with the discount.

SOLUTION 5. FREE PARKING PHOENIXGARAGE FOR LICENCE HOLDERS AT NIGHT (M6)

The Phoenixgarage is situated next to the Spoorzone, less than 100 meters away from the neighbourhoods Olofsbuurt-Westerkwartier. The garage has a capacity of 202 places. The Phoenixgarage is not fully occupied during the entire day (Section 3.3). Especially at night, there is unoccupied capacity. This capacity could be used to overcome the temporal loss of parking places in the nearby Spoorzone. Based on the occupation rate it is assumed that this solution can provide 110 parking places. Licence holders B and C could be granted free access at night.

SOLUTION 6. IMPROVE ATTRACTIVENESS P+R NIJVERHEIDSPLEIN AT NIGHT (M13)

The Nijverheidsplein, just south of Delft station, has a capacity of 200 parking places. For licence holders B and C use of this P+R facility is free (for other users only free of charge on Sundays) (Appendix A). Nevertheless, the area does not prove to be very attractive yet for residents of the neighbourhoods Olofsbuurt-Westerkwartier. The parking lot is hardly surrounded by housing, making it an unpleasant place for car users to leave behind their parked car. The attractiveness of the Nijverheidsplein could be improved by taking security measures. Fences, bright lights, and access levers could be used to discourage vandalism. Another option is to deploy security guards at night.

SOLUTION 7. IMPROVE ATTRACTIVENESS P+R NIJVERHEIDSPLEIN AT NIGHT WITH BICYCLE (M13+M8)

This solution is more elaborated than solution 6 above. Here an additional measure to improve the usage of the Nijverheidsplein is to make promotion in order that car users cover the distance from the Nijverheidsplein to the neighbourhoods by bicycle. The Nijverheidsplein which can be quite a long walk for some residents of the neighbourhoods could become more attractive when the bicycle is used. Promotion of the mode bicycle could be done by providing bicycles (for example in a similar way to the OV-fiets), but good information services and bicycle parking places might also suffice.

SOLUTION 8. INCREASE CAPACITY HUGO DE GROOTSTRAAT PARKING LOT (M35)

A small parking lot can be found in the Elsje van Houwelingenstraat, near the Hugo de Grootstraat. The available surface could be used for creation of an extra parking level, resulting in various additional parking places in the heart of the neighbourhoods Olofsbuurt-Westerkwartier. Both modular solutions could be used. A modular solution concerns a simple parking construction, providing various parking places. Such a construction already exists at the Yperstraat in the city centre of Delft (Figure 21). It is estimated that around 60 parking places will be created with such a solution.

FIGURE 21: TWO STORY PARKING, YPERSTRAAT DELFT (STRAATKAART, 2009)

SOLUTION 9. SPACE AT AMBACHTSSTRAAT (M26)

The area around the Ambachtsstraat (indicated as areas 8a and 8b in the Integraal Ontwikkelingsplan (Gemeente Delft, 2013d)) will be used for the development of housing in 2019 (Gebruik de lege ruimte, 2013; Gemeente Delft, 2013d). Until then, the area could be used to create new parking places south of the Delft railway station close to the Nijverheidsplein. It is estimated that this parking lot can provide around 300 parking places.

SOLUTION 10. SPACE AT AMBACHTSSTRAAT WITH BICYCLE (M26+M8)

This solution has an additional measure compared to solution 9. The additional measure to improve the usage of the Ambachtsstraat is promoting to cover the distance from the Ambachtsstraat to the neighbourhoods by bicycle. The Ambachtsstraat which can be quite a long walk for some residents of the neighbourhoods could become more attractive when the bicycle is used. Promotion of the mode

bicycle could be done by providing bicycles (for example in a similar way to the OV-fiets), but good information and bicycle parking places might also suffice.

SOLUTION 11. SPACE AT AMBACHTSSTRAAT WITH PUBLIC TRANSPORT (M26+M9)
This solution looks like the two solutions 9 and 10 above, but is slightly different. The Ambachtsstraat is situated close to tramline 1 and bus line 81. The tram (line 1) passing through the Spoorzone area covers the neighbourhoods at their entire western flanks, while the bus (line 81) covers most of the eastern side. Providing free tickets to licence holders or specifically to users of the parking facilities could turn the Ambachtsstraat in an attractive parking alternative during the removal of the Spoorzone viaduct.

SOLUTION 12. LIMIT ACCESS OF VISITORS TO PHOENIXGARAGE COMBINED WITH AN DISCOUNT FOR LICENCE HOLDERS (M4+M49)
Currently, the Phoenixgarage is the busiest garage of the city centre (Section 3.3). If the users of parking places in the Spoorzone are redirected towards this garage it would become even busier. This could be avoided by regulating the access to this parking garage. When the Phoenixgarage is only accessible for residents, visitors could be redirected towards to the Zuidpoort and/or Marktgarage. But since parking on a daily basis is too expensive for inhabitants an additional discount is necessary. Since the whole capacity of the garage can be used this solution generates 202 parking places.

5.5 CONCLUSION

In this chapter a list of 54 means has been made (Table 7). The means can be subdivided into four categories. Regarding the spatial distribution of these means, it can be concluded that means from category 1 (improve utilization of current parking places) can only be found south and west from the neighbourhoods Olofsbuurt-Westerkwartier. Means from category 2 (create additional parking places) can be found all around the neighbourhoods, except for the western side of it.

After evaluating the means for four criteria (derived in Section 4.2) regarding the feasibility, resulting means have been combined into solutions (Section 5.4). Regarding the spatial distribution of the remaining feasible solutions, it can be concluded that no feasible solutions are found north of the neighbourhoods Olofsbuurt-Westerkwartier. Solutions that will be evaluated in the next chapter involve the Phoenixgarage, the Nijverheidsplein, Hugo de Grootstraat, and the Ambachtsstraat.

6. MULTIPLE-CRITERIA DECISION ANALYSIS

In this chapter the following sub-question will be answered:

11. *Which solution(s) suit(s) best for the problem?*

In order to give an advice on which solution should be implemented, a Multiple-Criteria Decision Analysis (MCDA) will be executed.

6.1 CHOICE OF MCDA AND METHOD

As can be concluded from the analysis of this research, the temporal loss of parking places in the Spoorzone is a rather complex problem: it inter alia concerns different actors, a sensitive time schedule, and many interrelated possible solutions. In this research it is chosen to list requirements from the points of view of the most important actors (problem owner and main stakeholder) and use these to derive criteria for evaluation. Monetizing the effects of the derived criteria would make cost-benefit analysis possible, but we have chosen not to do this. For the level of detail of this research we have deemed it preferable to assess each criterion in its most appropriate unit, instead of translating it into monetary values. As multiple-criteria decision analyses can deal with various design aspects and dimensions (Pruyt, 2009) we have chosen to use this type of evaluation method.

6.1.1 CHOICE FOR ELECTRE II METHOD

For multiple-criteria decision analysis many (sorts of) methods exists, all with different properties and (dis)advantages. For this research several methods were considered. Utility functions and goal programming methods were found unsuitable because these methods are able only to deal with quantitative data; the ARGUS method was found less appropriate because it converts all quantitative data in qualitative data, which could cause loss of information. The Analytical Hierarchy Process was considered too demanding and rather non-transparent because of the amount of necessary calculations. Many methods however remained suitable for evaluation. Among these methods were the lexicographical method, the ELECTRE methods, and the PROMETHEE methods. From these possibilities, the ELECTRE II ranking method has been chosen for its ability to deal with both quantitative and qualitative data, its ability to use various weight sets (according to different actor visions), its simplicity, and overall transparency (Pruyt, 2009, pp. 130-132).

6.1.2 THE ELECTRE METHODS IN GENERAL (CONCORDANCE)

The ELECTRE methods concern pair-wise comparison of strategies. For each pair of strategies and for each criterion, it is determined which of the two strategies outperforms the other, or if the strategies are indifferent. This (in)difference can be multiplied with weights for each criterion, after which a ranking of the solution strategies could be derived (with the ELECTRE II in particular) (Pruyt, 2009).

The ELECTRE II method is chosen, because it can deal with both quantitative and qualitative data and the use of weights (according to different actor visions) can be done in a very clear way. Other advantages are the simplicity of this method and the clear ranking outcome of the evaluation. In the next sections the steps of the ELECTRE II evaluation are explicitly explained.

6.2 WEIGHTS FOR EVALUATION

As explained in section 4.2.2, criteria have been determined to evaluate the solutions with. In order to make a distinction between the significance of the criteria, the criteria can be weighted. As it was concluded in section 4.3, for the problem owner and the main stakeholder the significance of the requirements largely differ. Therefore it is decided to make two separate sets of weights and sub-weights (called visions):

- A set derived from the point of view of the problem owner (combination of CCL, ProRail and Municipality Delft), in which in particular solution costs and feasibility criteria are heavy-weighted;
- A set derived from the point of view of the main stakeholder (residents from the neighbourhoods Olofsbuurt-Westerkwartier that park in the Spoorzone Delft), in which the functionality criterion is heavy-weighted.

In addition to the problem owner and main stakeholder, the research customer (BVOW) has been identified (section 3.1.2). A separate vision from the point of view of the research customer has not been constructed, because an overlap is assumed between the interests of residents that use the parking places and the BVOW. Comparing the outcomes for the two chosen sets is expected sufficient for deriving at an interesting solution.

6.2.1 WEIGHTS

Even though the requirement analysis (section 4.2.2) already showed a bias towards certain requirements for both considered visions, it has been chosen to elaborate more extensively on the weight determination. Pair-wise comparisons of all criteria have been used to determine the weights. The comparisons can be found in Table 8.

When a horizontal criterion is considered more important than the vertical one, a value of 1 is assigned (for the contrary a value of 0). The values of each criterion are summed (at the end of the row), and doubled. The one criterion with a sum of 0 gets a double total value of 1. The final weight is derived by normalizing the double total; each double total is divided by the sum of double totals for all criteria.

Content-wise, the weights have been based on the actor analysis (Section 3.1) and where possible on literature. The description of the assignment of the score for the pair-wise comparisons can be found in Appendix F.

TABLE 8: WEIGHT VISION OF THE PROBLEM OWNER

Point of view from: Problem Owner							
CCL, ProRail and Municipality of Delft							
	Functionality	Costs	Environment	Feasibility	Totals	Double Total	Weights
Functionality	-	0	1	0	1	2	0.15
Costs	1	-	1	1	3	6	0.46
Environment	0	0	-	0	0	1	0.08
Feasibility	1	0	1	-	2	4	0.31
							1

TABLE 9: WEIGHT VISION OF THE MAIN STAKEHOLDER

Point of view from: Main stakeholder							
Residents from the neighbourhoods Olofsbuurt-Westerkwartier that park in the Spoorzone Delft							
	Functionality	Costs	Environment	Feasibility	Totals	Double Total	Weights
Functionality	-	1	1	1	3	6	0.46
Costs	0	-	0	0	0	1	0.08
Environment	0	1	-	1	2	4	0.31
Feasibility	0	1	0	-	1	2	0.15
							1.00

6.2.2 SUB-WEIGHTS

To determine the sub-weights (later on assigned to the sub-criteria) the same method has been applied, with the exception that also a tie value of 0.5 can be assigned if the sub-criteria were considered equally important. The pair-wise tables and explanations can be found in Appendix F.

TABLE 10: WEIGHTS MCDA PROBLEM OWNER

Criteria	Sub-criteria	Weights criteria	Weight sub-criteria
Functionality	N° Parking Places	0.15	0.09
	Parking costs users		0.04
	Travel time		0.02
Solution costs		0.46	0.46
Environment impacts	Pollution	0.08	0.03
	Sustainability		0.03
	Liveability		0.01
Technical Feasibility	Implementation time	0.31	0.15
	Life time of solution		0.15

TABLE 11: WEIGHT MCDA MAIN STAKEHOLDERS

Criteria	Sub-criteria	Weights criteria	Weight sub-criteria
Functionality	N° Parking Places	0.46	0.26
	Parking costs users		0.13
	Travel time		0.07
Solution costs		0.08	0.08
Environment impacts	Pollution	0.31	0.09
	Sustainability		0.04
	Liveability		0.18
Technical Feasibility	Implementation time	0.15	0.08
	Life time of solution		0.08

6.3 CATEGORIZATION OF EFFECT SCORES

The effect scores of the evaluation form the core of the evaluation. These scores indicate the successfulness of the solution for each criterion. The effect scores are objective, which means that they do not differ for any vision. Because the ELECTRE II method is able to deal with various types of criteria, it is important to clarify how the effect of each sub-criterion can be scored.

In the next sections, all possible effect indications and descriptions can be found for all criteria and sub-criteria. The columns ´Used in MCDA´ indicate the numerical values that were used for execution of the ELECTRE II method in Microsoft Excel. These numerical values relate to the elaborated list of effect scores, which can be found in appendix E. As the numerical values in many cases only have ordinal significance (i.e. they represent if a score is a better, but not to which extent), for the representation of the MCDA (Table 20) it was considered more transparent to use qualified descriptions.

6.3.1 EFFECTS OF FUNCTIONALITY SUB-CRITERIA

The functionality criterion considers if the solution proposed meets the functional requirements. The **number of parking places** provided will be evaluated by determining how many places will be made available for each new solution. Because the exact number of places was not always easy to calculate, six categories have been used, ranging from 50 till 300 places.

TABLE 12: ESTIMATED CAPACITY [NUMBER OF PARKING PLACES]

Indication	Used in MCDA	Description
50	1	About 50 parking places provided with the solution
100	2	About 100 parking places provided with the solution
150	3	About 150 parking places provided with the solution
200	4	About 200 parking places provided with the solution
250	5	About 250 parking places provided with the solution
300	6	About 300 parking places provided with the solution

The sub-criterion **parking costs** will also be evaluated by comparing it with the actual cost paid by the parking places users. If the costs are higher than the actual one it will be scored with 1 and similar

costs will be scored with 0. No solution will be cheaper than the actual one that is why it is not considered there.

TABLE 13: PARKING COSTS

Indication	Used in MCDA	Description
Increased	1	Higher costs for users than current situation
Equal	0	Similar costs for users as current situation

Finally, the **travel time** will also be evaluated by comparing the travel time from the actual parking spots to the new parking spots. This travel time will be evaluated because people with different destinations are parking at the Spoorzone, and it is not possible to take all the destinations into account. It has thus been decided to take into account the travel time to the current parking places that can be considered as the additional travel time to the final destination (see Figure 22). If the travel time is below 5 minutes the solution will be scored 1, if it is between 5 and 10 minutes it will be scored 2, if it is between 10 and 15 minutes it will be scored with a 3.

TABLE 14: TRAVEL TIME

Indication	Used in MCDA	Description
<5	1	Additional travel time between 0 and 5 min
5-10	2	Additional travel time between 5 and 10 min
11-15	3	Additional travel time between 10 and 15 min

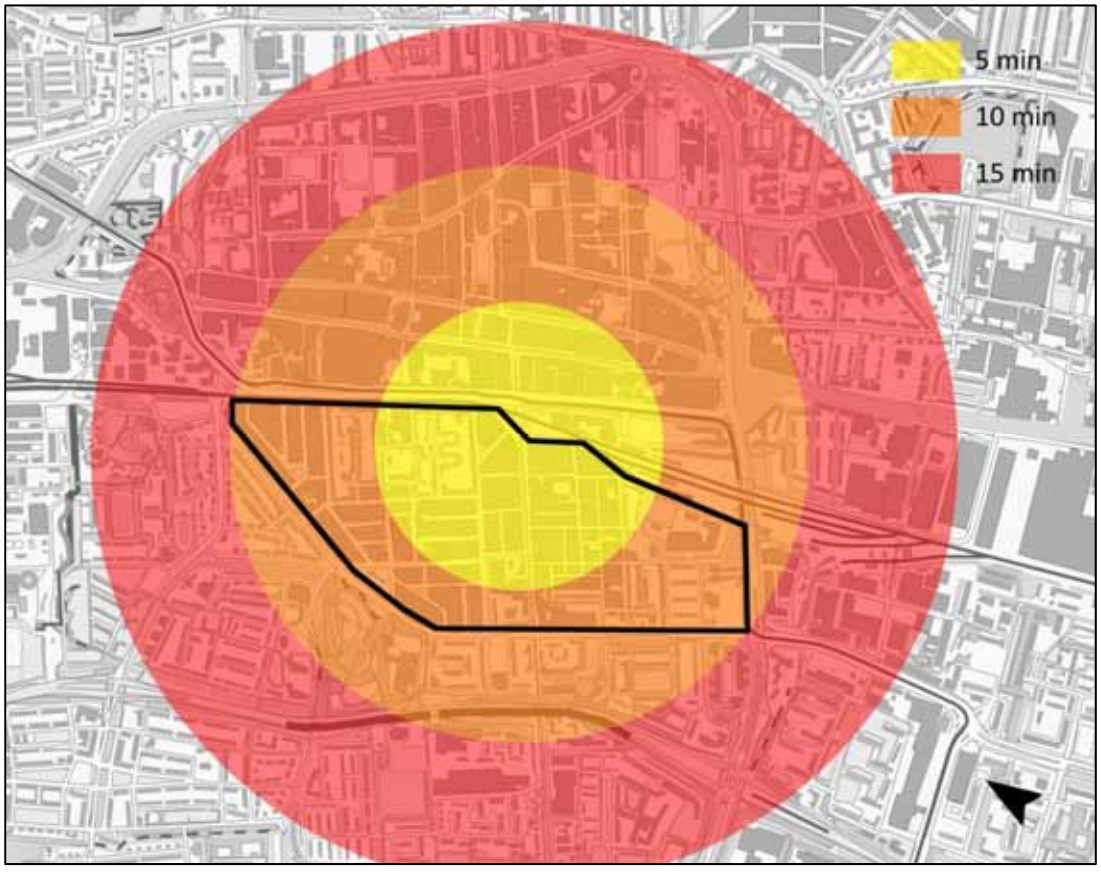

FIGURE 22: WALKING DISTANCES FROM THE CENTRE OF THE SPOORZONE AREA

6.3.2 EFFECTS OF COSTS CRITERION

The second main criterion is the solution costs. The unit for costs are Euros. Because it is considered too difficult to elaborate on the effects in exact monetary values, qualitative scores have been defined. The solutions are scored “low”, “medium”, “high”, and “very high”. The qualitative scores are based on the type of costs involved.

TABLE 15: COSTS

Indication	Used in MCDA	Description
Low	1	Only some implementation costs involved
Medium	2	Implementation and operation costs involved
High	3	(Significant) Implementation and/or operation costs involved, together with some construction and manufacturing costs
Very high	4	(Significant) Implementation and/or operation costs involved, together with significant construction and manufacturing costs

6.3.3 EFFECTS OF ENVIRONMENT SUB-CRITERIA

The environmental impact considers all effects of the solutions on the environment and the surrounding area. Because all the solutions are situated closely to the neighbourhoods, the **pollution** is measured by the aspect if people have to search for a parking place or not. When there is a determined parking lot outside the neighbourhoods, there is no need for the inhabitants to search for a place in their street. It can be assumed that people will go straight to the determined parking lot instead of going to their neighbourhoods first. In case of parking in the neighbourhoods, inhabitants have to drive around to search for a place which causes an increase of pollution.

TABLE 16: POLUTION

Indication	Used in MCDA	Description
Increased	1	Increased pollution; parking users will have to search for parking place
No additional	2	No additional pollution; parking users can directly drive to parking place without searching

The **sustainability** is measured by the surface that is used by the parking place. For some solutions, new land has to be constructed, whereas other solutions can use an existing parking place.

TABLE 17: SUSTAINABILITY

Indication	Used in MCDA	Description
Decreased	-1	Decreased sustainability; new land is used for construction
Equal	0	Improved sustainability; no new land is needed

Finally, the **liveability** is measured by the amount of cars in the area. When cars are moved out of the neighbourhoods, the liveability will increase.

TABLE 18: LIVEABILITY

Indication	Used in MCDA	Description
Decreased	-1	Decreased liveability; more cars are parked in the neighbourhoods
Increased	1	Increased liveability; more cars are parked outside of the neighbourhoods

6.3.4 EFFECTS OF TECHNICAL FEASIBILITY SUB-CRITERIA

The criterion technical feasibility refers to the difficulty related to the implementation of the solution. The **time of implementation** will be measured in months. It is the time that is expected to be needed to implement the solution. Since all solutions were seen as feasible in the first round, an implementation time of over 12 months is not possible.

The **life time of the solution** indicates the time that the solution can be used in the period between 2015 and 2017. So the maximum value is two years.

TABLE 19: SUBCRITERIA TECHNICAL FEASIBILITY WITH THEIR UNITS

Unit	Sub-criterion
Month	Implementation time
Year	Life time

For all the solutions the effects for all the criteria and sub criteria described above are available in Appendix E.

6.4 OVERVIEW OF FOUND EFFECT SCORES

In Table 20 all found effect scores are listed. In the table the weights and sub-weights for both actor visions are added as well. This way it is easy traceable which effects are influential on the outcome of the MCDA for which actor vision. As shown in Table 10 and Table 11, the weights for both actor visions are very different.

		Functionality			Solution costs	Environmental impacts			Technical feasibility		
		Estimated capacity [Parking places]	Parking costs user [qualitative]	Travel time [min]	Solution costs [qualitative]	Pollution [qualitative]	Sustainability [qualitative]	Liveability [qualitative]	Implementation time [months]	Life time [years]	CRITERIA / SUB-CRITERIA
POINT OF VIEW		0,46			0,08	0,31			0,15		WEIGHTS
MAIN STAKEHOLDER		**0,132**	**0,264**	**0,066**	**0,077**	**0,090**	**0,040**	**0,180**	**0,075**	**0,075**	SUB-WEIGHTS
Solution 1. (Hoven garage)		200	increased	11 - 15	medium	increased	equal	increased	2	2	
Solution 2. (Hoven + bicycle)		200	increased	<5	medium	increased	equal	increased	4	2	
Solution 3. (Hoven + pt)		200	increased	5 - 10	high	increased	equal	increased	2	2	
Solution 4. (Phoenix garage)		100	increased	<5	medium	increased	equal	increased	1	2	
Solution 5. (Free Phoenix)		100	equal	<5	high	no additional	equal	increased	1	2	
Solution 6. (Nijverheidsplein)		200	equal	5 - 10	low	increased	equal	increased	4	2	
Solution 7. (Nijverheidsplein + bicycle)		200	equal	<5	low	no additional	equal	increased	4	2	
Solution 8. (Hugo de Grootstraat)		50	equal	<5	high	no additional	equal	decreased	6	2	
Solution 9. (Ambachtsstraat)		300	equal	5 - 10	high	increased	decreased	increased	6	2	
Solution 10. (Ambachtsstraat + Bicycle)		300	equal	<5	high	no additional	decreased	increased	7	2	
Solution 11. (Ambachtsstraat + pt)		300	equal	11 - 15	very high	increased	decreased	increased	7	2	EFFECT SCORES FOR ALL CRITERIA
Solution 12. (Limit access Phoenix)		200	increased	<5	high	increased	equal	increased	1	2	
EVALUATED SOLUTIONS	SUB-WEIGHTS	**0,044**	**0,022**	**0,011**	**0,462**	**0,066**	**0,066**	**0,022**	**0,154**	**0,154**	POINT OF VIEW
	WEIGHTS	**0,08**			**0,46**	**0,15**			**0,31**		**PROBLEM OWNER**

TABLE 20: EFFECT SCORES AND SUB-WEIGHTS MAIN STAKEHOLDER (ABOVE) AND PROBLEM OWNER (BELOW)

6.5 EVALUATION AND RESULTS

6.5.1 ELECTRE II EVALUATION

The pair-wise comparisons of the ELECTRE II method have been done as follows. Every combination of two solutions is compared, after which the best scoring solution is rewarded with the related sub-weight; the other gets nothing. In case there is no difference, both solutions earn nothing. After comparing all solutions for each criterion, the winning scores for each solution are summed, as well as the losing scores of each solution. The losing sum can be distracted from the winning sum, after which a final score remains. These scores form the ranking of the solutions; the solution with the highest total score is considered the best scoring solution (from all solutions, it has won the most comparisons with other solutions), and the lowest scoring solution is regarded the least. While negative scoring solutions can be considered below average (compared to other solutions) and positive scoring solutions above average, it must be noted that the average of solutions is not strictly situated at the value 0. It is therefore important to compare the scores of solutions of independently from negative or positive scores.

6.5.2 RESULTING RANKING OF SOLUTIONS

The results for the point of view of the main stakeholder are as follows:

POINT OF VIEW **MAIN STAKEHOLDER**			SCORES and RANKING	
Solution 1. (Hoven garage)	1.990	3.991	-2.001	**11**
Solution 2. (Hoven + bicycle)	2.018	3.283	-1.265	**8**
Solution 3. (Hoven + pt)	1.496	4.035	-2.539	**12**
Solution 4. (Phoenix garage)	2.129	3.814	-1.685	**9**
Solution 5. (Free Phoenix)	4.262	1.837	2.425	**3**
Solution 6. (Nijverheidsplein)	3.899	1.875	2.024	**4**
Solution 7. (Nijverheidsplein + bicycle)	4.997	0.921	4.076	**1**
Solution 8. (Hugo de Grootstraat)	3.425	5.191	-1.766	**10**
Solution 9. (Ambachtsstraat)	3.839	2.529	1.310	**5**
Solution 10. (Ambachtsstraat + Bicycle)	4.787	1.725	3.062	**2**
Solution 11. (Ambachtsstraat + pt)	3.480	3.492	-0.012	**6**
Solution 12. (Limit access Phoenix)	1.778	2.989	-1.211	**7**
EVALUATED SOLUTIONS	SUMS WINNING	SUMS LOSING		

TABLE 21: RESULTING RANKING MAIN STAKEHOLDER

The results for the point of view of the problem owner are as follows:

POINT OF VIEW **PROBLEM OWNER**			SCORES and RANKING	
Solution 1. (Hoven garage)	6.045	2.386	3.659	**4**
Solution 2. (Hoven + bicycle)	5.177	2.551	2.626	**5**
Solution 3. (Hoven + pt)	1.925	4.188	-2.264	**8**
Solution 4. (Phoenix garage)	5.859	1.825	4.034	**3**
Solution 5. (Free Phoenix)	2.981	2.792	0.189	**6**
Solution 6. (Nijverheidsplein)	6.682	1.573	5.109	**2**
Solution 7. (Nijverheidsplein + bicycle)	7.375	1.210	6.165	**1**
Solution 8. (Hugo de Grootstraat)	1.837	4.706	-2.869	**9**
Solution 9. (Ambachtsstraat)	1.452	4.937	-3.485	**11**
Solution 10. (Ambachtsstraat + Bicycle)	1.837	4.882	-3.045	**10**
Solution 11. (Ambachtsstraat + pt)	0.660	8.970	-8.310	**12**
Solution 12. (Limit access Phoenix)	2.255	2.858	-0.603	**7**
EVALUATED SOLUTIONS	SUMS WINNING	SUMS LOSING		

TABLE 22: RESULTING RANKING PROBLEM OWNER

6.6 DISCUSSION OF RESULTS

In order to see how robust the outcome of the MCDA evaluation is, the sensitivity of the outcomes is regarded. Because the outcome of the evaluation depends on several parameters (i.e. weights, sub-weights, and effect scores), a choice has been made on how to do this. For two reasons it has been chosen to use differentiation of the effect scores instead of weight differentiation, namely:

- Sensitivity of weights and sub-weights is already taken into account by the use of two visions; as can be clearly seen in Table 20, the two visions have almost opposite values, which means that a solution that scores high for both actor visions, scores high on each criterion and apparently has no bias towards a specific weight in particular;
- It is reckoned that some details of the effect scores in this research need further attention, in particular the solution costs.

6.6.1 COMBINATION OF POINTS OF VIEW

As the results listed in Table 21 and Table 22 indicate the outcomes of the MCDA for two visions, these outcomes can be compared to see which solution scores the highest for both visions. It has been chosen to have a look at the average of both vision scores. These average scores can be found in the middle columns of Table 23. For solution 7 for example, the average vision of 5.121 is indeed the average of 4.076 (Table 21) and 6.165 (Table 22). The solutions have been ranked based on these average vision scores.

Because it is theoretically possible that an average vision scores has earned most of its score from one of the two visions (e.g. when one vision is very positive and the other vision slightly negative), in the right columns of Table 23 it is checked if the derived ranking of solutions based on the average, complies with the average ranking of the solutions for both actor visions. Solution 10 for example, has a high difference in preference; it comes in second place for the main stakeholder (Table 21), but it ends 10th (!) for the problem owner (Table 22).

COMBINED POINTS OF VIEW (Main stakeholder and Problem owner)

EVALUATED SOLUTIONS	AVERAGE VISION SCORES ranked from high to low		AVERAGE OF RANKINGS with their ranking (right)	
Solution 7. (Nijverheidsplein + bicycle)	**5,121**	1	**1**	1
Solution 6. (Nijverheidsplein)	**3,567**	2	**3**	2
Solution 5. (Free Phoenix)	**1,307**	3	**4,5**	3
Solution 4. (Phoenix garage)	**1,175**	4	**6**	4
Solution 1. (Hoven garage)	**0,829**	5	**7,5**	8
Solution 2. (Hoven + bicycle)	**0,681**	6	**6,5**	6
Solution 10. (Ambachtsstraat + Bicycle)	**0,009**	7	**6**	4
Solution 12. (Limit access Phoenix)	**-0,907**	8	**7**	7
Solution 9. (Ambachtsstraat)	**-1,087**	9	**8**	9
Solution 8. (Hugo de Grootstraat)	**-2,317**	10	**9,5**	11
Solution 3. (Hoven + pt)	**-2,401**	11	**10**	12
Solution 11. (Ambachtsstraat + pt)	**-4,161**	12	**9**	10

TABLE 23: AVERAGE SCORES AND RANKING OF SOLUTIONS FOR COMBINED POINTS OF VIEW

It can be noticed that both comparisons largely comply, in particular for the four **solutions that have the highest score**. Solution 7 (average number 1) scores the highest for both visions, while solution 6 (average number 2) finishes 2nd for the problem owner, but comes in 4th position for the main stakeholder. Solution 5 then (average number 3) comes in 3rd position for the main stakeholder, but it only finishes 6th in the ranking for the problem owner. Solution 4 (average number 4) behaves in opposite direction; for the problem owner it finishes at the 3rd position, while for the main stakeholder it finishes 9th.

In the middle we find **solutions scoring around 0**. Solution 1 (average number 5) and solution 2 (average number 6) on average have a small positive score. It can be observed that these are positively scored from the problem owner point of view, but negatively from the main stakeholder point of view. As indicated above, solution 10 also has a high difference in preference.

The **lowest scoring solutions** (12, 9, 8, 3 and 11) score negative for both visions, with the exception of solution 9 that has a positive score for the main stakeholder. Solution 12, which is the only regulation solution that has been evaluated, has a small negative score for both visions. Even though the neighbourhoods and the solutions are well-connected by public transport, the public transport solutions (3 and 11) score the lowest. This can be explained because of the high solution costs and the high travel time.

6.6.2 SENSITIVITY OF HIGH AND MEDIUM SCORING SOLUTIONS

For the combined MCDA evaluation, **solution 7** is the highest scoring solution. It concerns the combination of an improved attractiveness of the Nijverheidsplein with the use of bicycle. It comes in at first place for the main stakeholder because of its high scoring functionality; it offers a parking capacity of approximately 200 parking places, it does not increase the parking costs, and it has a short travel time towards the heart of the neighbourhoods Olofsbuurt-Westerkwartier. In addition, this solution scores optimally for the criterion of environmental impacts. For the problem owner solution 7 also comes in at first, assuming that the solution costs remain low. When these are increased to the category medium, the solution still remains in the top 4 (number 3); only when the solution costs turned out to be high, this solution ends up with a negative score.

Solution 6 concerns improvement of attractiveness of Nijverheidsplein without any complimentary means. Almost similar to solution 7, solution 6 scores high on environmental impacts and good on functionality (it has some additional pollution and a larger travel time than solution 7). Solution 6 scores high for the problem owner; because the costs for these solutions are by definition lower than solution 7, its outcome is considered even more robust than the robustness of solution 7.

Solution 5 (free parking at night in the Phoenixgarage) comes in 3rd. For the main stakeholder it scores high for its functionality, but for the problem owner the solution costs (considered high) turn it to the 6th position. When the solution costs are regarded lower, its position will rapidly improve, even to the 1st position for the problem owner for low solution costs.

Solution 1 (Hovengarage) and **solution 2** (Hoven with bicycle) both score low on functionality: increased parking costs for users and a long travel time for solution 2. The only way some improvement in ranking position could be reached would be to decrease the parking costs for users.

Because of the functionality of the Ambachtsstraat **solution 10** and **solution 9** (it is the only place where the total of 300 parking places could be created) these solutions score high for the main stakeholder. The solution costs however are the reason why the problem owner has less preference for these solutions. Solution 10 would reach the overall top 3 if the solution costs are regarded lower then high; a similar effect could be viewed for solution 9.

6.6.3 PRACTICAL INTERPRETATION OF SENSITIVITY COSTS

Because the outcome of the MCDA (in particular for the problem owner) is reckoned to be very sensitive to the solution costs, a detailed look now is taken on how the solution costs have been argued. For improvement of the attractiveness of the Nijverheidsplein (**solution 7**), only implementation costs have been taken into account. The use of guards has not been taken into account, but if it would have been, operational costs would undeniably come involved. The construction of a system that makes the area only accessible for parking users (and inaccessible for vandals) would result in high costs. It is however doubtful to what extend how efficient these additional options are.

The solution costs for the Phoenixgarage **solution 5** largely depend on the negotiations with Parking Delft B.V. In this research it is not investigated to what extend the problem owner is able to influence the willingness of Parking Delft B.V. to cooperate, for example by allowing discounts, free parking at

night, or limited access for visitors. If only small compensation needs to be paid for the use of the Phoenixgarage, these solutions would become very successful. Even the limited access of visitors to the Phoenixgarage (**solution 12**) would then become a high scoring and thus very interesting (additional) option.

If the parking costs for users of the Hovengarage (**solution 1** and **solution 2**) could be considered as low instead of medium, for instance by assuming free parking tickets for users. Even in this case however, these solutions are hardly likely to improve their position; it is assumed that when a decrease in parking costs for users is applied, the solution costs would increase, because of the involvement of the external party Interparking.

Finally, the solution costs of the Ambachtsstraat solutions, in particular **Solution 10** could be considered lower when instead of asphalt, cheap gravel materials could be used. Because this solution now has been considered to provide the total necessary capacity of 300 parking places, it would also become less expensive if only a part of this amount needs to be created.

6.7 CONCLUSION

Based on a comparison of the visions scores of the main stakeholder and problem owner, three solutions score positive for both visions and thus for most of the weighted sub-criteria:

- Solution 7. Improve attractiveness P+R Nijverheidsplein at night with bicycle (M13+M8)
- Solution 6. Improve attractiveness P+R Nijverheidsplein at night (M13)
- Solution 5. Free parking Phoenixgarage for licence holders (M6)

However, it must be noted that the high and medium scoring solutions show a high sensitivity of the MCDA outcomes for estimated solution costs. From a practical point of view this means that:

- Solution 7 and solution 6 might score lower when operational costs are included in evaluation (even though the necessity of operational features is doubted);
- Solution 10 (Room at Ambachtsstraat with Bicycle) becomes more attractive when a cheaper solution (e.g. other or less materials) could be executed;
- Even low scoring solution 12 (Limit access of visitors to Phoenixgarage) could become attractive if the problem owner could start a good cooperation with Parking Delft B.V.

As was already concluded in section 5.5, no feasible solutions are found north of the neighbourhoods Olofsbuurt-Westerkwartier. As the Hugo de Grootstraat (solution 8), which together with the Phoenixgarage is the only centred solution with regard to the Spoorzone area, has a very low score, use of the Phoenixgarage (solution 4 or solution 5) appears (almost) necessary to provide a solution for residents of the Olofsbuurt. A combination of the Phoenixgarage and Nijverheidsplein appears attractive from the points of view of both main stakeholder and problem owner.

7. CONCLUSIONS

The goal of this project was to provide a solution for the expected parking problems, due to construction works in the Spoorzone Delft 2015-2017. The solution that was aimed for needs to be feasible in a technical, socio-political and economic way.

Three groups of actors are be identified: the contractors that are directly involved in the construction of the project Spoorzone Delft, the users of the parking places and other actors such as the municipality, the BVOW and the shops located in parking area C. When looking at the power and interests of these actors, a research customer: the BVOW, a main stakeholder: residents that use the parking places in the Spoorzone area and a problem owner: a combination of the contractor CCL, ProRail and the Municipality of Delft, are identified. These last three parties have to be managed closely during the project.

It was shown that most of the people parking under the viaduct are licence holders from areas B and C. During the day it has been observed that in the neighbourhoods plenty of parking places are available. This generated the assumption that the commuters, who currently park only during the day under the viaduct, can park in the neighbourhoods. For irregularly visitors it was assumed that they are quite indifferent if they park under the viaduct or in a nearby parking garage. By doing this two assumptions no replacement parking places have to be created for these user groups. Therefore, only the licence holders from areas B and C were investigated as the group of people that is taken into account when calculating the number of parking places that needs to be replaced. Considering the current capacity and the occupation rate it was calculated that 300 of the 505 parking places need to be replaced in 2015.

Analysis of the planning of the developments in the Spoorzone area showed that between 2015 and 2017 a few areas are available for temporary use. Also the analysis of occupation rates of parking garages around the city centre showed that the these garages are in general not fully filled and therefore provide a possibility to take over a part of the parking requests.

During the generation of solutions the translation was made from a large list of 54 means of which the feasibility was unknown to twelve feasible solutions (for which different means could be combined):

- Solution 1. Discount parking the Hovengarage for licence holders
- Solution 2. Discount parking the Hovengarage for licence holders with bicycle
- Solution 3. Discount parking the Hovengarage for licence holders with public transport
- Solution 4. Discount parking Phoenixgarage for licence holders
- Solution 5. Free parking Phoenixgarage for licence holders at night
- Solution 6. Improve attractiveness P+R Nijverheidsplein at night
- Solution 7. Improve attractiveness P+R Nijverheidsplein at night with bicycle
- Solution 8. Increase capacity Hugo de Grootstraat parking lot
- Solution 9. Space at Ambachtsstraat
- Solution 10. Space at Ambachtsstraat with Bicycle
- Solution 11. Space at Ambachtsstraat with public transport

- Solution 12. Limit access of visitors to Phoenixgarage combined with an discount for licence holders (M4+M49)

These solutions were evaluated on five design aspects: environment, functionality, maintenance, technology, construction and implementation. These aspects were translated in concrete criteria: functionality, solution costs, environmental impacts and technical feasibility, which were used to value the quality of solutions in a Multi Criteria Decision Analysis (MCDA) for the problem owner and the main stakeholder.

From the MCDA evaluation, it is concluded that improvement of the attractiveness of the Nijverheidsplein, together with the use of a bicycle, scores the best. The costs of this solution should be investigated to see if they comply with the estimation made in this report. A combination with the use of Phoenixgarage appears attractive from the points of view of both main stakeholder and problem owner. It should be investigated how negotiations between problem owner and Parking B.V. could lower the solution costs and if it could lead to limited access to the Phoenixgarage.

8. POLICY ADVICE

This policy advice is written for the research customer, the resident association BVOW (Belangenvereniging Olofsbuurt-Westerkwartier). In addition to the research customer, two important actor groups have been defined, namely:

- The main stakeholder, residents of the Olofsbuurt-Westerkwartier that use the parking places in the Spoorzone area; even though the research customer is considered to have overlap in power and especially interests, it has been decided to treat the two differently, because they are not the same.
- The problem owner, the combination of CCL, ProRail, and the municipality of Delft, which is regarded as able to influence the parking possibilities in the area.

When the Spoorzone viaduct will be removed, starting in 2015, 505 parking places will be lost due to construction works. As these parking places will be replaced in 2017 by means of a garage below the new Spoorzone, the loss of parking capacity is only temporal. However, two years is a long period to overcome a lack of capacity, considering current parking capacity of the nearby neighbourhoods Olofsbuurt-Westerkwartier cannot compensate for it. Based on counting of parking occupation rates performed by the municipality of Delft in 2012, a parking capacity of 300 parking places is regarded necessary to overcome the problem.

8.1 EVALUATED SOLUTIONS

A list of 54 possible means to overcome the temporal loss of parking capacity has been made. After assessing the feasibility of these means, solutions were distilled. These solutions have been evaluated for multiple criteria that were based on a requirement analysis.

8.1.1 FEASIBLE SOLUTIONS

From the multiple-criteria decision analysis, three solutions may be regarded as positive from the points of view of both main stakeholder and problem owner:

- Solution 7. Improve attractiveness P+R Nijverheidsplein at night with bicycle (M13+M8)
- Solution 6. Improve attractiveness P+R Nijverheidsplein at night (M13)
- Solution 5. Free parking Phoenixgarage for licence holders (M6)

The **attractiveness of the Nijverheidsplein** can be improved by taking **security measures**. Fences, bright lights, and access levers could be used to discourage vandalism and give a feeling of security for the people that leave their car there at night. Another option is to deploy security guards at night. In order to see which measures should be taken at the Nijverheidsplein, it is advised to the research customer to establish a (ranked) list of desired measures. This list should be discussed with the problem owner, to see if additional measures are cost worthy.

An additional measure to improve the attractiveness of the Nijverheidsplein is to **promote the use of the bicycle**. As the Nijverheidsplein is situated further away from the centre of the neighbourhoods Olofsbuurt-Westerkwartier than the Spoorzone parking places, the bicycle appears attractive for reduction of travel time from the Nijverheidsplein to the final destination. Promotion of the mode

bicycle could be done by providing bicycles, for example in a similar way to the PT-bicycle (OV-fiets), but good bicycle parking places might also suffice. In order to determine if PT-bicycles are necessary an opportunity study could be performed.

The **Phoenixgarage** is situated next to the Spoorzone, less than 100 meters away from the neighbourhoods Olofsbuurt-Westerkwartier. The garage has a total capacity of 202 places. The Phoenixgarage is not fully occupied during the entire day, especially at night there is an unoccupied capacity. This capacity is advised to be used to overcome the temporal loss of parking places in the nearby Spoorzone. Licence holders B and C could be granted free access at night, but it is advised to allow a maximum of 100 available parking places.

8.1.2 POSSIBLY FEASIBLE SOLUTIONS

Sensitivity of the MCDA outcome is largest influenced by solution costs. From a practical point of view this means that:

- Solution 10 (Room at Ambachtsstraat with bicycle) becomes more attractive when a cheap (i.e. gravel) or partial solution (i.e. less than 300 parking places) could be executed;
- Solution 12 (Limit access of visitors to Phoenixgarage) could be attractive if the problem owner could initiate a good cooperation with Parking Delft B.V.

8.2 IMPLICATIONS OF EVALUATED SOLUTIONS

For two reasons it could be stated that a combination of solutions is necessary for solving the problem of the temporary loss parking places in the Spoorzone area:

1. The locations of the (highest scoring) feasible solutions are unequally distributed around the neighbourhoods Olofsbuurt-Westerkwartier;
2. The capacity of the separate (high scoring) solutions in only few cases lead to the desired capacity of 300 parking places.

8.2.1 SECURING SPATIAL DISTRIBUTION OF SOLUTIONS

When looking at the spatial distribution of the solutions it can be concluded that most of the solutions are situated south of station Delft and none north of the Olofsbuurt. Around this neighbourhood only infeasible means have been found, such as parking lots that would be too devastating (e.g. means 17, Meeslaan), or too small (e.g. means 18, Ruys de Beerenbrouckstraat). Free parking in the Phoenixgarage (situated halfway the neighbourhoods), therefore is considered a good solution to combine with.

When the locations of the Nijverheidsplein and the Ambachtsstraat are compared, it should be noted that building new parking facilities in the Ambachtsstraat would be rather unwise, when it is not first tried to improve the attractiveness of the nearby Nijverheidsplein.

8.2.2 SECURING NECESSARY PARKING CAPACITY

The solution of Nijverheidsplein offers a parking capacity of approximately 200 parking places, it does not increase the parking costs, and it has an acceptable travel time towards the heart of the

neighbourhoods Olofsbuurt-Westerkwartier. Moreover, it is still possible to provide additional capacity at this location by building a second floor through a mechanical structure. This way the capacity could be extended to 300 parking places. Because of costs and its location however, a combination with the Phoenixgarage seems more appropriate. The 100 parking places in the Phoenixgarage appear especially useful for everyday commuters, which need a parking place at night and are willing to remove their car in the morning. Because the Phoenixgarage has its peak occupation on Saturday, during the weekend an additional solution should be sought for. Saturday the 200 parking places at the Nijverheidsplein might suffice because not all residents are at home. At Sunday night, when it is assumed that all residents are at home, the Phoenixgarage is considered to be useable again.

Regarding the time slots at weekdays, the usability of the Phoenixgarage has been based on the occupation analysis (Section 3.3) and the survey (Section 3.6); 9:00 as latest time of departure seems very plausible. The arrival at night is more difficult. At least 100 places are available from 10:00 on, which is due to an occupation peak between 20:00 and 22:00. This time however does not appear very attractive for everyday commuters. Allowing licence holders to park in the Phoenixgarage from 18:00 (which would prevent a confrontation between daytime users of the garage that leave the garage between 16:00 and 18:00. and commuting residents returning home) would only be possible when access to the Phoenixgarage is limited for visitors during the night. The latter could be done by shifting visitors towards the Zuidpoortgarage.

In above mentioned decisions, negotiation with Parking Delft B.V. is considered essential. Although this research has not clarified the power of this party, it seems likely that the strong relationship with the municipality of Delft could be advantageous in this.

8.3 ADDITIONAL KNOWLEDGE AND RESEARCH

The research customer (and other readers of this report) should take into account that this report has been made for the course TIL5050 at the Delft University of Technology; only a period of three months has been spent on its realization. In general this means that the research has focused on sketching possible solutions by evaluating a list of possible means and (sub-)solutions, rather than designing one final solution. Before implementation of the now proposed solutions, additional information is required in order to sharpen the decision making process. Some remarks should be made on the followed methodology:

- The weights for the MCDA have been determined by pair-wise comparisons. Due to a lack of time, these weights have not explicitly been checked with the particular actors. Checking of these weights could relatively easy be done for the problem owner, who has contributed to this research. For residents from the neighbourhoods Olofsbuurt-Westerkwartier that park in the Spoorzone Delft it might be more difficult, but as the BVOW has several tools to assess the opinion of its fellow residents, it could be done. A direct confirmation on weights could lead to higher trust in the outcome of the now proposed MCDA method.
- In order to determine the effects of each solution for the MCDA, the solutions costs have been assumed in a really rough way. More precise estimations of the costs should be made

in order to come with a more robust ranking of solutions especially for the vision of the problem owner.

- No information was available concerning the precise final destinations (specific address) of the parking users. A household distribution could allow a better calculation of travel times as effect score in the MCDA.
- A household distribution might even give answer to the question to what extent the lack of found feasible solutions at the north side of the neighbourhoods Olofsbuurt-Westerkwartier is troublesome.
- For all environmental sub-criteria, eventually only two effect scores were appointed. Even though the environmental impacts have not been recognised as influential for sensitivity, it could be questioned whether this level of detail is sufficient.

Furthermore it must be noticed that available data, such as the planning of the Spoorzone project is constantly changing. Publications such as the "Voortgangsrapportage over het 3e kwartaal 2013" could be interesting sources for additional, unexpected new means.

As stated above, no final design has been made for this research. Therefore, implementation is touched but not extensively elaborated. For implementation it is advised to involve the concerned actors, in order to prevent resistance.

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APPENDICES

A. PARKING ANALYSIS

This appendix contains some additional information concerning the parking analysis of Delft. The first part will describe the parking policy of Delft. Here inter alia information can be found on the way of payment. The second part of this appendix includes information of the parking garages around the city centre. This contains general information of the garages and an analysis on the utilization of the garages.

A.1 PARKING REGULATIONS IN THE CITY OF DELFT

In a large area in and around the city centre of Delft paid parking has been introduced. This appendix provides more detailed information on the way this is organized.

For each of the seven parking areas a detailed map is available where for each street is indicated if parking is allowed for licence holders' only or mixed parking is possible. When a mixed parking regime is maintained, licence holders can park, but also non licence holders can park there by buying a parking ticket. Figure 23 below shows an example of such a map for parking area C, the area of interest for this analysis.

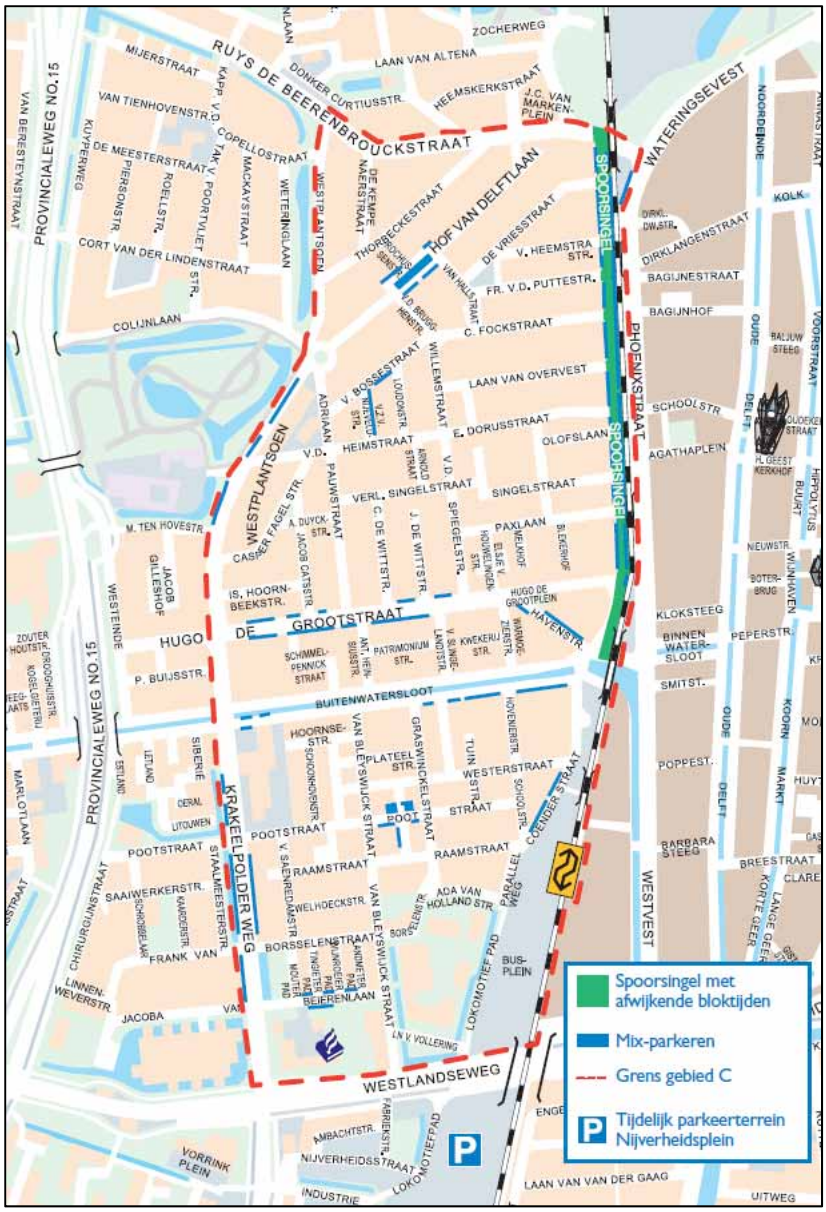

FIGURE 23: DETAILED MAP OF PARKING AREA C (GEMEENTE DELFT, 2013A)

In Figure 23, it can be seen that nearly all streets are reserved for licence holders besides the Spoorsingel, Hugo de Grootstraat, Hof van Delftlaan and some additional small areas which are mixed parking. These areas are in general located around locations of shops. In mixed zones in area C paid parking is from Monday until Saturday from 12:00 to 24:00. The Spoorsingel is different; here it is Monday until Saturday from 10:00 to 24:00 and also on Sunday from 12:00 to 18:00.

Above the possibility of buying a parking licence was mentioned. There are several types of licences each with their own restrictions. There are 7 day licences (for both companies and residents) and 5 day licences (companies only). For both companies and residents it is possible to buy an additional visitors card. Also there is the possibility for companies to buy scratch cards. In Table 24 all available parking permits that can be used in the Spoorzone area are explained for area B and C.

TABLE 24: OVERVIEW OF ALL AVAILABLE PARKING PERMITS

Parking permit	Area B		Area C	
	Residents	**Company**	**Residents**	**Company**
7 pass days available	Yes	Yes *	Yes	Yes**
5 pass days available	No	Yes	No	No
Scratch cards available	No	Yes ***	No	No
Visitors pass available	With disk for 3 hours		With disk for 4 hours	

*Maximum two licenses per company

**Maximum two licenses and one visitor card or two visitor cards and one licence per company

***With a scratch card (6 euro each) you can park at both a licence holder place and a mixed parking place for one day part, three different day parts are distinguished: 10:00 to 14:00, 13:00 to 18:00 and 17:00 to 22:00.

Since the first of November 2010 a new zone is defined on the border of area B and C: the Spoorzone area (Spoorzone Delft, 2013d). For this zone currently no specific licences are available, it is only a mixed parking zone in the area situated along the Spoorsingel where parking is allowed for licence holders of area B and C. Additional to the Spoorsingel this area also consists of the Phoenixstraat, de Westvest en de Wateringsevest.

Another special area which is not on the map above is the Nijverheidsplein. It is situated just south of the central station and on this parking lot also both licence B as licence C are accepted.

A.2 ANALYSIS OF THE UTILISATION OF PARKING GARAGES AROUND THE CITY CENTRE

As described in Section 2.3 three large parking garages are located on the edge of the city centre. The Phoenixgarage, at the west side of the city centre has a capacity of 202 places. The Zuidpoortgarage at the south side of the city centre has a capacity of 810 places. And at the east side of the city centre there is the Marktgarage consisting of 332 places. These garages might take over some parking demand when the parking places under the viaduct will be removed. Therefore it is useful to see to which extend this is possible. To get more insight in this it is necessary to see what the utilisation of these garages is now divided over the time of day. On the website of Parking Delft (www.parkingdelft.nl) it is possible to view at any time the free places left in each of the garages. With this information it is possible to compute the utilisation rate.

On a total of five days each hour the utilisation rates are computed for each of the three garages.

- Wednesday 13 November: from 8:00 to 24:00 with missing values for 18:00, 19:00 and 20:00 (Figure 24)
- Thursday 14 November: from 8:00 to 24:00 with missing values for 18:00, 19:00 and 20:00 (Figure 25)
- Wednesday 20 November: from 10:00 to 24:00 (Figure 26)
- Thursday 21 November: from 10:00 to 24:00 (Figure 27)
- Saturday 7 December from 10:00 to 24:00 (Figure 28)

It was chosen to analyse a normal weekday: Wednesday, the day with the Market: Thursday and the busiest day in the weekend: Saturday. Because of the missing values on Wednesday the 13th and Thursday the 14th two additional days were analysed: Wednesday the 20th and Thursday the 21st.

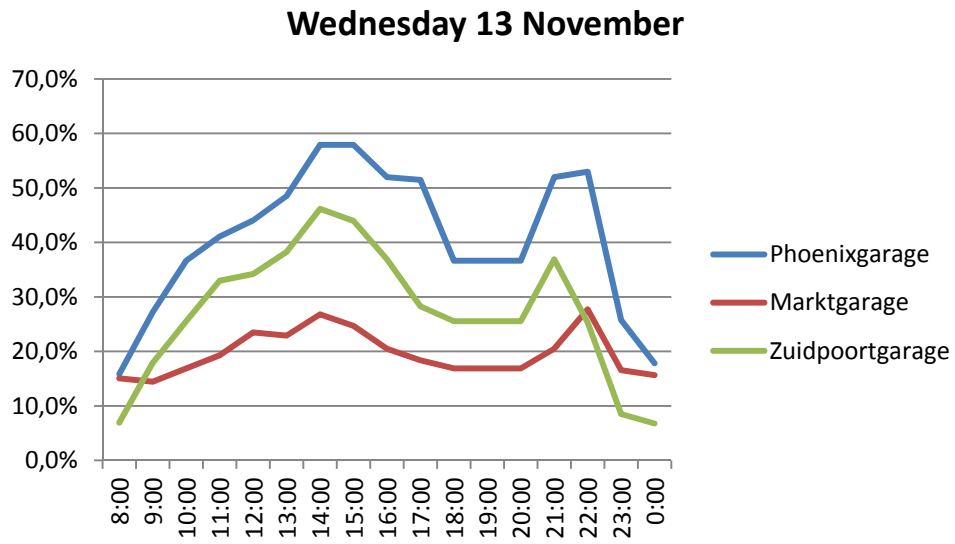

FIGURE 24: UTILISATION PARKING GARAGES WEDNESDAY 13 NOVEMBER

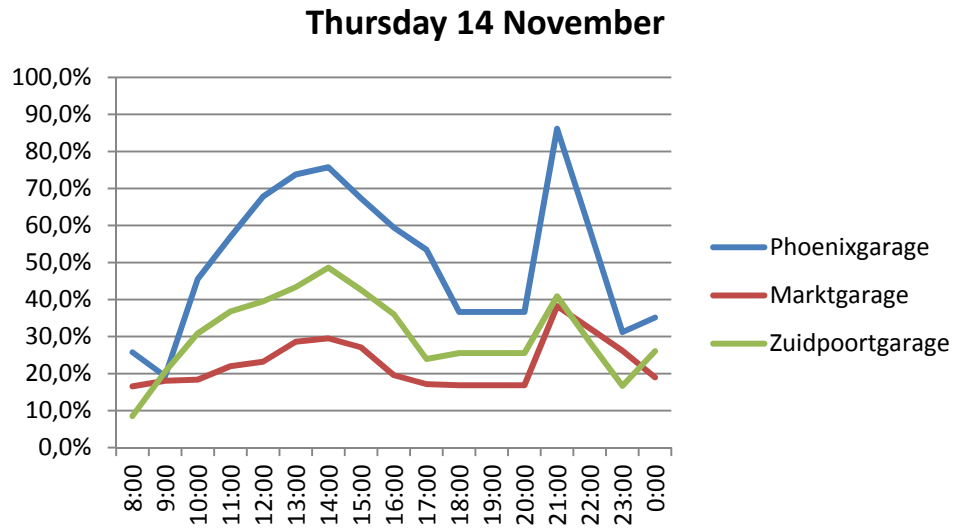

FIGURE 25: UTILISATION PARKING GARAGES THURSDAY 14 NOVEMBER

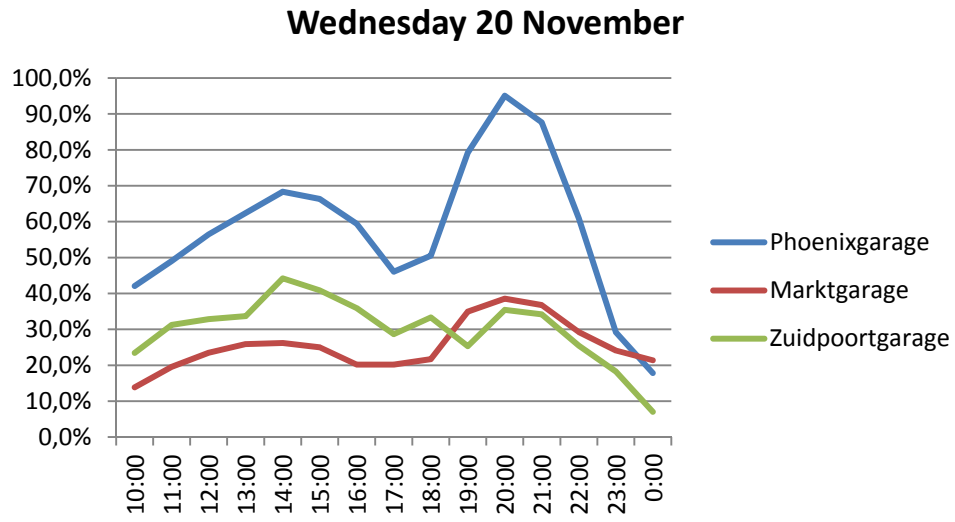

FIGURE 26: UTILISATION PARKING GARAGES WEDNESDAY 20 NOVEMBER

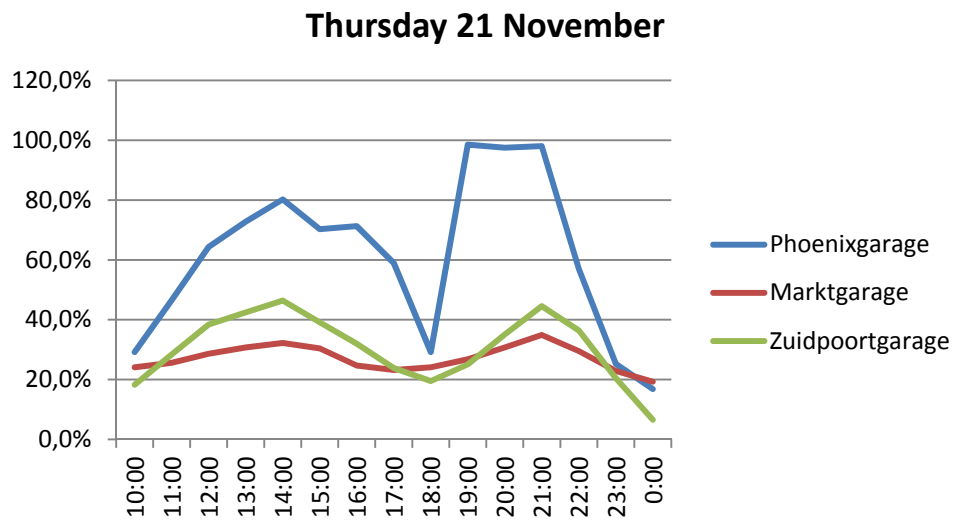

FIGURE 27: UTILISATION PARKING GARAGES THURSDAY 21 NOVEMBER

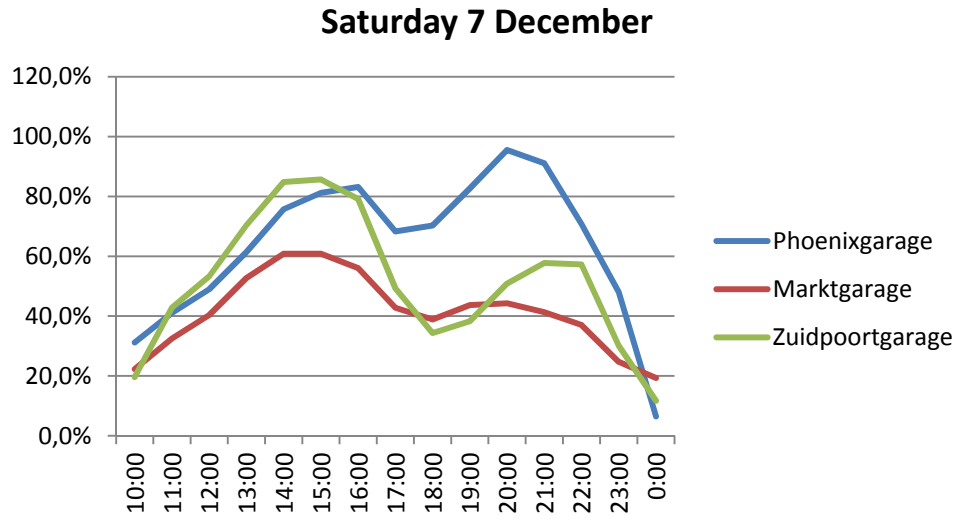

FIGURE 28: UTILISATION PARKING GARAGES SATURDAY 7 DEDEMBER

B. ACTOR ANALYSIS

This appendix will look at the different actors involved in the problem of removing the parking spots at the Spoorzone. Section 2.2 already stated the concerned actors. In this appendix some more background information of the actors can be found. To get to know the interests of the actors and other relevant information to this project Table 25 has been made. This table shows on a clear way the most important information about the actors, regarding the removal of the parking places at the Spoorzone and Spoorsingel, see Table 25.

The wanted situation of the actors as stated in Table 25 is the situation that is best for them, concerning their main interests. This might not always directly be related to the parking at the Spoorzone and/or parking area C. Based on the ideal situation for the actors, the current situation is analysed and a solution on how the ideal situation can be achieved is given.

TABLE 25: ACTOR ANALYSIS

Actor	Interests	Position	Important resources	Wanted situation	Current situation	Solutions
OBS	Oversees the work of its direct subcontractors and has some projects on its own.	The Spoorzone project needs to go as smooth as possible and needs to execute the made agreements.	Is an overarching organization of the Spoorzone Delft, ProRail, Combinatie CrommeLijn and municipality of Delft concerning the Spoonzone project (Spoorzone Delft, 2013f).	All made agreements with stakeholders are executed on a proper way and on time, concerning spatial development and bottlenecks for public transport. Also having a healthy financial status.	For the parking spots that will be removed in the future a solution is not yet presented. Delays have occurred in the preparation and the shifting of cables and pipelines. Planned is that in 2015 the train traffic will be underground.	A compliance of the made agreement about compensating the removed parking spots.
ProRail	To have a safe and efficient railway network within the Netherlands with enough capacity.	Is responsible for constructing the tunnel and other construction work, which is been tendered to CCL.	ProRail can lobby at the national government. They have a lot of knowledge about rail maintenance and can communicate to the transport users of the railway.	No delays during the construction work. A safe construction of the tunnel and the other construction work. Fast construction of the tunnels, so the trains can ride underground. Good communication between the actors involved in the Spoorzone Project	There are a few delays, but overall the planning goes well. There is good collaboration and communication between the actors of the Spoorzone Project.	Keep the collaboration between the Spoorzone actors good and have good communication between each other.
CCL	Responsible for completing the construction work for the underground	The construction work needs to be done in a safe and efficient way.	ProRail tendered the construction work to CCL. CCL enables various subcontractors for	The only concern is on the main focus, namely the construction of the underground	Next to the main focus there are also other focusses like replacing parking spots. There is a good	Wants to focus on the main task (building the Spoorzone Delft project) without

	Spoorzone Project in time.		specialized work. CCL consists of the companies; Mobilis BV, Dura Verkeer Groep NV and contractor company CFE NV.	Spoorzone Project and a good communication with the actors involved in the Spoorzone Project.	collaboration between the actors of the Spoorzone Project.	having a lot of extra tasks.
Municipality of Delft	Good vitality of the city (safe, accessible and nice living environment for the inhabitants, companies and visitors).	The neighbourhoods of Delft need to be accessible. Both the construction work and the residents need to come to a consensus.	Has an important role between the contractor and stakeholders. It is an important chain between the communications of these parties. Sets requirements.	The Spoorzone Delft will be constructed according to the schedule. The accessibility and enough parking spots will remain for the neighbourhoods.	It is not clear if the amount of parking spots is enough during the construction works. Also the implications for the neighbourhoods Olofsbuurt-Westerkwartier are unclear.	Extra parking spots will be created for both the residents, commuters and other visitors of Delft. The neighbourhoods will not experience a negative effect of the extra created parking spots/cars in the streets.
BVOW	Having a good living environment for the neighbourhoods Olofsbuurt-Westkwartier, concerned about the tariffs of the parking licence and the developments of the Spoorzone Delft.	Want to participate in the process of finding replacement parking spots. The BVOW will help searching for a solution, but will be against solutions that lead to fewer parking spots. If new parking spots will be created at places that have currently a	Communication to the residents of Olofsbuurt-Westerkwartier. Can lobby against plans. Can complain at the municipality of Delft.	Find immediately a parking spot close to their home and cheap parking licences. An attractive and safe neighbourhood. Only residents or visitors of residents can park in the neighbourhood.	The plans are yet not known for the places of replacement of the parking places. The Nijverheidsplein is a place that is designated as replacement. The occupation rate of the parking spots in the neighbourhoods is already high.	More parking spots only for residents in the neighbourhood and fewer other visitors. And lowering the prices of parking licences.

		recreational function they will also disagree.				
Residents of parking area C (that use the parking area at the Spoorzone)	Having a good living environment, concerned about the tariffs of the parking licence and the developments of the Spoorzone Delft and city centre.	Wants to be involved in the process of finding replacement parking spots.	Can complain at the municipality of Delft.	Have parking area close to their homes where they immediately can find a parking spot. Cheap parking licences. An attractive and safe neighbourhood.	The plans are yet not known for the places of replacement of the parking places. The Nijverheidsplein is a place that is designated as replacement. There are not a lot of parking facilities in the city centre for residents.	More parking spots close to the car owned residents in the neighbourhoods Olofsbuurt-Westkwartier, especially residents living close to the city centre side of the neighbourhoods. And lowering the prices of parking licences.
Residents of parking area B (that use the parking area at the Spoorzone)	Having a good living environment, concerned about the tariffs of the parking licence and the developments of the Spoorzone Delft and city centre.	Wants to be involved in the process of finding replacement parking spots.	Can complain at the municipality of Delft.	Have parking area close to their homes where they immediately can find a parking spot. Cheap parking licences. An attractive and safe neighbourhood.	The plans are yet not known for the places of replacement of the parking places. The Nijverheidsplein is a place that is designated as replacement. There are not a lot of parking facilities in the city centre for residents.	More parking spots close to the car owned residents in the city centre. And lowering the prices of parking licences.

Commuters	Having a nice and accessible working place/environment.	Will be against solutions that will lead to long (walking) distances to their work.	The companies will support the commuters in a good solution for the replacement of parking spots.	Immediately finding a parking spot that is close to their work without paying for it.	The Nijverheidsplein is one of the places designated as replacement. Further places are not yet known.	More parking places close to the companies/working area. And let companies pay for the licences.
Irregularly visitors	Have a nice time visiting Delft city or relatives/friends. Having a comfortable visit to the shops in the area Olofsbuurt-Westerkwartier	Will park as close and cheap as possible to their final destination.	They can lobby against plans that are undesired.	Immediately finding a cheap parking spot close to their final destination, e.g. visiting or city centre or visit relatives/friends.	The Nijverheidsplein is one of the places designated as replacement, as the parking garages at the edge of the city centre. Further places are not yet known.	More parking places in the neighbourhoods and nearby/in the city centre and lowering the prices.
Shops in parking area C	An attractive and accessible shop(location)	They will lobby against situations that will lead to lower customer satisfaction and encourage situations that lead to higher accessibility.	A large part of interests of the residents and shops correspond with each other. They can lobby for the same interests.	Have a lot of parking spots close to the shops. Have enough space to (un)load trucks in front/at the back of the shop.	There are not a lot of parking spots close to the shops and also not a lot of space for (un)loading trucks.	More space for unloading and more parking spots in the street of the shops.

CONCLUSION ACTOR ANALYSIS

To be able to implement an effective strategy one should incorporate the point of views of the stakeholders towards the problem and policy (Enserink et al., 2010). The points of views of the actors concerned by the parking problem have been investigated in the preceding table (Table 25).

To conclude this actor analysis, an overview of the interest and power of the actors is given in Table 26. The interest and power of the actor can be high, neutral or low. In this case almost all actors have a high interest.

Actor	Interest	Power
OBS	High	Low
ProRail	High	High
CCL	High	High
Municipality of Delft	High	High
BVOW	High	Low
Residents of area C	High	Low
Residents area B	Low	Low
Commuters	High	High
Irregularly visitors	Low	Low

TABLE 26: OVERVIEW OF POWER AND INTEREST OF THE ACTORS

The residents of area B and irregularly are not strongly connected to this parking area and can easily park on other places. Concluded from the survey can be that not a lot of them park at the concerned problem area. In contrary to residents from area C, these are the biggest user group of the parking area at the Spoorzone. Residents from area C have a higher interest, since the neighbourhoods they live in has already a high occupation rate at their parking spots. The irregular visitors have not much influence to participate in this problem. The key-actors are the municipality, ProRail, CCL and the commuters, since they can lobby at their company.

C. SURVEY AND RESULTS

In this appendix the setup and the results of the survey are discussed. Based on the survey the users of the Spoorzone parking area are defined. This appendix is a more elaborated version of Section 3.6 in the text. The design of the survey, the window screen note, the survey questions and the results of the survey will be discussed.

C.1 DESIGN OF THE SURVEY

To come up with a suitable solution for the future parking problem more information of the users of the Spoorsingel and Spoorzone parking zone is needed. To obtain this information a survey has been initiated by use of an online survey. This online survey has been chosen rather than direct interview on the site, because it was considered that people will not have time to answer questions on site, as people are often in a hurry. Another reason was because this solution was less time consuming for the team.

The survey has been set up by distributing notes below the window screens of the cars parked in the Spoorzone area, thus the places that will be removed. The notes were in Dutch and included a small text of the current and future situation. Next to this the receiver was asked to fill in an online survey, the link was stated at the window screen paper. In Appendix C2 the window screen paper can be found. Due to the limited of time for distributing the survey we hoped to approach several user groups like residents and people who come to shop. The papers were distributed on the following days:

- Wednesday 27th of November in the late afternoon from 16h30 to 17h30 in order to have answer from people working in Delft city centre and parking there during the day, but also people visiting the city centre in the afternoon.
- Wednesday 27th of November during the night from 22h50 to 23h30, in order to have answers of inhabitants that park there at night.
- Thursday 5th or December 10h30 to have response from people parking there during the day to go to the market or to achieve other activities during the day.
- Saturday 7th of December 13h to approach the people that park in during the weekend at the Spoorzone, or go shopping on Saturday in the city centre.

The survey was in Dutch, since assumed was that most of the people who parked there would be Dutch. The survey questions can be found in Appendix C.3. There are three different categories distinguished in the survey; the first group is the group that has the final destination city centre, the second group Olofsbuurt-Westerkwartier (neighbourhoods), and a third group was different than one of those two destinations.

C.2 THE WINDOW SCREEN NOTE

Parkeeronderzoek Spoorzone door de TU Delft

Beste autobezitter,

Zoals u misschien al weet zal, wanneer het spoorviaduct wordt gesloopt, de parkeerplaats waar u nu geparkeerd staat verdwijnen. Er komt een parkeergarage, maar die is niet meteen beschikbaar; wat moet er in de tussentijd gebeuren? Bij de Technische Universiteit Delft wordt gewerkt aan een oplossing, maar zij kan daarbij niet zonder de hulp van u, de parkeerder. Met het invullen van een zeer korte digitale enquête (anoniem) zou u in 2 minuten kunnen helpen om uzelf een aantrekkelijk parkeeralternatief te bieden.

De enquête is te vinden op: www.thesistools.nl/delft

U kunt ons bereiken via: parkerenspoorzone@gmail.com

C.3 SURVEY QUESTIONS (DUTCH)

Vanuit de TU Delft doen wij onderzoek naar de huidige parkeermogelijkheden aan de Spoorsingel. Binnen twee jaar worden deze parkeerplaatsen verwijderd als gevolg van de sloop van het viaduct. Dit betekent dat er vervangende parkeerruimte moet worden gevonden. Op dit moment is het nog onduidelijk waar dit mogelijk is. Daarom willen wij hiervoor een oplossing bedenken. Om dit te doen hebben wij uw informatie nodig. Hopelijk kunnen we tijdens ons project een oplossing verzinnen die ook u kunt helpen.

1. WAT IS MEESTAL UW EINDBESTEMMING?
- Binnenstad (A)
- Olofsbuurt-Westerkwartier (wijk aan de andere kant van het spoor) (B)
- Anders (C)

2. A. WAAROM PARKEERT U MEESTAL OP DEZE LOCATIE?
- U woont in de binnenstad
- U werkt in de binnenstad
- U gaat winkelen
- U gaat naar de Markt
- U gaat naar een restaurant/café
- U gaat vrienden bezoeken in de binnenstad
- Anders

B. WAAROM PARKEERT U MEESTAL OP DEZE LOCATIE?
- U woont in de wijk
- U werkt in de wijk
- U gaat winkelen in de wijk
- U gaat vrienden bezoeken in de wijk

3. HOE VAAK PARKEERT U HIER?
- Minder dan 1 keer per jaar
- Minder dan 1 keer per maand
- Minder dan 1 keer per week
- Wekelijks

4. OP WELKE DAGEN PARKEERT U HIER?
- Maandag
- Dinsdag
- Woensdag
- Donderdag
- Vrijdag
- Zaterdag
- Zondag

5. WELKE PERIODE PARKEERT U HIER? VOOR HOELANG?
- Van … h tot … h

6. A. HOE BETAALT U?

- Parkeervergunning B (wonen)
- Parkeervergunning B (werken)
- Bezoekerskaart B
- Parkeerticket
- Telefoon
- Ik parkeer alleen wanneer het gratis is
- Anders

B. HOE BETAALT U?

- Parkeervergunning C (wonen)
- Parkeervergunning C (werken)
- Bezoekerskaart C
- Parkeerticket
- Telefoon
- Ik parkeer alleen wanneer het gratis is
- Anders

C. HOE BETAALT U?

- Parkeervergunning B (wonen)
- Parkeervergunning C (wonen)
- Parkeervergunning B (werken)
- Parkeervergunning C (werken)
- Bezoekerskaart B
- Bezoekerskaart C
- Parkeerticket
- Telefoon
- Ik parkeer alleen wanneer het gratis is
- Anders

7. HEEFT U AANVULLENDE OPMERKINGEN? WAT ZOU IN UW OGEN DE BESTE OPLOSSING ZIJN VOOR DIT PROBLEEM?

Bedankt voor uw tijd. Wij gaan ons best doen om een oplossing te verzinnen die ook u kunt helpen!

C.4 RESULTS AND EVALUATION OF THE SURVEY

After the data of the survey was obtained some difficulties occurred. At the question about people's destination, some respondents filled in the street name or another place in the city centre or neighbourhoods. Therefore, these respondents came in another group for answering the questions (group of others). When their final destination was the city centre or neighbourhood, this was changed and the answers were copied to the right group.

After one day it had shown that at the question about frequency the answer possibility of *daily* was not available. This answer was immediately added, but after all data was obtained it seemed that it was still not available for the respondents. Afterwards it was clear that adding an extra answer possibility, only saving was not enough. The survey had to be republished. Luckily a lot of respondents had answered weekly or other with extra addition that they park there daily. For the analysis of the survey an extra level of the attribute frequency was added; *daily*. Some respondents have indicated that they park daily at the Spoorzone/Spoorsingel, but no assumption can be made that all respondents have done this. It could be that respondents only answered weekly and not have indicated that they park daily at the area. An example can be seen at the outcome of the survey from residents at the neighbourhoods. Of these residents 44% parks here weekly, this can signify two things; the level weekly was missing and respondents answered weekly but they meant daily. It could also mean that they sometimes park at the area when they cannot find a parking spot at the street they live in. Another concerning point is that the level of the attribute *several times a week* is not included in the survey, e.g. 2-3 times a week or 4-5 times a week. Expected is that those people have indicated to park weekly in the concerned area.

For the outcome of the indication on which days people park at the Spoorzone/Spooringel no conclusions can be drawn. Most of the respondents have indicated to park here all the days of the week, even if they have indicated to park less than one time a week. Assumed is that the respondents do not park on a fixed day of the week, but depending on the situation park at different days of the week. This is the reason why this data is not included in the results, since it is not useful.

As can be seen in the survey here is a very high response of residential licence holders (mostly for the neighbourhoods). Expected is that those users see the value of answering the survey questions because it concerns their living area. As expected on forehand almost no irregular/one time visitors (that pay with a ticket) have responded. Assumed is that these people do not see a problem in removing the parking spots. When the parking places will be removed they will search for another location to park.

Below the results of the survey are shown in several graphs.

FINAL DESTINATION

In the graph below the final destination of the respondents can be seen. Most of the respondents have the neighbourhoods as final destination. As already stated above, some respondents answered *other* and then filled in a street or certain area of the neighbourhoods. We have changed these answers to the right respondent group.

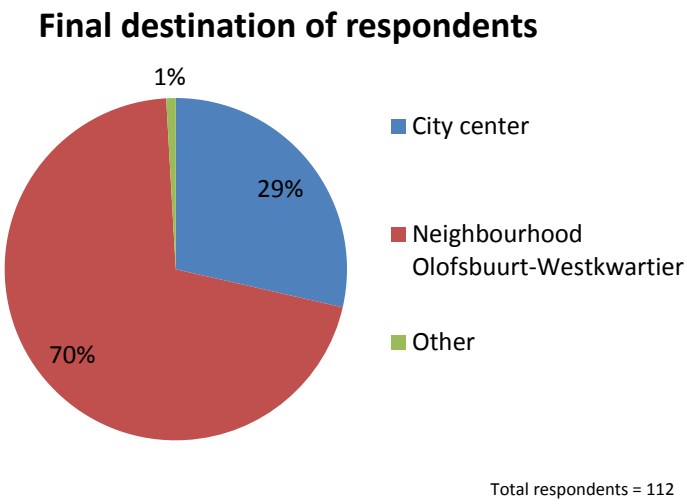

FIGURE 29: GRAPH OF FINAL DESTINATIONS OF RESPONDENTS

PAYMENT

Below three graphs can be seen concerning the payment of the respondents. The first graph shows the payment of all respondents. Most of the payments of the users of the parking spots have an inhabitant licence for the neighbourhoods. This makes sense because most of the respondents (82%) have an inhabitant licence city centre or neighbourhoods. Also the way of payment per final destination (city centre or neighbourhoods) is shown.

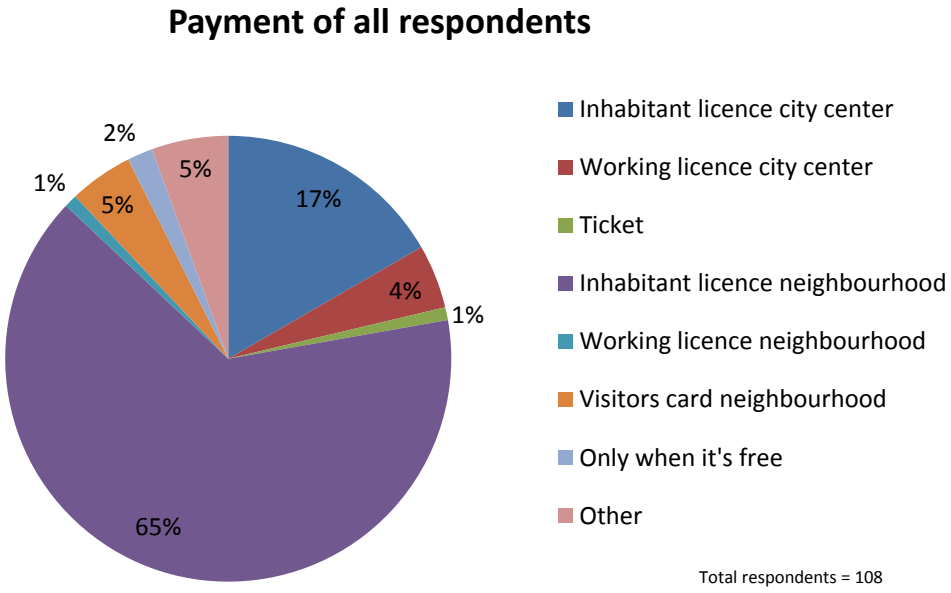

FIGURE 30: GRAPH OF PAYMENT OF ALL RESPONDENTS

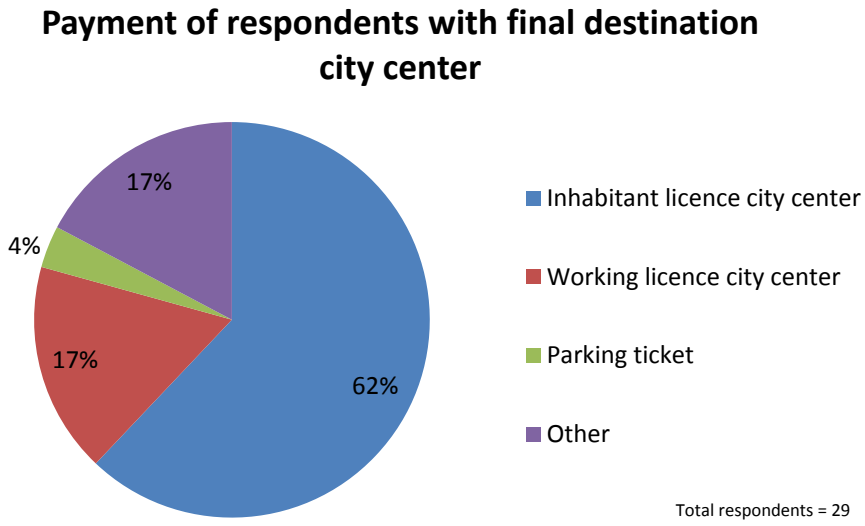

FIGURE 31: GRAPH PAYMENT WITH FINAL DESTINATION CITY CENTER

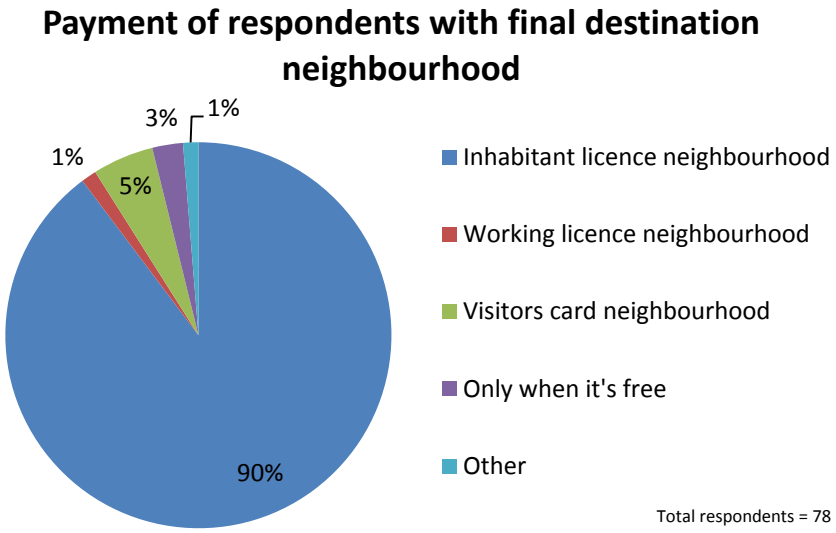

FIGURE 32: GRAPH OF PAYMENT WITH FINAL DESTINATION NEIGHBOURHOODS

FREQUENCY

Next to the payment of the respondents also the frequency how often they park at the Spoorzone/Spoorsingel is investigated. Below several graphs can be seen. Only for the people with inhabitant licence neighbourhoods the graph is also made, since this is the only response group that had quite some respondents (70 of 116 respondents). The other group had fewer respondents, this would give not any information conclusions can be drawn from. As already stated above, some problems have occurred. At first, the answer possibility *daily* was not included in the survey. The respondents who have indicated that they park daily are included in this group, but expected is that a lot of respondents who are now in weekly also park daily at the concerned area.

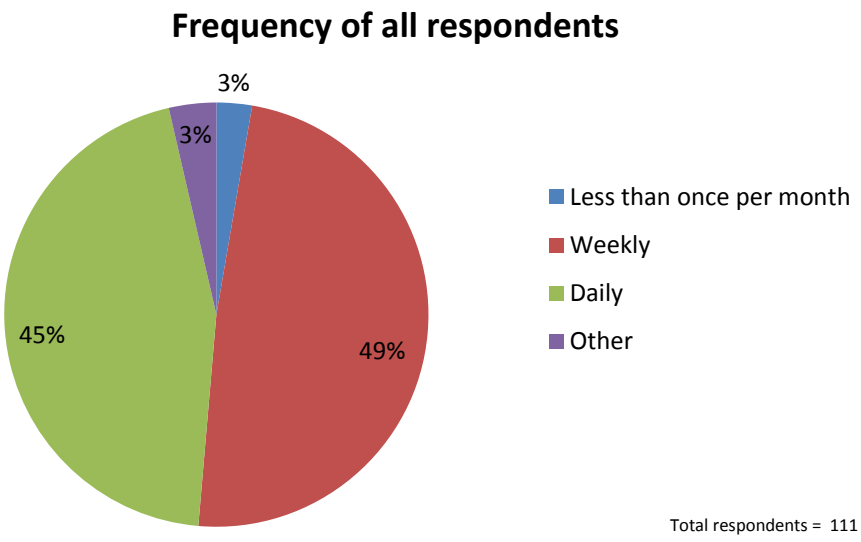

FIGURE 33: PARKING FREQUENCY ALL RESPONDENTS

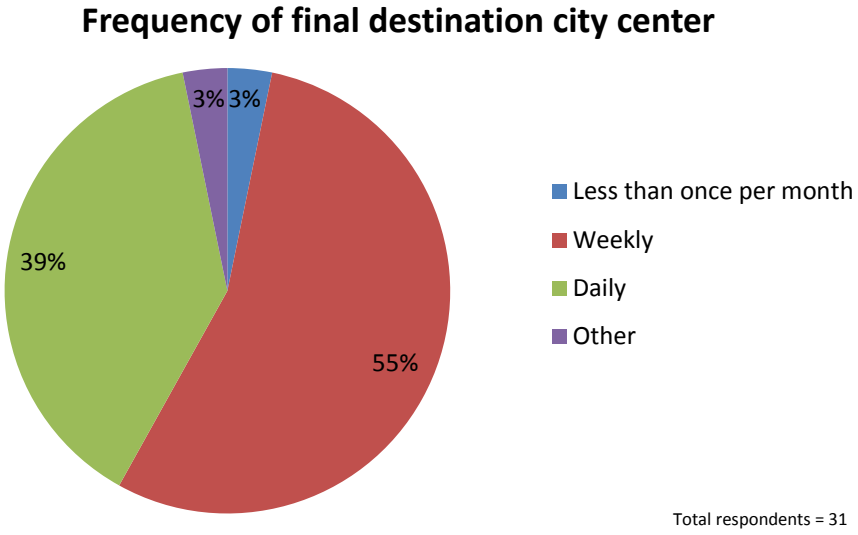

FIGURE 34: PARKING FREQUENCY WITH DESTINATION CITY CENTER

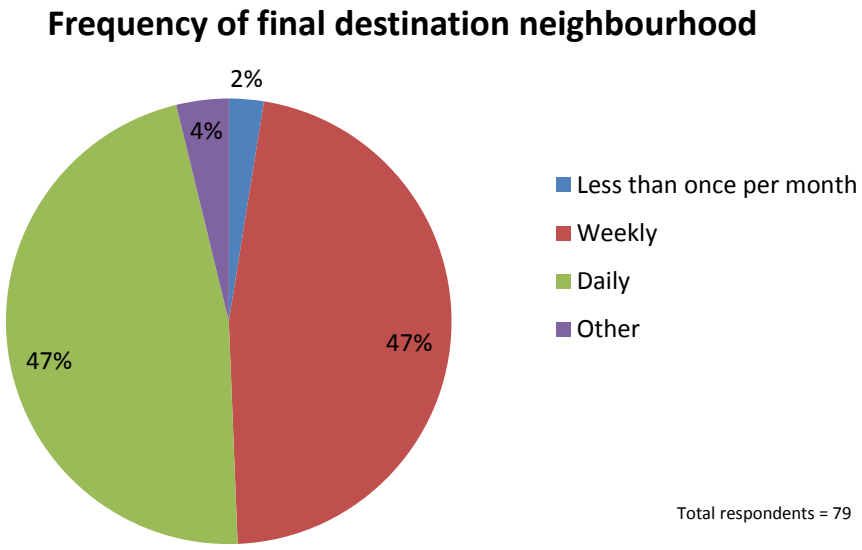

FIGURE 35: PARKING FREQUENCY WITH DESTINATION NEIGHBOURHOODS

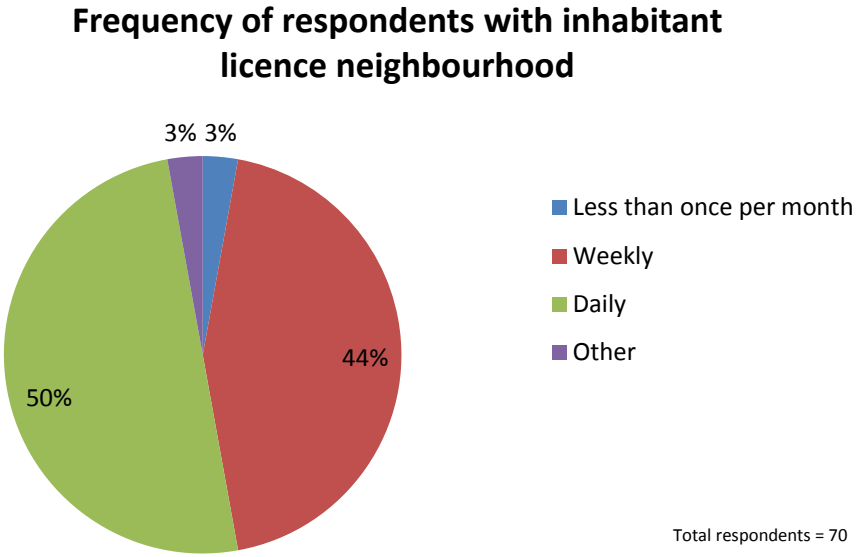

FIGURE 36: PARKING FREQUENCY INHABITANT LICENCE OF AREA C

ARRIVAL AND DEPARTURE

The departure and arrival times are stated in Figure 37 and Figure 38. A small pattern can be seen, that in the morning a lot or residents depart from the parking area and arrive in the late afternoon/evening. As can be seen some people park at the area from 0:00 or in the middle of the night and some leave at 24:00. It can be that the question was misunderstood, since the day starts at 0:00, or that people do not use the car to travel to their work and only use it for other purposes.

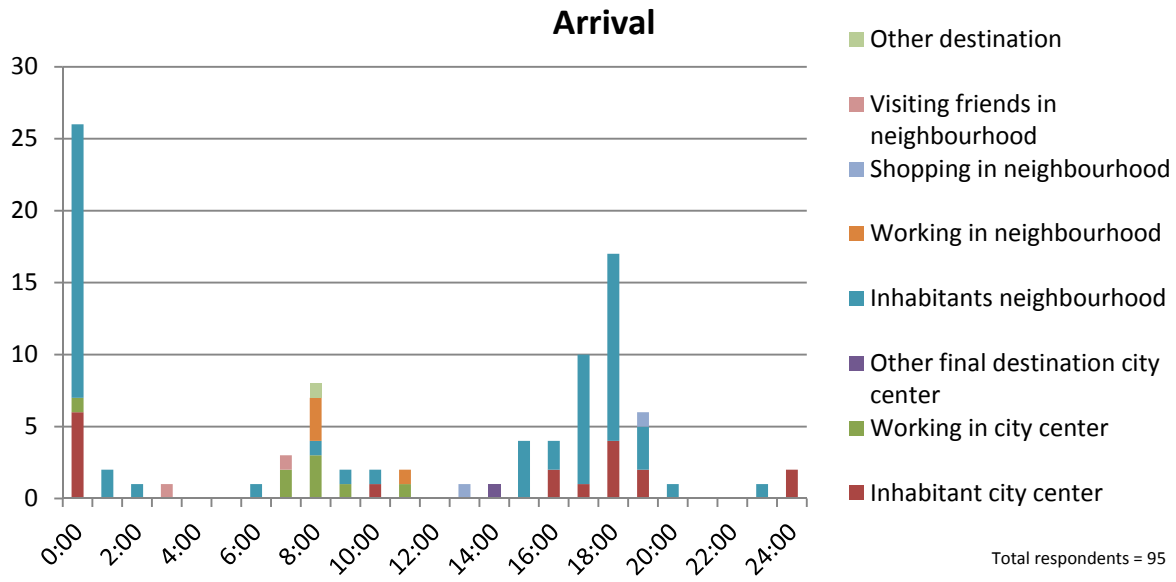

FIGURE 37: ARRIVAL PATTERNS OF ALL RESPONDENTS

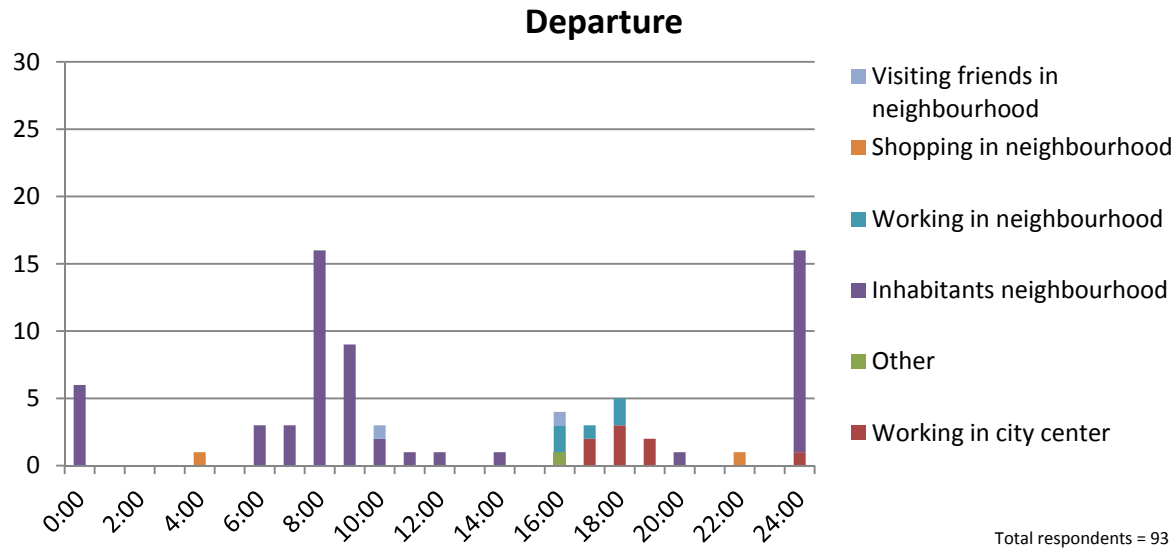

FIGURE 38: DEPATURE PATTERNS OF ALL RESPONDENTS

In Figure 39 below only the respondents with an inhabitant licence are included, both for the city centre and neighbourhoods. The total number of respondents was 85. Expected was that those people will depart in the morning to go to work and arrive at the late afternoon/begin evening. As can be seen in the graph the expectation was right, but not for all respondents. For the commuters this kind of graph was not possible, since only six respondents have a working licence. The same holds for the other groups, the number of responses is too low to make a graph only of these groups.

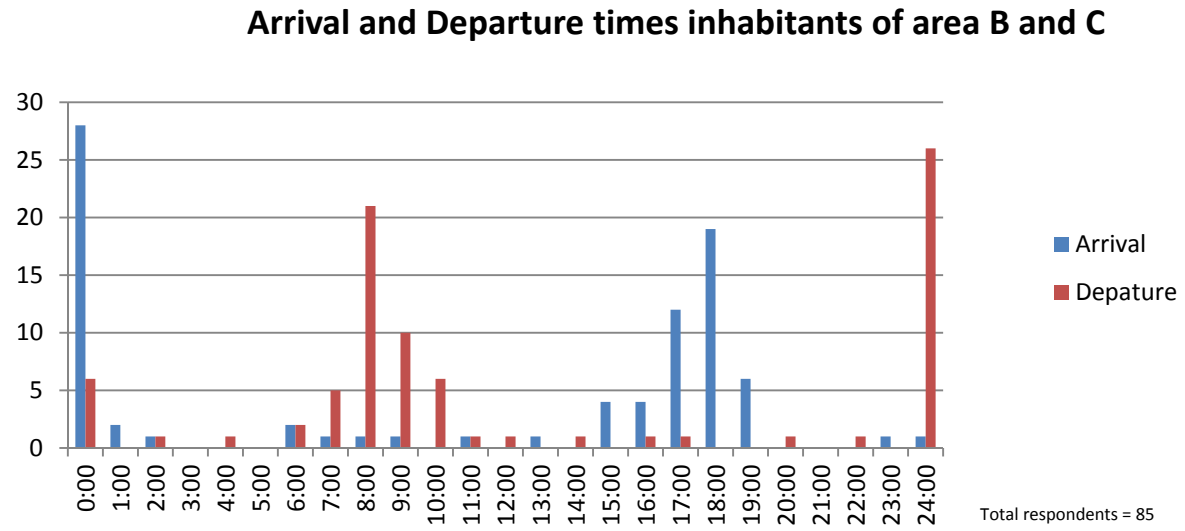

FIGURE 39: ARRIVAL AND DEPARTURE PATTERNS INHABITANTS' AREA B AND C

D. MEANS

This appendix give insight and how many people proposed each means in the survey. In the second part, the description of all the means can be found, together with an explanation on the scores in the brainstorm evaluation. The means are classified according to the means-end diagram.

D.1 MEANS PROPOSED BY SURVEY

TABLE 27: MEANS PROPOSED BY SURVEY

	Proposed means	Proposed (x)
1	Park on the building site	10
	Demolish the viaduct in phases	3
	On top of second tunnel	7
2	Park in the parking garages	9
	Additional payment for licence holders	6
	Free accessible with licence	1
	Make Phoenixgarage only accessible for inhabitants	2
3	Build/create new parking place in neighbourhoods	7
	Ruys de Beerenbroucklaan	1
	Double parking garage at Hugo de Groot	1
	Agathaplein/Hoogheemraadschap	1
	Agnetapark	1
4	New parking possibilities outside the neighbourhoods	4
5	Parking in the entire city of Delft allowed	3
	In combination with licence	1
	In combination with free PT	2
6	New parking possibilities in neighbourhoods	3
	Parking places in 90 degrees	1
	Double parking/sidewalk parking	2
7	Only allow inhabitants with a licence in the neighbourhoods	3
8	Make a B licence usable for area C (during work hours)	2
9	Create parking places at Bacinol	1
10	Do not demolish the viaduct but make a city park	1
11	Limit licences for inhabitants	1
12	Car-sharing	1
13	Parking in time frames	1
14	Allow parking at Oude Delft	1
15	Dedicated parking place for each house	1

D.2 Description of means

Category 1. Improve utilization of current parking places nearby the Spoorzone

Means 1. Introduce time slots for all parking users

A better utilization rate of the current parking places could be achieved by introducing time slots for different types of parking users. Distinction could be made between licence holders B and C, visitors of the neighbourhoods, and visitors of the city centre. Residents could be allowed to park during the entire day, while visitors could only be allowed at specific times.

This solution does not make it through this (brainstorm) evaluation round. Introducing time slots for all parking users does not trouble the construction plans of the Spoorzone, but there are doubts whether the implementation of this solution can be finished before 2015. Another weakness is that this solution will make other solutions impossible, without solving the entire problem.

Means 2. Introduce time slots for different types of licence holders

A better utilization rate of the current parking places could be achieved by introducing time slots for different types of licence holders. At night the time slots could be reserved for residents of the neighbourhoods (licence holders C), while during the day the parking places could be made available for licence holders B as well. The turnaround time of the slots could be chosen based on the return of commuters from the neighbourhoods, for instance at 18:00.

This solution does not make it through this (brainstorm) evaluation round. Introducing time slots for all parking users does not trouble the construction plans of the Spoorzone, but there are doubts whether the implementation of this solution can be finished before 2015. Another weakness is that this solution will make other solutions impossible, without solving the entire problem.

Means 3. Discount parking the Hovengarage for licence holders

The Hoven shopping area is situated at a distance of less than 1 kilometre from the neighbourhoods Olofsbuurt-Westerkwartier. It has a parking garage with a capacity of 550 parking places (Parkeerlijn, 2014b). Of these 550 places it is assumed 200 are available for usage. A discount for licence holders from area B and C could turn this garage into an interesting alternative for residents of the neighbourhoods Olofsbuurt-Westerkwartier.

This solution fulfils all the criteria for the brainstorm evaluation. It will be evaluated in a Multiple-Criteria Decision Analysis.

Means 4. Discount parking Phoenixgarage for licence holders

The Phoenixgarage is situated next to the Spoorzone, less than 100 meters away from the neighbourhoods Olofsbuurt-Westerkwartier. The garage has a capacity of 202 places. Based on the occupation rate it is assumed that this solution can provide 110 parking places. Allowing residents to park in the garage for a lower price than the normal tariff would improve the attractiveness of the garage. This way, residents might consider the nearby garage as an alternative for parking places in the Spoorzone. Both licence holders B and C could be provided with the discount.

This solution fulfils all the criteria for the brainstorm evaluation. It will be evaluated in a Multiple-Criteria Decision Analysis.

MEANS 5. FREE PARKING THE HOVENGARAGE FOR LICENCE HOLDERS

Instead of providing discount for licence holders B and C, the Hovengarage could be made freely accessible for licence holders B and C. This way the garage could become even more interesting for residents of the neighbourhoods Olofsbuurt-Westerkwartier.

This solution does not make it through this (brainstorm) evaluation round, because it is assumed that the problem owner is not able to reach consensus with the operator of the Hovengarage. The costs for allowing free parking in this garage are assumed to become too high.

MEANS 6. FREE PARKING PHOENIXGARAGE FOR LICENCE HOLDERS AT NIGHT

The Phoenixgarage is not fully occupied during the entire day (section 3.3 and Appendix A). Especially at night, there is unoccupied capacity. This capacity could be used to overcome the temporal loss of parking places in the nearby Spoorzone. Based on the occupation rate it is assumed that this solution can provide 110 parking places. Licence holders B and C could be granted free access at night.

This solution fulfils all the criteria for the brainstorm evaluation. It will be evaluated in a Multiple-Criteria Decision Analysis.

MEANS 7. INTRODUCE PARKING VALET

A way to decrease travel time from parking places to the destination of the users is the parking valet. Parking valet service concerns drivers, which are in charge of bringing and taking cars to and from the parking facilities. Because the users of the parking facilities will no longer need to travel to the parking facilities themselves, the location of the parking facilities will have less influence their preferences.

This solution does not make it through this (brainstorm) evaluation round, because it is assumed that the problem owner will regard the solutions costs too high. It is doubtful whether or not this solution could be implemented before 2015.

MEANS 8. USE MODE BICYCLE TO DECREASE TRAVEL TIME

An additional solution to cover the distance from newly or temporarily created parking places is the use of the bicycle. Parking facilities that are placed out of walking range of the neighbourhoods could become more attractive when the bicycle is used. Promotion of the mode bicycle could be done by providing bicycles (for example in a similar way to the OV-fiets), but good information and bicycle parking places might also suffice.

This solution fulfils all the criteria for the brainstorm evaluation. It will be evaluated in a Multiple-Criteria Decision Analysis.

MEANS 9. USE MODE PUBLIC TRANSPORT TO DECREASE TRAVEL TIME

Several parking facilities nearby the neighbourhoods Olofsbuurt-Westerkwartier are provided with public transport connections. The tram (line 1) passing through the Spoorzone area covers the neighbourhoods at their entire western flanks, while the bus (line 81) covers most of the eastern side. Providing free tickets to licence holders or specifically to users of the parking facilities could turn more

distant parking facilities in attractive parking alternatives during the removal of the Spoorzone viaduct.

This solution fulfils all the criteria for the brainstorm evaluation. It will be evaluated in a Multiple-Criteria Decision Analysis.

MEANS 10. USE MODE SHUTTLE BUS TO DECREASE TRAVEL TIME

Parking facilities that are situated more than a certain amount of minutes walking (e.g. 15 minutes) could be made more attractive by temporarily deploying a shuttle bus. This bus could take commuting residents from the neighbourhoods to the parking facility in the morning (e.g. from 7:00 till 10:00) and back again (e.g. between 16:00 and 19:00).

This solution does not make it through this (brainstorm) evaluation round, because it is assumed that the problem owner will regard the solutions costs too high. Besides that it is the social acceptance is doubtful since people need to travel for a relative long time and also have to deal with waiting times for the shuttle bus.

MEANS 11. USE MODE TRAIN TO DECREASE TRAVEL TIME

Because railway station Delft is situated within fair walking distance of the (southern parts of the) neighbourhoods Olofsbuurt-Westerkwartier, the train could be used to decrease the travel time from the parking facility to the neighbourhoods. The P+R at Delft-Zuid for example could become an attractive alternative when users are provided with free train tickets from and to home

This solution does not make it through this (brainstorm) evaluation round, because it is assumed that the problem owner will regard the solutions costs too high. Besides that it is the social acceptance is doubtful since people need to travel for a relative long time and also have to deal with waiting times for the train.

MEANS 12. USE MODE WATER TAXI TO DECREASE TRAVEL TIME

The city of Delft is famous for its large amount of channels. A water taxi therefore could be used to bring parking users from and to alternative parking facilities. Room for parking place might be found next to the river Schie, east of the TU Delft district.

This solution does not make it through this (brainstorm) evaluation round, because it is assumed that the problem owner will regard the solutions costs too high. Moreover, it is doubtful if this solution could be implemented before 2015; some construction works might be required to create additional taxi stops alongside the channels

MEANS 13. IMPROVE ATTRACTIVENESS P+R NIJVERHEIDSPLEIN AT NIGHT

The Nijverheidsplein, just south of Delft station, has a capacity of 200 parking places. For licence holders B and C use of this P+R facility is free (for other users only free of charge on Sundays) (Appendix A). Nevertheless, the area does not prove to be very attractive yet for residents of the neighbourhoods Olofsbuurt-Westerkwartier. The parking lot is hardly surrounded by housing, making it an unpleasant place for car users to leave behind their parked car. The attractiveness of the Nijverheidsplein could be improved by taking security measures. Fences, bright lights, and access levers could be used to discourage vandalism. Another option is to deploy security guards at night.

This solution fulfils all the criteria for the brainstorm evaluation. It will be evaluated in a Multiple-Criteria Decision Analysis.

MEANS 14. IMPROVE ATTRACTIVENESS PARKING LOT RAILWAY STATION DELFT-ZUID

At the railway station Delft-Zuid, a parking lot is situated that has a capacity of 150 parking places (Parkeerlijn, 2014a). Even though it is often regarded as a P+R, it has no P+R facilities. Providing free train tickets towards railway station Delft could improve the attractiveness of this parking lot for visitors. This way the parking places in and nearby the Spoorzone would be less demanded.

This solution does not make it through this (brainstorm) evaluation round, because it is assumed that the problem owner will regard the solutions costs too high. The problem owner needs to discuss the costs with external party NS. Moreover, implementing P+R facilities might not be finished before 2015.

MEANS 15. INTRODUCE APPLICATION FOR AVAILABLE PARKING PLACES

In order to improve the utilization rates of the garages in Delft, a phone application could be created to indicate available parking places nearby the Spoorzone. This way, the time necessary to find a parking place could be minimised. The application could also be used to redirect different types of users to specific parking facilities. Visitors of the city centre, for example, could be directed to parking garages (instead of the neighbourhoods).

This solution does not make it through this (brainstorm) evaluation round; implementation of parking applications might not be finished before 2015. The solution will not solve the entire problem, because the willingness to use the service is assumed to be too low, but the solution could work against (the successfulness of) other sub-solutions.

MEANS 16. PRESENT PARKING AT THE PAPSOUWSELAAN AS ALTERNATIVE

At the northern part 16 of the Papsouwselaan at the place the junction with the Krakeelpolderweg and Westlandseweg, close to the border of the neighbourhoods, a parking lot is located. In front of the Aldi supermarket a parking lot of around 70 places is located which is used as mixed parking (paid parking between 9:00 and 17:00 on Monday to Thursday, and from 9:00 to 22:00 on Friday and Saturday). During the night this parking lot is almost nearly empty which provides the possibility to use this parking lot during the night by licence owners of Area C and B.

This solution does not make it through this (brainstorm) evaluation round. The socio-political support is doubtful because of the relative long distance to the neighbourhoods in combination with the possible objections from shop owners. Its effectiveness is also doubtful since the parking places are only available during certain time periods. Residents of the neighbourhoods who use their car for commuting during the week can use these places then, but cannot leave their car there in the weekend.

MEANS 17. PRESENT PARKING AT ROLAND HOLSTLAAN AS ALTERNATIVE

More to the south of Delft near the Hoven passage the Albert Heijn is located. At the back entrance of this supermarket at the Roland Holstlaan a parking lot of around 45 places is located which is used as mixed parking (paid parking between 9:00 and 17:00 on Monday to Thursday, and from 9:00 to 22:00

on Friday and Saturday). During the night this parking lot is almost nearly empty which provides the possibility to use this parking lot during the night by licence owners of Area C and B.

This solution does not make it through this (brainstorm) evaluation round. The socio-political support is doubtful because of the relative long distance to the neighbourhoods in combination with the possible objections from shop owners. Its effectiveness is also doubtful since the parking places are only available during certain time periods. Residents of the neighbourhoods who use their car for commuting during the week can use these places then, but cannot leave their car there in the weekend.

CATEGORY 2. CREATE ADDITIONAL PARKING PLACES

MEANS 18. CREATE ONE DIRECTION STREETS

The circulation plan of the neighbourhoods could be modified in such way that two direction streets are turned into one direction streets. Narrow two direction streets often allow room for cars from opposite directions to pass. This room could be used for additional parking places.

This solution does not make it through this (brainstorm) evaluation round. It is doubtful if the implementation of one direction streets is realistically doable before 2015 and its effectiveness is expected very low. At the same time this solution will make other solutions impossible. It is doubtful whether or not residents of the neighbourhoods Olofsbuurt-Westerkwartier are happy with a reduction of streets usable for driving around.

MEANS 19. SPACE AT MEESLAAN

At the Meeslaan, northwest of the Agnethapark in the neighbourhoods, a small park is situated. This park, called the Meeslaan park, is currently used for letting out dogs, but it also could be used to create new parking places.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be very low. Residents from the neighbourhoods Olofsbuurt-Westerkwartier will lose a piece of green area. Knowing the area should be restored after the duration of Spoorzone viaduct removal, the problem owner (especially the municipality) is faced with unwanted works (and costs). Implementation time is doubtful.

MEANS 20. SPACE AT RUYS DE BEERENBROUCKSTRAAT

The Ruys de Beerenbrouckstraat is situated north of the neighbourhoods Olofsbuurt-Westerkwartier. While the eastern part of this street is provided with parking places alongside the road, the western half is not. The green sidewalks of this part of the Ruys de Beerenbrouckstraat could be turned into parking places and then become nearby parking facilities for the northern part of the Olofsbuurt-Westerkwartier especially. Also along the Ruys de Beerenbrouckstraat on the location of the old Albert Heijn supermarket a small area is left undeveloped. On this surface there may be a possibility to create temporal parking places.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be very low. The sidewalks at the Ruys de Beerenbrouckstraat are changed into green strips not so long ago (Verkeersnet, 2014). This means that the problem owner (especially

the municipality) is faced with unwanted works (and costs). Implementation time is doubtful. Developing the area where the Albert Heijn was located, the building of houses is planned and therefore this is not feasible (Raad Delft, 2008).

MEANS 21. SPACE AT SIDEWALKS NEIGHBOURHOODS

Currently, sidewalk parking is allowed during the night. During the day it is not allowed, mainly because of playing children. Nevertheless, this could provide additional parking places.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be very low and the effectiveness is doubtful. It is assumed that residents regard sidewalk parking as an inevitable (temporary) solution and that they will not approve extension of the possibilities to allow this. Using sidewalks costs room, these cannot be used anymore for other sub-solutions.

MEANS 22. SPACE AT THE ADA VAN HOLLANDSTRAAT

At the Ada van Hollandstraat, a piece of grass is situated, that currently does not appear to be used. Access is prevented by gates. The location is situated at the southern side of the neighbourhoods and can be reached by bike in less than six minutes, from all the parts of the neighbourhoods. There is room for a modular parking lot, with an extra level. City development plans should be investigated to see what the (future) plans for the area are.

This solution does not make it through this (brainstorm) evaluation round, because other plans have been made for the use of this area which are planning wise conflicting with this solution (Gemeente Delft, 2013d).

MEANS 23. BUILD NEW GARAGE IN DELFT

A lack of capacity could be solved by constructing a new parking garage. Because of the available parking garages in the city centre, a location on the other side of the neighbourhoods appears to be a good solution.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be very low. The current parking garages in and around the city centre of Delft are not fully occupied (Appendix A), which means that the problem owner (especially the Municipality) is faced with unwanted works (and costs). It is assumed that a new garage will not be finished before 2015.

MEANS 24. BUILD NEW PARKING LOT NEXT TO A13

Near exit 8 of the A13 highway, room could be made for parking facilities. The advantage of this location is the direct access to the highway and the nearby tram stop Lombokstraat of tramline 1. This tram passes by the neighbourhoods Olofsbuurt-Westerkwartier. It might even be possible to create a temporal tram stop even closer to the exact location of the parking lot.

This solution does not make it through this (brainstorm) evaluation round, because the socio-political support is doubtful. Current parking garages in and around the city centre of Delft are not fully occupied (Appendix A), which means that the problem owner (especially the municipality) is faced

with unwanted works (and costs). It is also doubtful if this new parking lot (for which room needs to be made) can be finished before 2015.

MEANS 25. DEMOLISH HOUSES TO BUILD MORE PARKING PLACES

Extra room for parking places could be earned by demolishing structures, such as (old) buildings. Based on city development plans and traffic flows, the best places to do so could be chosen.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be very low. It is an expensive solution and it has many negative effects on the liveability of the neighbourhoods Olofsbuurt-Westerkwartier. It is also assumed that this solution will not be finished before 2015.

MEANS 26. MAKE AVAILABLE PARKING NEXT TO NEW CITY HALL

In the development plans of the Spoorzone, several areas are indicated to become available before 2015 (Gemeente Delft, 2013d). One of these places is the area near the new city hall. It might be possible to temporarily use this area as a parking lot.

This solution does not make it through this (brainstorm) evaluation round, because other plans have been made for the use of this area (Gemeente Delft, 2013d). Related to socio-political it is also doubtful whether or not the problem owner (especially CCL) likes to have the area for its own activities during the removal of Spoorzone viaduct (Ten Haaf et al., 2013).

MEANS 27. SPACE AT SINT AGATHAPLEIN PRINSENHOF

The Sint Agathaplein (square) is a historic landmark, nearby the Phoenixstraat. At this square, the historic Prinsenhof is situated. Currently, the square is furnished with shrubbery and statues, but when these are (temporarily) removed, a fair piece of ground could be used as a (temporary) parking lot, nearby the Spoorzone.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be very low. The problem owner (especially the municipality) is assumed not to be willing to give (temporarily) away one of its main historic values. Also it is doubtful if the parking lot at the Sint Agathaplein can be finished before 2015.

MEANS 28. SPACE AT AMBACHTSSTRAAT

The area around the Ambachtsstraat (indicated as areas 8a and 8b in the Integraal Ontwikkelingsplan (Gemeente Delft, 2013d) will be used for the development of housing in 2019 (Gebruik de lege ruimte, 2013b; Gemeente Delft, 2013e). Until then, the area could be used to create new parking places south of the Delft railway station close to the Nijverheidsplein. It is estimated that this parking lot can provide around 300 parking places.

This solution fulfils all the criteria for the brainstorm evaluation. It will be evaluated in a Multiple-Criteria Decision Analysis.

MEANS 29. SPACE AT BACINOL/DSM AREA

At the northern side of the Spoorzone, the DSM factory area is situated. Around the place where the former Bacinol building has been demolished, it might be possible to create a (temporal) parking facility. There are, however, plans to rebuild an office building of DSM. Information on this

reconstruction is not consistent; a map of DSM indicates the building will be ready in 2015 (DSM, 2009), whereas it is stated at the Spoorzone website that the construction work will start after finishing the tunnel (Spoorzone Delft, 2013b), which is after 2015. Because of the existing fences, it might be even possible to turn this into a secured parking lot.

This solution does not make it through this (brainstorm) evaluation round, because this area will be used during the removal of Spoorzone viaduct. Also the socio-political is doubtful since the area is restricted by regulations due to the activities at the DSM factories (Ten Haaf et al., 2013).

MEANS 30. SPACE AT CURRENT BUS STATION STATION DELFT

In 2015, the new bus station will be opened at the Phoenixstraat, which is on the other side of the railway tracks than the current bus station. Even though the room of the current bus station is destined to be used for housing, it could provide temporal room for parking places. There is also room for a modular parking garage with an extra floor.

This solution does not make it through this (brainstorm) evaluation round, because this area will be used during the removal of Spoorzone viaduct (Gemeente Delft, 2013d). Also the implementation time is doubtful.

MEANS 31. SPACE AT INDUSTRIESTRAAT

The area around the Industriestraat (indicated as areas 8a and 8b in Integraal Ontwikkelingsplan Gemeente Delft (Gemeente Delft, 2013d) will be used for the development of housing in 2019 (Gebruik de lege ruimte, 2013). Until then, the area could be used to create new parking places south of the Delft railway station. Currently, there is hardly any infrastructure, which means that this needs to be created in order to make it suitable for car parking.

This solution does not make it through this (brainstorm) evaluation round, because it scores low on implementation time and socio-political support. All infrastructure should still be created and the area is situated further than Nijverheidsplein from the neighbourhoods Olofsbuurt-Westerkwartier, making it unlikely that parking users of the neighbourhoods will prefer this parking facility.

MEANS 32. SPACE IN AGNETAPARK

The Agnetapark is situated at the north side of the neighbourhoods. It is a special area, for it is the oldest factory colony in the Netherlands that was built in a landscape (Rijksdienst voor het Cultureel Erfgoed, 2012). The green zones in this area could be used to create parking places. There should be dealt with the fact that the area has been marked as protected landscape in 2011 (Van 't Veen, 2011).

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be very low. The Agnetapark has unique green values and it is assumed unlikely that both residents and problem owner (especially the municipality) are willing to sacrifice this. Implementation time is also doubtful.

MEANS 33. SPACE ON TOP OF THE TUNNEL WHEN READY

As soon as the second tunnel is ready, there might be room to park on top of it. This solution should be checked with construction plans and with city development plans that indicate how the area will

be furnished. The parking places obtained with this process might not be available during the whole time horizon 2015-2017.

This solution does not make it through this (brainstorm) evaluation round, because this area will be used during the removal of Spoorzone viaduct, it is simply impossible.

MEANS 34. CREATE DIAGONAL PARKING PLACES

Most of the streets in the neighbourhoods have parallel parking places. In the streets that are wide enough, diagonal parking could be used to provide more places. Parking places perpendicular to the street (90° angle) could even provide more places, but it also needs more room.

This solution does not make it through this (brainstorm) evaluation round, because it is doubted whether or not implementation could be finished before 2015. Moreover, it is assumed that this solution will not solve the entire problem, while using existing room for diagonal parking does make other sub-solutions impossible.

MEANS 35. INCREASE CAPACITY HUGO DE GROOTSTRAAT PARKING LOT

A small parking lot can be found in the Elsje van Houwelingenstraat, near the Hugo de Grootstraat. The available surface could be used for creation of an extra parking level, resulting in various additional parking places in the heart of the neighbourhoods Olofsbuurt-Westerkwartier. Both modular solutions and individual mechanic solutions could be used. A modular solution concerns a simple parking construction, providing various parking places. Individual solution concerns a parking construction for only one car and is especially appropriate for households that have two cars; it is not possible to exit when the car at ground level is parked below. For the car at the 1st level it takes less than 60 seconds to exit (Blank, 2010).

This solution fulfils all the criteria for the brainstorm evaluation. It will be evaluated in a Multiple-Criteria Decision Analysis.

MEANS 36. INCREASE CAPACITY P+R NIJVERHEIDSPLEIN

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be low. The parking lot is currently not fully occupied (Appendix A). This means that the parking lot is currently not very attractive, making it doubtful for the problem owner to invest in this solution. It is assumed more logical to first improve the attractiveness of this parking lot.

The Nijverheidsplein, just south of Delft station, has a capacity of 200 parking places. By creating an extra level on the existing parking lot, its capacity would be increased.

MEANS 37. INCREASE CAPACITY STATION DELFT-ZUID

At the railway station Delft-Zuid, a parking lot is situated that has a capacity of 150 parking places (Parkeerlijn, 2014a). The capacity of this parking facility could be increased by creating an extra parking deck.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be too low. It can be really doubted how attractive this solution is for residents from the neighbourhoods Olofsbuurt-Westerkwartier, because of the travel distance.

MEANS 38. ALLOW PARKING AT OUDE DELFT

The Oude Delft is situated alongside a channel (the Oude Delft) in the western side of the city centre, parallel and relatively nearby the Spoorzone area. Some parts of this street are not allowed for parking, but if it would be, more people could make use of it.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be very low. Creating a car free city centre is one of the main strategies of the municipality of Delft to increase the attractiveness for visitors and liveability for residents. Therefore, this solution is assumed to be politically unfeasible.

MEANS 39. ALLOW PARKING IN ENTIRE CITY OF DELFT

Currently, the use of parking places in Delft is restricted. The city of Delft is divided in several zones, for which licences are sold. By allowing licence holders C (and B) to park everywhere in Delft, the range of parking possibilities would be extended. This might encourage residents of the neighbourhoods Olofsbuurt-Westerkwartier to search their own favourite parking place, somewhere in Delft.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be very low. This measure goes against parking policies of the municipality of Delft and residents of the neighbourhoods Olofsbuurt-Westerkwartier are unlikely to be very happy with parking places at large travel distance.

MEANS 40. ALLOW PARKING IN HOOGHEEMRAADSCHAP GARAGE

The institution Hoogheemraadschap of Delfland is situated at the Oude Delft, nearby the Spoorzone. It has its own parking garage of which the capacity is uncertain. It might be possible to allow residents to park in this garage at night.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be very low. The Hoogheemraadschap Delfland is very unlikely to go along with this measure. Besides, its parking facility is not suitable for a massive demand, leave alone at peak hours.

MEANS 41. MAKE AVAILABLE PARKING COMPANIES IN THE NEIGHBOURHOOD

At the borders of the neighbourhoods, several places can be indicated where companies have parking places available, that might be used less (or not at all) during night of the weekend. These places are usually locked by gates. A partnership with those companies could provide additional parking places. An example is the parking places of the companies located at the Buitenwatersloot 312.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be very low. It is assumed to be very difficult to convince companies to share their parking facilities.

MEANS 42. SPACE AT GARAGE ALBERT HEIJN RUYS DE BEERENBROUCKSTRAAT

Along the Ruys de Beerenbrouckstraat, at the northern part of the neighbourhood, an Albert Heijn is situated which consist of an own parking garage. Here around 110 parking places are potentially available during certain periods of day.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support and the effectiveness is assumed to be doubtful. It is doubtful if the Albert Heijn is willing to share a part of its own garage. Also when they do it the garage will be only available during non-shopping hours.

MEANS 43. SPACE AT COMPANY GARAGES' EXITS

In the neighbourhoods, several companies and shops have parking places that are mainly used for their employees and deliveries. At times these companies are closed (for example during night) these places could be used by others.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be low. It is assumed to be very difficult to convince companies to share their parking facilities. Moreover, it could be reasoned that application of this measure wouldn't gain a lot of places and therefore its effectiveness is doubtful.

MEANS 44. SPACE AT PRIVATE GARAGES' EXITS

Parking at private exits (i.e. exits that are owned by residents) could be implemented. It is currently forbidden. If garage owners know that they do not need the garage during an entire day, they could allow others to use the room in front of the garage. By means of an indication sign, the owners could indicate until what time the place is free for use.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be low. It is assumed to be very difficult to convince residents with private parking places to share these. Moreover, it could be reasoned that application of this measure would not gain a lot of places and therefore its effectiveness is doubtful.

MEANS 45. SPACE AT POLICE AND FIRE DEPARTMENT KRAKEELPOLDERWEG

The police and fire departments situated at the crossing Westlandseweg-Krakeelpolderweg, have a parking lot, for their employees. It might be possible to allow residents of the nearby neighbourhoods to park here, for example at night.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be very low. Consensus with the police and fire department on how or when to use the parking facilities is assumed to be unachievable.

CATEGORY 3. DECREASE PARKING DEMAND

MEANS 46. ENCOURAGE CAR SHARING

Car-sharing "is a neighbourhood-based transportation service that allows people to use a car when needed, without the costs and responsibilities of ownership. It converts automobile use from a product to a service, providing people with use of a car instead of ownership." (City Carshare, 2013). Currently, Greenwheels (2013) is used; this is commercial service with nine stations in the neighbourhoods, but only one type of car available: the Peugeot 107. By providing more types of cars, the use of Greenwheels could be encouraged. Private car sharing could be stimulated by providing some administrative support.

This solution does not make it through this (brainstorm) evaluation round, because implementation of car sharing is doubtful, because it might take longer than 2015 to reach the desired lower parking demand.

MEANS 47. ENCOURAGE PEOPLE TO USE ONLY ONE CAR

A quarter of the households in the Netherlands have more than one car (Van Beuningen, Molnár-in 't Veld, & Bouhuijs, 2012). People that have no car or only one could be stimulated to keep it that way. They for instance could be provided with discount for the use of public transport. On a longer term this could lower the parking demand. Although uncertain, it might even influence the decision of people that currently have two cars to get rid of one.

This solution does not make it through this (brainstorm) evaluation round, because the socio-political support and effectiveness is assumed to be low. It is difficult to get people out of their car. Moreover implementation is doubtful, because it might take longer than 2015 to reach the desired lower parking demand.

MEANS 48. LIMIT ACCESS OF VISITORS TO PARKING NEIGHBOURHOODS

The demand for parking places during the removal of the Spoorzone viaduct could be reduced by not allowing people visiting the city centre to park in the neighbourhoods Olofsbuurt-Westerkwartier. Visitors could be sent to one of the nearby parking facilities, such as the P+R Nijverheidsplein or the Zuidpoortgarage. For customers of the shops in the neighbourhoods from outside the Olofsbuurt-Westerkwartier an exception could be made.

This solution does not make it through this (brainstorm) evaluation round, because the socio-political support and effectiveness is assumed to be low. The shops in the neighbourhoods will not accept the removal of mixed parking places therefore the socio-political support is seen as doubtful. And because there are only a few small areas with mixed parking in the neighbourhoods not many parking places will be gained.

MEANS 49. LIMIT ACCESS OF VISITORS TO PHOENIXGARAGE

Currently, the Phoenixgarage is the busiest garage of the city centre (Appendix A). If the users of parking places in the Spoorzone are redirected towards this garage it will become even busier. This could be avoided by regulating the access to this parking garage. While the Phoenixgarage is only accessible for residents, visitors could be redirected towards to the Zuidpoort and/or Marktgarages.

This solution fulfils all the criteria for the brainstorm evaluation. It will be evaluated in a Multiple-Criteria Decision Analysis.

MEANS 50. LIMIT NUMBER OF LICENCES PER HOUSEHOLD

At the beginning of 2010, seven out of ten households in the Netherlands had a car and a quarter of the households had two or more cars. When the income raises the percentage households with at least one car also increases (Van Beuningen et al., 2012). A policy could limit the number of licences per household, which means that households with for instance more than one car are obliged to park their second car outside of the neighbourhoods. This way the parking demand in the neighbourhoods will be decreased.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be low. It is difficult to get people out of their car. Moreover implementation is doubtful, because it might take longer than 2015 to reach the desired lower parking demand.

MEANS 51. MAKE NEIGHBOURHOODS CAR FREE

The parking demand in the neighbourhoods Olofsbuurt-Westerkwartier could be reduced by not allowing any cars for parking. This could be introduced for the entire neighbourhoods, but partial prohibition, for example in the eastern areas (nearby the Spoorzone) might be sufficient to discourage visitors of the city centre to park in the neighbourhoods. In this solution there should be dealt with partial accessibility; all parts of the neighbourhoods should remain accessible for emergency services and residents processing heavy goods. Shifting demands should be dealt with too; residents might start parking in other parts of the neighbourhoods, which results in increasing demands over there.

This solution does not make it through this (brainstorm) evaluation round, because socio-political support is assumed to be low. Creating a car free neighbourhood might not be approved by all residents and its implementation is doubtful, for it might take longer than 2015. Moreover, allowing no cars means that other sub-solutions that do involve cars in the neighbourhoods will become unfeasible.

MEANS 52. STOP PROVISION OF NEW PARKING LICENCES

Parking demand could be lowered by stopping the provision of new parking licences. Residents that already have a licence could be left unbothered, but still the number of licence holders will decline over time.

This solution does not make it through this (brainstorm) evaluation round, because it will take much longer than 2015 to reach the desired lower parking demand. Moreover socio-political support is also assumed to be low. New residents might be scared to settle in the neighbourhoods if they are no longer allowed to buy a parking licence and the municipality will lose some of its income.

CATEGORY 4. LIMIT LOSS OF PARKING PLACES IN THE SPOORZONE AREA

MEANS 53. LEAVE THE VIADUCT AS IT IS

Leaving the viaduct (partially) the way it is would create less loss of parking places. The viaduct could become part of a city park, while below it, parking places remain. This solution originates from New York, where a public park has been built on an historic freight rail line elevated above the streets. The solution should be checked with construction plans.

This solution does not make it through this (brainstorm) evaluation round, because it conflicts with the execution of the construction works in the Spoorzone area. Removal of the viaduct and its piles is necessary to finish the tunnels of the Spoorzone.

MEANS 54. REMOVAL OF VIADUCT IN PHASES

Removal of the viaduct in various phases, might lead to (a temporal and regularly shifting) room for parking places. This solution should be checked with construction plans.

This solution does not make it through this (brainstorm) evaluation round, because it conflicts with the execution of the construction works in the Spoorzone area. In the construction planning of the viaduct removal there is no room for temporal shifting parking places (Ten Haaf et al., 2013).

E. EVALUATION OF SOLUTIONS

In this appendix for each of the 12 investigated solutions the effects on each of the four criteria with associated sub criteria are presented.

SOLUTION 1. DISCOUNT PARKING THE HOVENGARAGE FOR LICENCE HOLDERS (M3)

EFFECTS ON FUNCTIONALITY

NUMBER OF PARKING PLACES [4]

The parking garage of the Hoven has 550 places, and is only open during the day (from 7:30 to 20:00 from Monday to Saturday and from 10:30 to 18:00 on Sunday) (Parkeerlijn, 2014b). Thus, it can only be used by commuters and visitors. In addition, it is known that the utilization rate of this garage is pretty low, even if no number was found regarding this data.

It is assumed that 200 places can be used by people currently parking at the Spoorzone even if the demand during the opening hour of this parking is probably lower. This 200 parking places relate to a score of 4 on this sub criterion.

USERS PARKING COSTS [1]

It is assumed that licence holders of area C will have discount to park in the parking The Hoven. Nevertheless, these costs will be added to the price of their licence, so a score of 1 has been assigned.

TRAVEL TIME [3]

On the walking distance map the travel time by foot is a bit less than 15 minutes to the Spoorzone parking places.

EFFECTS ON COSTS [2]

Providing discount for licence holders needs implementation as well as operation costs. Discounts decrease the profits of the parking operator, for which it should be compensated. This compensation could be kept relatively low when it is considered that the measure will seduce new customers to use this garage. Besides compensation, operation costs are not significantly higher than usual. An advantage of this solution is there are not any construction costs involved.

EFFECTS ON ENVIRONMENT

POLLUTION [2]

The parking the Hoven is situated at a distance of less than one kilometre from the neighbourhoods. Because there is no connection with the neighbourhoods and a small fee still has to be paid it can be assumed that inhabitants first try to search for a parking place in their street and then drive to the discount parking the Hoven.

SUSTAINABILITY [0]

Because an existing parking garage can be used there is no need for a new construction that uses ground surface. Therefore, this is a sustainable solution because no surface is used.

LIVEABILITY [1]
The liveability of the neighbourhoods will improve because the cars that are currently parked under the viaduct will be moved out of the area. No street furniture, children playgrounds or green areas are removed.

EFFECTS ON FEASIBILITY

IMPLEMENTATION TIME [2 MONTHS]
Since only a small policy adjustment should be made and no physical adjustments are necessary the implementation time is short. Only an agreement about the compensation should be reached with Interparking, the owner of the parking facility.

LIFE TIME [2 YEARS]
Since the Hovengarage will exist for the coming years, the life time of the solution will be sufficient for the whole period between 2015 and 2017.

SOLUTION 2. DISCOUNT PARKING THE HOVENGARAGE FOR LICENCE HOLDERS WITH BICYCLE (M3+M8)

EFFECTS ON FUNCTIONALITY

NUMBER OF PARKING PLACES [4]
The parking garage of the Hoven has 550 places, and is only open during the day (from 7:30 to 20:00 from Monday to Saturday and from 10:30 to 18:00 on Sunday) (Parkeerlijn, 2014b). Thus, it can only be used by commuters and visitors. In addition, it is known that the utilization rate of this garage is pretty low, even if no number was found regarding this data.

It is assumed that 200 places can be used by people currently parking at the Spoorzone even if the demand during the opening hour of this parking is probably lower. This 200 parking places relate to a score of 4 on this sub criterion.

USERS PARKING COSTS [1]
It is assumed that licence holders of area C will have discount to park in the parking The Hoven. Nevertheless, these costs will be added to the price of their licence, so a score of 1 has been assigned.

TRAVEL TIME [1]
By bike the travel time is three time faster than by walking, thus below 5 minutes.

EFFECTS ON COSTS [2]
Providing discount for licence holders needs implementation as well as operation costs. Discounts decrease the profits of the parking operator, for which it should be compensated. This compensation could be kept relatively low when it is considered that the measure will seduce new customers to use this garage. Besides compensation, operation costs are not significantly higher than usual. An advantage of this solution is there are not any construction costs involved.

Additional costs will be due to the fact that bicycle facilities need to be provided, such as parking garages or the provision of Public Transport Bicycle. Those costs will not be significant comparing to the discount cost of the Hoven, and r then not taken into account.

EFFECTS ON ENVIRONMENT

POLLUTION [2]
The parking the Hoven is situated at a distance of less than one kilometre from the neighbourhoods. Because there is a bicycle connection with the neighbourhoods it is likely that some inhabitants go to the Hoven immediately because they have their bicycle parked there. Although the parking in the Hoven is with a discount it is not free like in the neighbourhoods. Therefore, it can be assumed that inhabitants first try to search for a parking place in their street and then drive to the discount parking the Hoven.

SUSTAINABILITY [0]
Because an existing parking garage can be used there is no need for a new construction that uses ground surface. Therefore, this is a sustainable solution because no surface is used.

LIVEABILITY [1]
The liveability of the neighbourhoods will improve because the cars that are currently parked under the viaduct will be moved out of the area. No street furniture, children playgrounds or green areas are removed.

EFFECTS ON FEASIBILITY

IMPLEMENTATION TIME [4 MONTHS]
Besides the agreement related to the compensation with the owner of the parking facility also some physical adjustments should be made. Nearby the Hovengarage secured bike parking and/or borrowing facilities should be created. Because the bicycle facilities, which are expected to have an implementation time of 2 months, will only be created when an agreement is reached the implementation time will be longer than solution 1.

LIFE TIME [2 YEARS]
Since the Hovengarage will exist for the coming years, and the bike facilities can also exist for a longer period, the life time of the solution will be sufficient for the whole period between 2015 and 2017.

SOLUTION 3. DISCOUNT PARKING THE HOVENGARAGE FOR LICENCE HOLDERS WITH PUBLIC TRANSPORT (M3+M9)

EFFECTS ON FUNCTIONALITY

NUMBER OF PARKING PLACES [4]
The parking garage of the Hoven has 550 places, and is only open during the day (from 7:30 to 20:00 from Monday to Saturday and from 10:30 to 18:00 on Sunday) (Parkeerlijn, 2014b). Thus, it can only

be used by commuters and visitors. In addition, it is known that the utilization rate of this garage is pretty low, even if no number was found regarding this data.

It is assumed that 200 places can be used by people currently parking at the Spoorzone even if the demand during the opening hour of this parking is probably lower. This 200 parking places relate to a score of 4 on this sub criterion.

USERS PARKING COSTS [1]
It is assumed that licence holders of area C will have discount to park in the parking The Hoven. Nevertheless, these costs will be added to the price of their licence, so a score of 1 has been assigned.

TRAVEL TIME [2]
The ride by tramway between the two stops serving the garage and the current parking places is of 3 minutes. Nevertheless, the frequency of the tramway should also be taken into account. During the week the headway is of 10 minutes, by assuming random arrival of passengers (due to the short headway) the average waiting time of passengers is of 2.5 minutes. Thus, if we add the walking distance from the tramway stop to the parking place it can be assumed that the total trip is less than 10 minutes by tramway.

EFFECTS ON COSTS [3]
Providing discount for licence holders needs implementation as well as operation costs. Discounts decrease the profits of the parking operator, for which it should be compensated. This compensation could be kept relatively low when it is considered that the measure will seduce new customers to use this garage. Besides compensation, operation costs are not significantly higher than usual. An advantage of this solution is there are not any construction costs involved.

Additional costs will be due to the fact that free Public Transport tickets will be provided to the people that parked there in order to reach their final destination. This cost will be quite significant that is why a high score is put.

EFFECTS ON ENVIRONMENT

POLLUTION [2]
The parking the Hoven is situated at a distance of less than one kilometre from the neighbourhoods. Because there is a public transport connection with the neighbourhoods it is possible that some inhabitants go to the Hoven immediately. Although the parking in the Hoven is with a discount it is not free like in the neighbourhoods. Therefore, it can be assumed that inhabitants first try to search for a parking place in their street and then drive to the discount parking the Hoven.

SUSTAINABILITY [0]
Because an existing parking garage can be used there is no need for a new construction that uses ground surface. Therefore, this is a sustainable solution because no surface is used.

LIVEABILITY [1]
The liveability of the neighbourhoods will improve because the cars that are currently parked under the viaduct will be moved out of the area. No street furniture, children playgrounds or green areas are removed.

EFFECTS ON FEASIBILITY

IMPLEMENTATION TIME [2 MONTHS]
Besides the agreement related to the compensation with the owner of the parking facility also agreement should be reached with the public transport operator. In this case this is the HTM, the local tram operator. Since these two tasks can be done parallel the implementation time will be short.

LIFE TIME [2 YEARS]
Since the Hovengarage and the tramline 1 will exist for the coming years, the life time of the solution will be sufficient for the whole period between 2015 and 2017.

SOLUTION 4. DISCOUNT PARKING PHOENIXGARAGE FOR LICENCE HOLDERS (M4)

EFFECTS ON FUNCTIONALITY

NUMBER OF PARKING PLACES [2]
The Phoenixgarage has a capacity of 202 places. It is the one with the highest utilization rate in the city centre. Nevertheless, if this solution is implemented it is assumed that visitors to the city centre of Delft will preferentially be redirected to other parking garages of the city.

By looking at the current utilization rate of the Phoenixgarage (Appendix A) it can be seen that at 18h during the weekday the average utilization rate is between 40% and 50%. If we assume that commuters come back from work around 18:00, and then 55% of the capacity is available, thus 110 places. But the main peak of utilization of the garage occurs after between 19:00 and 22:00. This mean that visitors arriving at this time will be redirected to other parking garage of the city centre having a lower utilization rate such has the Zuidpoortgarage. Residents that leave their cars there the weekend, will be parked there already in the morning, thus will took the place of the visitors, so they will have as much capacity as wanted.

In addition it can be noticed that the Zuidpoortgarage that has a capacity of 810 places has a maximum utilization rate of 82%, on Saturday morning (Appendix A), on the other day of the week the maximum utilization rate is of 50%. Thus there are always 145 places free at the Zuidpoortgarage, so the 110 places that will be taken from the visitors in Phoenixgarage can be compensated by the 145 places in Zuidpoortgarage. This 110 parking places relate to a score of 2 on this sub criterion.

USERS PARKING COSTS [1]
The costs will be higher for current users of the Spoorzone places in average, as they will pay their licence and the price of the parking.

TRAVEL TIME [1]
The travel time will be almost the same as now, as the Phoenixgarage is situated at 100 meter of the Spoorzone parking places.

EFFECTS ON COSTS [2]
Providing discount for licence holders needs implementation as well as operation costs. Discounts decrease the profits of the parking operator, for which it should be compensated. This compensation could be kept relatively low when it is considered that the measure will seduce new customers to use this garage. Besides compensation, operation costs are not significantly higher than usual. An advantage of this solution is there are not any construction costs involved.

EFFECTS ON ENVIRONMENT

POLLUTION [2]
The Phoenixgarage is situated at the border of the neighbourhoods. Because a parking place is not free, it can be assumed that inhabitants first try to search for a parking place in the neighbourhoods and then drive to the Phoenixgarage.

SUSTAINABILITY [0]
Because an existing parking garage can be used there is no need for a new construction that uses ground surface. Therefore, this is a sustainable solution because no surface is used.

LIVEABILITY [1]
The liveability of the neighbourhoods will improve because the cars that are currently parked under the viaduct will be moved out of the area. No street furniture, children playgrounds or green areas are removed.

EFFECTS ON FEASIBILITY

IMPLEMENTATION TIME [1 MONTH]
Since only a small policy adjustment should be made and no physical adjustments are necessary the implementation time is very short. Only an agreement about the compensation should be reached with Parking Delft, the owner of the parking facility.

LIFE TIME [2 YEARS]
Since the Phoenixgarage will exist for the coming years, the life time of the solution will be sufficient for the whole period between 2015 and 2017.

SOLUTION 5. FREE PARKING PHOENIXGARAGE FOR LICENCE HOLDERS AT NIGHT (M6)

EFFECTS ON FUNCTIONALITY

NUMBER OF PARKING PLACES [2]
The Phoenixgarage has a capacity of 202 places. It is the one with the highest utilization rate in the city centre. Nevertheless, if this solution is implemented it is assumed that visitors to the city centre of Delft will preferentially be redirected to other parking garages of the city. It is assumed that the parking garage will be free for inhabitants of the neighbourhoods after 18:00.

By looking at the current utilization rate of the Phoenixgarage (Appendix A) it can be seen that at 18:00 during the weekday the average utilization rate is between 40% and 50%. If we assume that commuters come back from work around 18:00, then 55% of the capacity is available, thus 110 places. But the main peak of utilization of the garage occurs after between 19h and 22h. This mean that visitors arriving at this time will be redirected to other parking garage of the city centre having a lower utilization rate such has the Zuidpoortgarage. Residents that leave their cars there the weekend, will be parked there already in the morning, thus will took the place of the visitors, so they will have as much capacity as wanted.

In addition it can be noticed that the Zuidpoortgarage that has a capacity of 810 places has a maximum utilization rate of 82%, on Saturday morning (Appendix A), on the other day of the week the maximum utilization rate is of 50%. Thus there are always 145 places free at the Zuidpoortgarage, so the 110 places that will be taken from the visitors in Phoenixgarage can be compensated by the 145 places in Zuidpoortgarage. This 110 parking places relate to a score of 2 on this sub criterion.

USERS PARKING COSTS [0]
In average the costs will be the same as current costs for users, as most of the people parking below the viaduct are licence holders.

TRAVEL TIME [1]
The garage being situated at less than 100 meters of the Spoorzone parking places the additional travel time is null.

EFFECTS ON COSTS [3]
Providing free parking for licence holders needs implementation as well as operation costs. Even though free parking requires a compensation for the lost benefits, this solution only provides free parking at night, when the occupation rate of the Phoenixgarage is rather low (Appendix A). No construction costs are involved. Nevertheless, the parking operators need to be compensated for the use of its parking places for free by the residents; that is why high costs are assigned.

EFFECTS ON ENVIRONMENT

POLLUTION [1]
The Phoenixgarage is situated at the border of the neighbourhoods. Because a parking place is free, it is likely that several inhabitants that live at the border of the neighbourhoods go straight to the Phoenixgarage. Because there is no need for searching, the amount of pollution will decrease.

SUSTAINABILITY [0]
Because an existing parking garage can be used there is no need for a new construction that uses ground surface. Therefore, this is a sustainable solution because no surface is used.

LIVEABILITY [1]
The liveability of the neighbourhoods will improve because the cars that are currently parked under the viaduct will be moved out of the area. No street furniture, children playgrounds or green areas are removed.

EFFECTS ON FEASIBILITY

IMPLEMENTATION TIME [1 MONTH]
Since only a small policy adjustment should be made and no physical adjustments are necessary the implementation time is very short. Only an agreement about the compensation should be reached with Parking Delft, the owner of the parking facility.

LIFE TIME [2 YEARS]
Since the Phoenixgarage will exist for the coming years, the life time of the solution will be sufficient for the whole period between 2015 and 2017.

SOLUTION 6. IMPROVE ATTRACTIVENESS P+R NIJVERHEIDSPLEIN AT NIGHT (M13)

EFFECTS ON FUNCTIONALITY

NUMBER OF PARKING PLACES [4]
The P+R is currently hardly used by cars at night. The capacity being of 200 places it can be assumed that the total capacity can be used, especially at night. This 200 parking places relate to a score of 4 on this sub criterion.

USERS PARKING COSTS [0]
The price will be the same for the licence holders, so this solution has a score of 0. This is because the licence holders are the main user (87%) of the parking places at the Spoorzone and they can park for free at the Nijverheidsplein.

TRAVEL TIME [2]
The travel time (Figure 22) by foot is less than 10 minutes, thus a score of 2 is assigned.

EFFECTS ON COSTS [1]
Improving the attractiveness at the P+R requires construction of some facilities, such as fences, extra lights, access levers, and maybe some additional costs for eventual safety guard at night or camera.

It is assumed that those construction works will be only executed once, and will thus be cheaper than discounting a parking garage during two years. That is why low score has been assigned.

EFFECTS ON ENVIRONMENT

POLLUTION [1]
The Nijverheidsplein is situated at the south side of the neighbourhoods. Because a parking place is for free and the circumstances are improved, it can be assumed that more people are willing to park their car at the Nijverheidsplein. However, there is no connection with the neighbourhoods which causes people to search for a parking place in the neighbourhoods first before they go to the Nijverheidsplein.

SUSTAINABILITY [0]
Because an existing parking place can be used there is no need for a new construction that uses ground surface. Therefore, this is a sustainable solution because no surface is used.

LIVEABILITY [1]
The liveability of the neighbourhoods will improve because the cars that are currently parked under the viaduct will be moved out of the area. No street furniture, children playgrounds or green areas are removed.

EFFECTS ON FEASIBILITY

IMPLEMENTATION TIME [4 MONTHS]
A few physical adjustments should be made to the Nijverheidsplein to convert the regular parking area to a secured parking area. The installation of a lever and other facilities to make it a guarded parking lead to this expected implementation time.

LIFE TIME [2 YEARS]
The area where the Nijverheidsplein is located will be developed from 2019 (section 3.4) so the life time of the solution will be sufficient for the whole period between 2015 and 2017.

SOLUTION 7. IMPROVE ATTRACTIVENESS P+R NIJVERHEIDSPLEIN AT NIGHT WITH BICYCLE (M13+M8)

EFFECTS ON FUNCTIONALITY

NUMBER OF PARKING PLACES [4]
The P+R is currently hardly used by cars at night. The capacity being of 200 places it can be assumed that the total capacity can be used, especially at night. This 200 parking places relate to a score of 4 on this sub criterion.

USERS PARKING COSTS [0]
The price will be the same for the licence holders, so this solution has a score 0. This is because the licence holders are the main user (87%) of the parking places at the Spoorzone and they can park for free at the Nijverheidsplein.

TRAVEL TIME [1]
By bike the travel time from the current parking places at Spoorzone to the P+R is less than 5 minutes, around 2 min so the score is 3.

EFFECTS ON COSTS [1]
Improving the attractiveness at the P+R requires construction of some facilities, such as fences, extra lights, access levers, and maybe some additional costs for eventual safety guard at night or camera.

It is assumed that those construction works will be only executed once, and will thus be cheaper than discounting a parking garage during two years. That is why low score has been assigned.

Additional costs will be due to the necessity to provided bike facilities, such as parking garages or the provision of Public Transport Bicycle. Those costs will not be significant comparing to the discount cost of the Hoven, and then not taken into account. Indeed, it is assumed that most people will use their own bike.

EFFECTS ON ENVIRONMENT

POLLUTION [1]
The Nijverheidsplein is situated at the south side of the neighbourhoods. Because a parking place is for free and the circumstances are improved, it can be assumed that more people are willing to park their car at the Nijverheidsplein. There is a connection by bicycle; therefore it can be assumed that more people will go straight to the Nijverheidsplein because they have their bicycle parked there. This decreases the pollution because less people will search for a parking place in the neighbourhoods.

SUSTAINABILITY [0]
Because an existing parking place can be used there is no need for a new construction that uses ground surface. Therefore, this is a sustainable solution because no surface is used.

LIVEABILITY [1]
The liveability of the neighbourhoods will improve because the cars that are currently parked under the viaduct will be moved out of the area. No street furniture, children playgrounds or green areas are removed.

EFFECTS ON FEASIBILITY

IMPLEMENTATION TIME [4 MONTHS]
Besides the installation of the car security facilities also secured bike parking and/or borrowing facilities should be created. Because these tasks can be done parallel the expected implementation time will be the same as solution 6.

LIFE TIME [2 YEARS]
The area where the Nijverheidsplein is located will be developed from 2019 (section 3.4) so the life time of the solution will be sufficient for the whole period between 2015 and 2017.

SOLUTION 8. INCREASE CAPACITY HUGO DE GROOTSTRAAT PARKING LOT (M35)

EFFECTS ON FUNCTIONALITY

NUMBER OF PARKING PLACES [1]
Around 60 parking places can be gain by building a second level at the Hugo de Grootstraat parking. Indeed currently there are around 90 places, but if a second storey solution is chosen some places will be necessary to implement the access ramp to the second floor. This 60 parking places relate to a score of 1 on this sub criterion.

USERS PARKING COSTS [0]
The costs for the users will be zero as they can park there with a licence C.

TRAVEL TIME [1]
This parking is situated at less than 5 min walk from the current parking places of the Spoorzone.

EFFECTS ON COSTS [3]

The construction of an extra level parking at the Hugo de Grootstraat Parking lot, both by modular or individual mechanical solutions will derived high costs. Indeed, for the individual mechanical solutions the cost of each mechanical facility due to manufacturing, for a simple second level the construction costs will be high. Thus a high score has been assigned.

EFFECTS ON ENVIRONMENT

POLLUTION [1]

The Hugo de Grootstraat parking lot is situated in the neighbourhoods. Because a parking place is secured, there is no need for people to search for a parking place which decreases the pollution.

SUSTAINABILITY [0]

Currently, there is already a parking lot at the Hugo de Grootstraat. This solution only increases the capacity of this parking lot by adding an extra parking level or constructing a parking system for households that have two cars. No extra surface is used because there is already a parking facility. However, the construction of the additional parking place has a negative effect on the sustainability.

LIVEABILITY [-1]

The liveability of the neighbourhoods will deteriorate because more cars will be parked in the neighbourhoods. Also, the view of the inhabitants of the houses that are situated at the parking lot will decrease.

EFFECTS ON FEASIBILITY

IMPLEMENTATION TIME [6 MONTHS]

The modular parking solution that will be implemented is known for the short construction period. Before the construction can start the trees on the square first need to be removed. It should be noted that during this period the square cannot be used for parking.

LIFE TIME [2 YEARS]

Since no plans exist for developing the area where the parking lot is located, the life time of the solution will be sufficient for the whole period between 2015 and 2017.

SOLUTION 9. SPACE AT AMBACHTSSTRAAT (M26)

EFFECTS ON FUNCTIONALITY

NUMBER OF PARKING PLACES [6]

The place available at the Ambachtsstraat has a surface of 1.6 hectares (2Travel2, 2013). It is recognized that for off-street parking between 250 and 370 places can be built per hectare, including access lanes and landscaping, depending on the design (Litman, 2009). Thus, for the surface available between 400 and 592 places could be constructed there. However the Nijverheidsplein which is located nearby consists of 200 places and occupies 1.2 ha. When this ratio is translated to the Ambachtsstraat 266 places can be created. But since the Nijverheidsplein is spaciously designed it is

assumed on the Ambachtsstraat the necessary 300 places can be created. This 300 parking places relate to a score of 6 on this sub criterion.

USERS PARKING COSTS [0]
These parking places could be used by licence holders and a visitor using a visitor's card or paying at the ticket machine. Thus, the price will be the same as now.

TRAVEL TIME [2]
This area is situated at the limit of the 10-15 minutes on the walking distance map.

EFFECTS ON COSTS [3]
Currently at the Ambachtsstraat there is free land use (abandoned) that does not have any purpose. The land is not yet ready to host parking places. It is first necessary to pave the land and put some asphalt, to design the new parking lot, with the access and excess road, and to draw the parking places on the ground. It is assumed that the cost for this solution will be high due to the high cost of the pavement phase.

EFFECTS ON ENVIRONMENT

POLLUTION [2]
The Ambachtsstraat is situated at the south side of the neighbourhoods. Because there is no connection with the neighbourhoods, it can be assumed that people first try to search for a parking place in the neighbourhoods before going to the Ambachtsstraat.

SUSTAINABILITY [-1]
Currently, there is no parking at the Ambachtsstraat so new parking places should be constructed. The area at the Ambachtsstraat is 1.6 ha. Because the parking area needs to be newly constructed the sustainability of this solution is low.

LIVEABILITY [1]
The liveability of the neighbourhoods will improve because the cars that are currently parked under the viaduct will be moved out of the area. No street furniture, children playgrounds or green areas are removed.

EFFECTS ON FEASIBILITY

IMPLEMENTATION TIME [6 MONTHS]
The area where the parking lot will be created needs to be levelled and subsequently covered with tarmac. After this lines and lampposts should be added.

LIFE TIME [2 YEARS]
The area where the Ambachtsstraat is located will be developed from 2019 (section 3.4) so the life time of the solution will be sufficient for the whole period between 2015 and 2017.

SOLUTION 10. SPACE AT AMBACHTSSTRAAT WITH BICYCLE (M26+M8)

EFFECTS ON FUNCTIONALITY

NUMBER OF PARKING PLACES [6]

The place available at the Ambachtsstraat has a surface of 1.6 hectares (2Travel2, 2013). It is recognized that for off-street parking between 250 and 370 places can be built per hectare, including access lanes and landscaping, depending on the design (Litman, 2009). Thus, for the surface available between 400 and 592 places could be constructed there. However the Nijverheidsplein which is located nearby consists of 200 places and occupies 1.2 ha. When this ratio is translated to the Ambachtsstraat 266 places can be created. But since the Nijverheidsplein is spaciously designed it is assumed on the Ambachtsstraat the necessary 300 places can be created. This 300 parking places relate to a score of 6 on this sub criterion.

USERS PARKING COSTS [0]

These parking places could be used by licence holders and a visitor using a visitor's card or paying at the ticket machine. Thus, the price will be the same as now.

TRAVEL TIME [1]

By bike it will take less than 5 min.

EFFECTS ON COSTS

Currently at the Ambachtsstraat there is free land use (abandoned) that does not have any purpose. The land is not yet ready to host parking places. It is first necessary to pave the land and put some asphalt, to design the new parking lot, with the access and excess road, and to draw the parking places on the ground. It is assumed that the cost for this solution will be high due to the high cost of the pavement phase.

Additional costs will be due to the necessity of providing bike facilities, such as parking garages or the provision of Public Transport Bicycle. Those costs will not be significant comparing to the discount cost of the Hoven, and then not taken into account. Indeed, it is assumed that most people will use their own bike.

EFFECTS ON ENVIRONMENT

POLLUTION [1]

The Ambachtsstraat is situated at the south side of the neighbourhoods. Because there is a bicycle connection with the neighbourhoods it is likely that some inhabitants go to the Hoven immediately because they have their bicycle parked there. Therefore, it can be assumed that less people will search in the neighbourhoods for a parking place which decreases the pollution.

SUSTAINABILITY [-1]

Currently, there is no parking at the Ambachtsstraat so new parking places should be constructed. The area at the Ambachtsstraat is 1,6 ha (2Travel2, 2013). Because the parking area needs to be newly constructed the sustainability of this solution is low.

LIVEABILITY [1]
The liveability of the neighbourhoods will improve because the cars that are currently parked under the viaduct will be moved out of the area. No street furniture, children playgrounds or green areas are removed.

EFFECTS ON FEASIBILITY

IMPLEMENTATION TIME [7 MONTHS]
The bicycle facilities can be added after the area is covered with tarmac, but can start before the other aspects are added (lines, lightning). Therefore the implementation time is expected to be one month longer than in solution 9.

LIFE TIME [2 YEARS]
The area where the Ambachtsstraat is located will be developed from 2019 (section 3.4) so the life time of the solution will be sufficient for the whole period between 2015 and 2017.

SOLUTION 11. SPACE AT AMBACHTSSTRAAT WITH PUBLIC TRANSPORT (M26+M9)

EFFECTS ON FUNCTIONALITY

NUMBER OF PARKING PLACES [6]
The place available at the Ambachtsstraat has a surface of 1.6 hectares (2Travel2, 2013). It is recognized that for off-street parking between 250 and 370 places can be built per hectare, including access lanes and landscaping, depending on the design (Litman, 2009). Thus, for the surface available between 400 and 592 places could be constructed there. However the Nijverheidsplein which is located nearby consists of 200 places and occupies 1.2 ha. When this ratio is translated to the Ambachtsstraat 266 places can be created. But since the Nijverheidsplein is spaciously designed it is assumed on the Ambachtsstraat the necessary 300 places can be created. This 300 parking places relate to a score of 6 on this sub criterion.

USERS PARKING COSTS [0]
These parking places could be used by licence holders and a visitor using a visitor's card or paying at the ticket machine. Thus, the price will be the same as now. In addition, it is consider that free public transport ticket will be provided to the people that park there, so there will not face any additional costs.

TRAVEL TIME [3]
Bus 81 or Tram 1 could be used to reach the current parking place at Spoorzone. The whole trip will take between 10 to 15 minutes without taking into account the waiting time. Thus the travel time is the same than walking and larger than using the bike.

EFFECTS ON COSTS [4]
Currently at the Ambachtsstraat there is free land use (abandoned) that does not have any purpose. The land is not yet ready to host parking places. It is first necessary to pave the land and put some asphalt, to design the new parking lot, with the access and excess road, and to draw the parking

places on the ground. It is assumed that the cost for this solution will be high due to the high cost of the pavement phase.

Additional costs will be due to the fact that free Public Transport tickets will be provided to the people that parked there in order to reach their final destination. This cost will be quite significant that is why a very high score is assigned.

EFFECTS ON ENVIRONMENT

POLLUTION [2]
The Ambachtsstraat is situated at the south side of the neighbourhoods. There is a free public transport connection which causes more inhabitants to park their carat the parking area. However, it can be assumed that inhabitants first try to find a parking place in their neighbourhoods before going to the Nijverheidsplein.

SUSTAINABILITY [-1]
Currently, there is no parking at the Ambachtsstraat so new parking places should be constructed. The area at the Ambachtsstraat is 1,6 ha. Because the parking area needs to be newly constructed the sustainability of this solution is low.

LIVEABILITY [1]
The liveability of the neighbourhoods will improve because the cars that are currently parked under the viaduct will be moved out of the area. No street furniture, children playgrounds or green areas are removed.

EFFECTS ON FEASIBILITY

IMPLEMENTATION TIME [7 MONTHS]
Besides the creation of the new parking lot also an agreement with the bus operator (Veolia) should be reached about compensation. Because these tasks can be done parallel the expected implementation time will be the same as solution 9.

LIFE TIME [2 YEARS]
The area where the Ambachtsstraat is located will be developed from 2019 (section 3.4) so the life time of the solution will be sufficient for the whole period between 2015 and 2017.

SOLUTION 12. LIMIT ACCESS OF VISITORS TO PHOENIXGARAGE COMBINED WITH AN DISCOUNT FOR LICENCE HOLDERS (M4+M49)

EFFECTS ON FUNCTIONALITY

NUMBER OF PARKING PLACES [4]
With this solution 202 places will be gained, as the whole garage will be made available only for residents of area B and C. This 202 parking places relate to a score of 4 on this sub criterion.

USERS PARKING COSTS [1]
If it is consider that by reserving the parking to the residents they still have to pay the price of the parking, the costs will increase considerably for them.

TRAVEL TIME [1]
The travel time to the final destination will be the same as this garage is situated at 100 meters from the Spoorzone parking places.

EFFECTS ON COSTS [3]
Providing discount for licence holders needs implementation as well as operation costs. Discounts decrease the profits of the parking operator, for which it should be compensated. In addition, the current users of the garage could not park at the parking anymore and a 100% utilization rate cannot be guarantee to the operator of the garage. Besides compensation, operation costs are not significantly higher than usual. An advantage of this solution is there are not any construction costs involved. That is why a high cost has been assigned.

EFFECTS ON ENVIRONMENT

POLLUTION [2]
The Phoenixgarage is situated at the border of the neighbourhoods. Because visitors will park at other places, more space will become available in the Phoenixgarage. Visitors have to search for new places which causes an increase of pollution.

SUSTAINABILITY [0]
Because an existing parking garage can be used there is no need for a new construction that uses ground surface. Therefore, this is a sustainable solution because no surface is used.

LIVEABILITY [1]
The liveability of the neighbourhoods will improve because the cars that are currently parked under the viaduct will be moved out of the area. No street furniture, children playgrounds or green areas are removed.

EFFECTS ON FEASIBILITY

IMPLEMENTATION TIME [1 MONTH]
Since only a policy adjustment is needed and no physical adjustments are necessary the implementation time is expected to short. Only an agreement about the compensation should be reached with Parking Delft, the owner of the parking facility. But because it is a radical measure it is expected the negations will be a more complex. Therefore a longer implementation time is expected than in case of solution 4 or 5.

LIFE TIME [2 YEARS]
Since the Phoenixgarage will exist for the coming years, the life time of the solution will be sufficient for the whole period between 2015 and 2017.

F. EXPLANATION OF THE PAIR-WISE COMPARISON OF THE CRITERIA

In this appendix the calculation to compute the weight for each criterion and sub-criterion of the MCDA will be explained. First the weights for the problem owners' point of view will be clarified, after this the weights for the main stakeholders will be explained. For each case, first the table in which the computations were made will be presented before explaining why these weights are assigned.

F.1 PROBLEM OWNER PAIR-WISE COMPARISON

First, it was necessary to determine the weight for the main criteria.

TABLE 28: WEIGHT VISION OF THE PROBLEM OWNER

Point of view from: Problem Owner							
CCL, ProRail and Municipality of Delft							
	Functionality	Costs	Environment	Feasibility	Totals	Double Total	Weights
Functionality	-	0	1	0	1	2	0.15
Costs	1	-	1	1	3	6	0.46
Environment	0	0	-	0	0	1	0.08
Feasibility	1	0	1	-	2	4	0.31
Total							1

From the interview with the problem owner (CCL, ProRail and the Municipality of Delft) it has been revealed that the solution costs are the main preoccupation of the problem owner. They want to find a solution as cheap as possible, as they do not have a specific budget allocate for the implementation of the solution. This is why the solution costs outperform all the other criteria. The second main preoccupation of the problem owner is the feasibility of the solution. They do not want to execute significant construction works for a temporary solution. Thus, feasibility outperforms environmental impact and functionality. Finally, it seems that the problem owner gives more interest to the functionality of the solution than to the environmental impact.

TABLE 29: PAIR-WISE COMPARISON SUB-CRITERIA FUNCTIONALITY

Sub-criteria criterion Functionality						
	Number of parking places	Parking costs for users	Walking distance	Totals	Double Total	Weights
Number of parking places	-	1	1	2	4	0.09
Parking costs for users	0	-	1	1	2	0.04
Walking distance	0	0	-	0	1	0.02
Total						0.15

It was assumed that the main goal of the problem owner is to provide enough parking places in order to match the current demand. This is why it is considered that the sub-criteria number of parking

places is more important than the parking costs for the users and the walking distance to the final destination. It is also assumed that the problem owner gives more importance to the parking costs for the users than to the walking distance, because it is considered that they will receive more complaints from inhabitants if the solution is expensive than if it is situated further away .

TABLE 30: PAIR-WISE COMPARISON SUB-CRITERIA ENVIRONMENT

Sub-criteria Environment						
	Pollution	Sustainability	Liveability of the neighbourhoods	Total	Double Total	Weights
Pollution	-	0,5	1	1,5	3	0.03
Sustainability	0,5	-	1	1,5	3	0.03
Liveability of the neighbourhoods	0	0	-	0	1	0.01
Total						0.08

Among the problem owners there is the municipality of Delft. One of the roles of the municipality is to ensure good quality of life for its inhabitants. Pollution will have impact on the whole city whereas the decrease of the liveability of the neighbourhood Olofsbuurt-Westerkwartier will only impact this specific area. That is why the criteria pollution outperforms the liveability. Sustainability and pollution are judged as important. Indeed, the pollution will influence the whole city of Delft but the decrease of sustainability as well, as less green land will be available in the city. For the same reason sustainability outperforms liveability.

TABLE 31: PAIR-WISE COMPARISON SUB-CRITERIA FEASIBILITY

Sub-criteria Feasibility					
	Implementation time	Life time of solution	Total	Double Total	Weights
Implementation time	-	0.5	0.5	1	0.15
Life time of solution	0.5	-	0.5	1	0.15
Total					0.31

Finally, implementation time and the life time of the solution are considered as important for the problem owner. If the solution is not provided when the viaduct will be removed, the municipality will face lots of complaints from the parking users. In addition, the problem owner does not want to replace the solution during the period of two years in order to limit the costs.

F.2 MAIN STAKEHOLDER PAIR-WISE COMPARISON

First, it was necessary to determine the weight for the main criteria.

TABLE 32: WEIGHT VISION OF THE MAIN STAKEHOLDER

Point of view from: Stakeholder							
Residents from the neighbourhoods Olofsbuurt-Westerkwartier that park in the Spoorzone Delft							
	Functionality	Costs	Environment	Feasibility	Totals	Double Total	Weights
Functionality	-	1	1	1	3	6	0.46
Costs	0	-	0	0	0	1	0.08
Environment	0	1	-	1	2	4	0.31
Feasibility	0	1	0	-	1	2	0.15
Total							1.00

According to the current users of the parking places the main criterion to be fulfilled is the functionality of the solution; they do not want to lose out from the temporary solution. Thus this criterion outperforms all the others. The second most important criterion is the environmental impacts. The inhabitants of Olofsbuurt-Westerkwartier want to keep their quality of life and do not want that the solution damage their environment. Finally, the users have no interest in the costs that the solution will cause to the problem owner. They give more importance to the feasibility of the solution to be sure that a solution will be provided to them.

TABLE 33: PAIR-WISE COMPARISON SUB-CRITERIA FUNCTIONALITY

Sub-criteria of criterion functionality						
	Number of parking places	Parking costs for users	Walking distance	Total	Double Total	Weights
Number of parking places	-	0	1	1	2	0.13
Parking costs for users	1	-	1	2	4	0.26
Walking distance	0	0	-	0	1	0.07
Total						0.46

The pair wise comparison done for the sub-criteria functionality is based on the results of the MSc Thesis realized by M. Chaniotakis. According to his results the key factors that influence where people will park are ranked as follow:

1. Price
2. Probability of finding a vacant parking spot after looking for it for eight minutes
3. Walking distance

In our pair-wise comparison the sub-criterion number of parking places determined the probability of finding a vacant spot. Therefore, the score pair-wise comparison is now evident.

TABLE 34: PAIR-WISE COMPARISON SUB-CRITERIA ENVIRONMENT

Sub-criteria of criterion environment						
	Pollution	Sustainability	Liveability of the neighbourhoods	Total	Double total	Weights
Pollution	-	1	0	1	2	0.09
Sustainability	0	-	0	0	1	0.04
Liveability of the neighbourhoods	1	1	-	2	4	0.18
Total						0.31

According to the point of view of the inhabitant of the neighbourhoods the liveability of their neighbourhoods is the most important sub-criterion. They do not want to decrease their quality of life in order to have more parking places. Pollution is the second most important sub-criterion because the inhabitants want to live in an environment with clean air. The sustainability is judged as less important because other green areas are available in Delft and these neighbourhoods are already really dense.

TABLE 35: PAIR-WISE COMPARISON SUB-CRITERIA FEASIBILITY

Sub-criteria criterion feasibility					
	Implementation time	Life time of solution	Total	Double total	Weights
Implementation time	-	0.5	0.5	1	0.08
Life time of solution	0.5	-	0.5	1	0.08
Total					0.15

The main stakeholders give as much interest to the implementation time as to the life time of the solution. They want the solution to be ready on time and they also want to have a solution during the two years (2015-2017).