Between mobility and monuments
A search for possible synergy between mobility and industrial heritage

Steven Delemarre
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This report presents the end result of a master thesis work conducted for the MsC program ‘Transport, Infrastructure and Logististics’ (TIL) at Delft University of Technology. Together with close external and internal support, this thesis project highlights the possible opportunity to co-operate industrial heritage in mobility problems of a city.

This thesis work could not have been conducted without extensive help. First of all I would like to thank my thesis committee members affiliated to TU Delft for critically reviewing my texts, underlying figures and outcomes of the research and design parts of this thesis work: Prof.dr.ir. B. van Arem, dr.ir. J.H. Baggen and dr.ir. R. van Nes.

Additionally I would like to thank my external thesis committee member Prof.dr.ir. J.A.A.M. Stoop from the foundation ‘Behoud Erfgoed De Vries Robbé’ for introducing me to municipality Gorinchem, the opportunity to research this interesting and relevant subject and for his extensive comments on all the work.

Another thanks goes to the employees of the municipality of Gorinchem for their co-operation, especially to E. van Wel and P.P. van der Werff.

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Enjoy reading,

Steven Delemarre
Delft, July 2015
SAMENVATTING

Er zijn in Nederland veel oude steden met een historische kern waarin het dagelijks woonwerkverkeer leidt tot ertegenissen en opstoppingen. Daarnaast kunnen in deze steden oude industrieel gebruikte gebouwen leeg staan, die men tot industrieel erfgoed kan rekenen en dus wil behouden voor de toekomst. De vraag die in dit afstudeer project werd onderzocht is dan ook:

“Is het mogelijk de leefbaarheid voor bewoners van een oude stadskern te verbeteren door de verkeersproblemen op te lossen, gebruik makend van industrieel erfgoed dat men een nieuwe functie geeft?”

Dit probleem speelt ook in Gorinchem en die stad speelt dus de hoofdrol in dit onderzoek. Gorinchem verwierf in 1382 zijn stadsrechten. Met de jaren groeide de stad tot één van de belangrijkste steden in de regio. De stad speelde belangrijke rollen in verschillende oorlogen, wat nog te herkennen is aan de vormgeving van de stad, het centrum wordt gekenmerkt door het oude fort deel uitmakend van de historische waterlinie met zijn bastions. De uitbreiding van de stad beurtelings met een industriewijk, dan weer met een woonwijk, maakt dat deze thans naast en tussen elkaar gesitueerd zijn. De nauwe straten in de stadskernen en de industrie gelegen tussen woonwijken hebben geleid tot diverse mobiliteitsproblemen in en rond Gorinchem.


Naast de mobiliteitsproblemen in Gorinchem, is er nog een probleem in de stad. De stichting Behoud Erfgoed De Vries Robbé heeft als doel de leegstaande loods op de locatie Linge II Zuid voor de toekomst te bewaren als industrieel erfgoed. Om dit te kunnen doen zoekt de stichting een nieuwe functie voor deze loods.

Beide problemen hebben als raakvlak het nieuwe bestemmingsplan van de binnenstad. In dit plan wordt de locatie Linge II Zuid aangewezen als een ontwikkelingsgebied, wat betekent dat de gemeente uitgewerkte plannen voor het gebied in beraad neemt. Een overeenkomst tussen beide problemen is dat beide probleemhouders partners zoeken om hun probleem op te lossen.

Samenvattend: Het onderwerp van dit onderzoek is het vinden van een oplossing voor de mobiliteitsproblemen in Gorinchem door het herdefiniëren van de functie van de leegstaande loods van de stichting Behoud Erfgoed De Vries Robbé op de locatie Linge II Zuid.

In het algemeen kan men twee vervoersstromen onderscheiden, namelijk personenvervoer en vrachtvervoer. Personenvervoer kan onderverdeeld worden in het privaat transport en openbaar vervoer. Privé transport is het creëren van eigen vervoer d.m.v. auto, fiets en/of lopen instantaan op het moment dat men dat wil. Openbaar vervoer is het vervoer waar een derde persoon en/of bedrijf betrokken is welke veelal tegen betaling en op gezette tijden het vervoer verzorgd.
Vrachtvervoer kan omschreven worden als het vervoer tegen betaling van goederen, cargo of bulk. Om de mogelijkheden te onderzoeken waarmee de problemen veroorzaakt door de twee vervoersstromen te verminderen zijn, is in de literatuur onderzoek gedaan.

Om de problemen vanuit het personenvervoer te verminderen, kan een Park & Ride (P&R) faciliteit geïntroduceerd worden. Deze faciliteiten liggen meestal aan de rand van de stad, om vervolgens de gebruikers met openbaar vervoer naar hun bestemming te brengen. In Dordrecht is reeds een P&R faciliteit dicht bij het centrum gerealiseerd, waar men de auto kan parkeren en vandaaruit kan men de stad lopend bereiken.

Eenzelfde idee kan geïntroduceerd worden voor het vrachtvervoer, namelijk een Stedelijk Consolidatie Centrum (SCC). Dit centrum verzamelt, slaat op en distribueert vracht met een bestemming in het centrum. Door het bundelen van het vracht, wordt de bezettingsgraad van de vrachtwagens verhoogd, waardoor er minder nodig zijn en het aantal vracht kilometers verminderd wordt.


In Gorinchem zijn door de hele stad beschermd de stadsgezichten te vinden. De Rotonde is een rijksmonument. Om ook de leegstaande loods in aanmerking te laten komen als monument, moet deze gerenoveerd worden door er een nieuwe functie aan toe te kennen. Om te onderzoeken wat de mogelijkheden zijn op het gebied van industrieel erfgoed, zijn referentie projecten gezocht. De succesvolle projecten zijn renovaties, waarbij het industrieel erfgoed meerdere functies heeft gekregen. Door deze multifunctionaliteit zijn vaak ook verschillende partners te vinden om het project te financieren.

Naast verschillende sterke punten bij het renoveren van industrieel erfgoed, zijn er ook bedreigingen. De bedreigingen hebben een aantal thema’s:

- Logistiek: *is de locatie voldoende bereikbaar en is de capaciteit voldoende?*
- Demografisch: *Is de locatie attractief genoeg om voldoende gebruikers en/of bezoekers te trekken?*
- Geografisch: *Is de locatie uniek genoeg of zijn er in de regio overeenkomstige projecten te vinden?*

De probleem analyse van de mobiliteit heeft verschillende raakvlakken met de probleem analyse van het industriële erfgoed. Het eerste raakvlak is het toewijzen van nieuwe functie aan een gebied binnen de gemeente. De gemeente zou de mobiliteitsproblemen kunnen verminderen door het introduceren van een P&R faciliteit en/of SCC. De stichting wilt de leegstaande loods op Linge II Zuid renoveren door het herdefiniëren van zijn functie. Beide problemen zouden samen kunnen op gaan door de loods in te richten als P&R faciliteit of SCC. Een tweede overeenkomst is dat in beide gevallen partners nodig zijn om de projecten te laten slagen.

Vanuit de probleem analyses zijn verschillende criteria naar voren gekomen, waarop de P&R faciliteit en/of SCC kunnen worden beoordeeld: milieu effecten, het aantal voertuig kilometers in de stad, leefbaarheid en als laatste de financiële haalbaarheid van de projecten.

De projecten hebben een locatie nodig om ze te vestigen. In Gorinchem zijn zes locaties beschikbaar, waaronder het industrieel erfgoed Linge II Zuid van De Vries Robbé & Co. De locaties kunnen
verdeeld in die welke aan de rand gelegen zijn en die dicht bij de binnenstad gesitueerd zijn. De locaties, beschikbaar aan de rand van de stad, zijn: de industrie parken Avelingen en Gorinchem Oost II en het huidige terrein van het Hotel Gorinchem (Stalkaarsen). De locaties, beschikbaar richting de binnenstad, zijn: de parkeergarage Kweeklust, het industrieeel erfgoed Linge II Zuid en het parkeerterrein van de fabriek Mercon Steel Structures BV. De locaties Kweeklust en Mercon Steel Structures BV kunnen alleen gebruikt worden als een P&R facilitie en niet als een SCC.

Om de P&R faciliteiten in Gorinchem te evalueren wordt gebruik gemaakt van logit modellen: “multinomial” (MNL) en “nested logit” (NL). Het MNL model berekent de kans dat de P&R facilitie op een locaties wordt gebruikt. Het MNL model kan vooral gebruikt worden indien de bezoeker éénmalig een keuze kan maken welk vervoersmiddel hij/zij wil gebruiken. Dit is vooral van toepassing bij een Park & Walk faciliteit, die dichtbij de binnenstad gelegen is. Het MNL model geeft aan dat de kans dat een bezoeker gebruikt maakt van de P&W faciliteit ligt tussen de 6,9 en 9,2 procent van het aantal bezoekers (geschat op 220.000 per jaar). De uitkomsten van MNL logit model zijn echter niet realistisch indien de keuzes bij het gebruik van een vervoersmiddel elkaar beïnvloeden, zoals bij een P&R facilitie. Immers, indien een bezoeker op de P&R faciliteit arriveert, moet deze kiezen tussen verder lopen, een taxi nemen of wachten op de bus. In dat geval is een NL model beter en geeft realistischer resultaten. De resultaten van het NL model worden gekenmerkt door een bandbreedte waarbinnen de kans ligt dat de P&R facilitie op een bepaalde locaties wordt gebruikt. De onderstaande tabel laat de bandbreedte voor de P&R faciliteiten zien.

Tabel 1, Bandbreedte van de kans dat men een P&R faciliteiten gebruikt

<table>
<thead>
<tr>
<th>Locatie</th>
<th>Bovengrens %</th>
<th>Ondergrens %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avelingen</td>
<td>5,8</td>
<td>3,4</td>
</tr>
<tr>
<td>Oost II</td>
<td>3,9</td>
<td>2,2</td>
</tr>
<tr>
<td>Stalkaarsen</td>
<td>4,9</td>
<td>2,6</td>
</tr>
</tbody>
</table>

De P&R faciliteiten verminderen in alle gevallen het aantal afgelegde kilometers in de stad en verminderen de uitstoot. Helaas echter leveren alle faciliteiten qua milieu aspecten, het verminderen van voertuig kilometers en het verbeteren van de leefbaarheid niet veel op. Doordat het overige verkeer door blijft gaan, zal het verschil tussen de huidige en de nieuwe situatie nauwelijks merkbaar zijn. Ook doordat de industrie en de inwoners blijven uitstoten, zullen de positieve effecten nog verder te niet gedaan worden. Vanuit financieel oogpunt zijn de parkeergelegenheden van Kweeklust en Mercon Steel Structures BV het beste, omdat deze gelegenheden al bestaan. Om gebruik te mogen maken van de parkeerlocatie van Mercon Steel Structures BV zal de gemeente een deal moeten maken met de fabriek om de extra investeringen te bekostigen. De overige locaties moeten nieuw gebouwd worden, zodat kosten van deze P&R faciliteiten hoger zullen zijn. De financiële situatie van de P&R faciliteiten zijn weergegeven in tabel 2.

Tabel 2, Overzicht van de financiële situaties per locatie

<table>
<thead>
<tr>
<th>P&amp;R facilitie</th>
<th>Mogelijke jaarlijkse gebruikers</th>
<th>Benodigde parkeerplaatsen</th>
<th>Jaarlijkse kosten</th>
<th>Parkeerkosten per parkeerplaats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avelingen</td>
<td>12,760</td>
<td>35</td>
<td>€ 13,680</td>
<td>€ 1.08</td>
</tr>
<tr>
<td>Oost II</td>
<td>8,580</td>
<td>24</td>
<td>€ 10,260</td>
<td>€ 1.20</td>
</tr>
<tr>
<td>Stalkaarsen</td>
<td>10,780</td>
<td>30</td>
<td>€ 13,680</td>
<td>€ 1.27</td>
</tr>
<tr>
<td>Linge II Zuid</td>
<td>20,240</td>
<td>55</td>
<td>€ 20,520</td>
<td>€ 1.02</td>
</tr>
</tbody>
</table>
Om de SCC’s te kunnen beoordelen is gebruik gemaakt van verschillende scenario’s, waarin het percentage deelnemers en het type voertuig dat gebruikt wordt voor de distributie varieert. De 4 scenario’s zijn: volledige participatie met brandstof voertuigen, volledige participatie met elektrische voertuigen, gelimiteerde participatie met brandstof voertuigen en gelimiteerde participatie met elektrische voertuigen. Alle locaties zijn beoordeeld op de vier criteria die volgden uit de analyses. De onderstaande tabel laat een Multi Criteria Analyse (MCA) zien hoe de SCC’s scoren op de genoemde criteria.

Tabel 3, Multi Criteria Analyse voor de Stedelijke Consolidatie Centrum

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Huidige situatie</th>
<th>Volledige participatie met brandstof scenario</th>
<th>Volledige participatie met elektrisch scenario</th>
<th>Partiële participatie met brandstof scenario</th>
<th>Partiële participatie met elektrisch scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milieu effecten</td>
<td>0 / +</td>
<td>0 / +</td>
<td>0 / +</td>
<td>0 / +</td>
<td>0 / +</td>
</tr>
<tr>
<td>Voertuig kilometers in de stad</td>
<td>0 ++</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Leefbaarheid</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Financieel haalbaarheid</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

De MCA laat zien dat de SCC’s, waarbij volledige participatie wordt bereikt, positief scoren op alle criteria behalve de financiële haalbaarheid. Echter, dezelfde opmerkingen als bij de P&R faciliteiten moet gemaakt worden. Door het introduceren van een SCC, daalt de uitstoot van het vrachtverkeer. Maar doordat de uitstoot van de industrie en de inwoners door gaat, zal de vermindering nauwelijks merkbaar zijn.

Het leefbaarheids criterium toont een verschil tussen de volledige en partiële. Doordat een nieuwe service wordt toegevoegd, waarvan niet elke winkeleigenaar gebruikt maakt, wordt het ongemak voor de inwoners alleen maar groter. Een SCC met partiële participatie heeft dus een negatief effect op de leefbaarheid binnen een stad.

Op het criterium van financiële haalbaarheid scoren alle scenario’s negatief. De hoge investeringskosten, de jaarlijkse kosten en de beperkte hoeveelheid vracht, die een SCC kan verzorgen, maken het niet mogelijk dat een SCC winstgevend kan bestaan zonder het ontvangen van subsidies.

Rekening houdend met alle bovenstaande aspecten, kan de onderzoeksvraag: “Is het mogelijk de leefbaarheid voor bewoners van een oude stadskern te verbeteren door de verkeersproblemen op te lossen, gebruik makend van industrieel erfgoed dat men een nieuwe functie geeft?” beantwoord worden.

In een stad zijn de mobiliteitsproblemen te verminderen en de leefbaarheid is te verbeteren, door het introduceren van een P&R faciliteit en/of SCC. Deze faciliteiten bundelen de verschillende vervoerstromen, waardoor het aantal afgelegde kilometers zal afnemen.

Ook in het geval van Gorinchem is gebleken dat deze faciliteiten de leefbaarheid verbeteren. Maar door de beperkte omvang van de stad en de relatief geringe hoeveelheid vracht die gebundeld kan worden, behalen de faciliteiten niet de voorgenomen financiële haalbaarheid. Deze aanbevelingen gelden alleen voor het gemeentebestuur. Voor de stichting Behoud Erfgoed De Vries Robbé, welke
als doel heeft het behoud van de leegstaande loods op Linge II Zuid, is nagegaan of deze locatie gebruikt kan worden als P&W faciliteit en/of SCC. Uit de berekeningen blijkt dat weliswaar een P&W faciliteit mogelijk is, maar de aanwezigheid van de recent gerenoveerde en weinig gebruikte Kweeklust parkeergarage, zal maken dat het gemeentebestuur niet bereid zal zijn de renovatie van de loods te subsidiëren. Hoewel de leefbaarheid in de stad zal verbeteren, zal door de locatie dichtbij het centrum het verkeer in de stad niet afnemen omdat de bezoekers nog steeds Gorinchem moeten doorkruisen. Als de locatie ingericht wordt als SCC, zal het vrachtverkeer ook gedwongen blijven door de stad te rijden. Bovendien zal de SCC niet financieel levensvatbaar zijn, gelet op de geschatte hoeveelheid vracht die verzorgd kan worden. Om een definitieve keuze te maken over het project, moet er echter niet alleen naar de financiële situatie gekeken worden. Andere aspecten, zoals de historische waarde, moeten ook meegenomen worden in de afweging. Vanuit de referentie projecten is gebleken dat monumentale renovaties in andere contexten wel degelijk tot succes kunnen leiden.
EXECUTIVE SUMMARY

In the Netherlands there are many cities with an old, historical city centre, in which daily traffic leads to inconveniences for the inhabitants and congestion. In these cities there may also be vacant industrial buildings, which one can assign as industrial heritage and accordingly wants to preserve. In order to combine the power of the two problems, the principal research question in this work has been formulated as:

“How can liveability related with mobility for inhabitants of a relatively small, old municipality be improved in synergy with preservation of monumental buildings by redefining their function?”

Gorinchem, an old town that received its city charter in 1382, has these problems and plays the leading role in this research. By its situation at the junction of two rivers, the ‘Boven Merwede’ and the ‘Linge’, the small city played a major role during many wars. This can still be recognised in the city centre by the fortification of the Dutch ‘Waterlinie’ and its ramparts. In the years, the city increased in size and industry became situated next to residential areas. By the alternating increase of residential area and industrial area, the city now knows places where industry is situated in between residential areas. Both the narrow streets of the old city centre and the industry within the city have introduced the mobility problems in Gorinchem.

The mobility problems have several aspects. In the whole town there exist congestion and blockades. In the city centre, due to the narrow streets and the fact that the delivery drivers do not use the available loading/unloading places, blockades are formed. During loading/unloading, the trucks stand on the side of the small streets, which makes the available space for other traffic too narrow to overtake. Emissions are also an overall theme that result from traffic in cities. The emissions can be divided in air and noise emissions. From previous research it is clear that the number of daily limits for fine particulars is exceeded in Gorinchem. The city council of Gorinchem wants to become more sustainable and has to take measures against the current amount of air emissions. Noise emissions will increase over time due to increasing traffic numbers.

Apart from its mobility problems, Gorinchem has another problem. The foundation ‘Behoud Erfgoed De Vries Robbé’ has the intention to preserve location Linge II Zuid and the empty storage facility, which is situated on this location, as industrial heritage. The foundation is currently looking for a new function for this storage facility.

The common ground of both problems is formed by the new zoning plan for the inner city. Location Linge II Zuid has been marked as a development area. As there are no detailed plans for any redevelopment yet, the city council will accept detailed plans for redevelopment of Linge II Zuid. Both the city council and the foundation need co-investors to solve their problems.

In conclusion: The subject of this work is to find a solution for the mobility problems in Gorinchem by redefining the function of the empty storage facility of the foundation ‘Behoud Erfgoed De Vries Robbé’ on ‘Linge II Zuid’.

In general, mobility can be divided in two kinds of transport flow: flow resulting from transport of human beings and freight transport. Transport of human beings can be differentiated in private transport (creating own transportation) and public transport (paid third parties are involved which organise the transport at set times). Freight transportation, whether by water, land or air, comprises the transport of goods, cargo or bulk by a transport service for which it is paid. To find solutions for both mobility problems, literature and reference projects were studied.
To reduce the amount of passenger flow, a Park & Ride (P&R) facility can be introduced. P&R facilities are usually located in the suburbs of a town. However, a reference project in Dordrecht, the Netherlands, showed that P&R facilities closer to the city centre are also successful. To reduce the amount of freight transport in a city, an Urban Consolidation Centre (UCC) can be introduced in the city logistics. Such a Centre collects, stores and bundles multiple shipments from retailers in order to deliver the freight with the Centre’s vehicles, improving the occupancy rate of their freight vehicles. Both the P&R facility and the UCC have the same method: bundling the in and out going transport flows, where the P&R facility bundles visitors and the UCC, freight. This results in traffic reduction. Although both facilities use the same process, they can’t be combined, due to the difference in time needed for entry and exit and to load and unload.

In whole Gorinchem there are conservation areas. The ‘Rotonde’ is a so-called monument. In order to be recognized as monument, the empty storage facility has to be renovated by redefinition of its function. To be successful, reference projects concerning industrial heritage have been investigated and showed that redefining the function of the heritage may turn the building into a useful object. Multi-functionality is an opportunity to find co-investors for redevelopment, making the chance for financial viability bigger. Apart from strong points in redefining the function of industrial heritage, there are also threats, which can be assigned on multiple aspects:

- Logistics; *is the accessibility and capacity of the location sufficient enough?*
- Demographically; *does the location attracts sufficient numbers of users/visitors?*
- Geographically; *is the location unique or are there other locations in the region like the project involved?*

The analysis of the mobility problem has a common ground with the analysis of the problems of the foundation’s industrial heritage. One has to indicate a new function to a location/building within the city. The council may solve its mobility problem by introducing a P&R facility and/or UCC, the foundation may redefine the function of the empty storage facility as Park & Walk (P&W) facility and/or UCC, merging both projects.

To assess a P&R facility and an UCC in Gorinchem, review criteria can be distilled from the reference projects and the literature, which are: environmental effects, vehicle kilometres in the city, liveability and financial feasibility. In order to assess the situation in Gorinchem, possible alternatives had to be developed.

The P&R facility and the UCC need a location to be established. With the reference projects in mind, six locations, among which industrial heritage ‘Linge II Zuid’ owned by the foundation, can be concerned as suitable locations. In the suburbs are located: the industrial park Avelingen, Gorinchem Stalkaarsen and Gorinchem Oost II and closer to the historical centre: Kweeklust, ‘Mercon Steel Structures BV’ parking facility and Linge II Zuid. The locations: Kweeklust and ‘Mercon Steel Structures BV’ parking facility can only be used as P&W facility and not as UCC.

In order to evaluate the effects of a P&R facility in Gorinchem on the passengers flow, two types of logit model have been applied to calculate the number of potential users: the multinomial (MNL) and nested logit (NL) model. The ‘simple’ MNL model calculates the probabilities for situations in which the visitor can only make one decision. This situation holds for the P&W facilities localised close to the city centre. The P&W facilities score probabilities between 6.9 and 9.2 per cent of the number yearly visitors (estimated 220,000). In the more complicated situation, where there is an interdependency between a set of transport modes from which a choice can be made, the NL model gives more realistic results with an upper and lower bound. This situation holds for the suburb located P&R facilities. The bandwidth for the three suburb located sights are given in Table 1.
Table 1, Bandwidth of the probabilities for the suburb locations

<table>
<thead>
<tr>
<th>Location</th>
<th>Upper bound</th>
<th>Lower bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avelingen</td>
<td>5.8 %</td>
<td>3.4 %</td>
</tr>
<tr>
<td>Oost II</td>
<td>3.9 %</td>
<td>2.2 %</td>
</tr>
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<td>Stalkaarsen</td>
<td>4.9 %</td>
<td>2.6 %</td>
</tr>
</tbody>
</table>

In all cases, the P&R facilities diminish the vehicle kilometres in the city centre and environmental effects. Unfortunately, the results will hardly be noticeable. Due to remaining traffic, the emissions of the inhabitants and industry, the difference between the old and new situation will be nullified. From a financial viewpoint the ‘Mercon Steel Structures BV’ facility and Kweeklust are the best options, as they already exist. However, because the steel factory is the owner of the facility, the city council has to make a financial agreement with the owner if using this potential location. The same holds for Kweeklust. The other four locations have to be developed from ground up. From factsheets of the CROW, the investment costs and yearly costs per 100 parking places have been derived. With the results from the logit models, the minimum required amount or parking places have been calculated. The following table gives an overview of the estimated number of users, parking places and the yearly costs and the cost per parking place.

Table 2, New parking facilities overview

<table>
<thead>
<tr>
<th>Parking facility</th>
<th>Estimation of yearly users</th>
<th>Parking places required</th>
<th>Yearly costs</th>
<th>Parking costs per place</th>
</tr>
</thead>
<tbody>
<tr>
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<td>12,760</td>
<td>35</td>
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</tbody>
</table>

To assess the possibilities of an UCC, scenarios are constructed based on lessons learned from former studies, reference projects and articles. In the 4 constructed scenarios, the percentage of consignees and the type of vehicle, that is used by the UCC to transport the freight, vary: the current situation (base scenario); full participation of the retailers and fossil fuel powered vehicles (scenario 1); full participation of the retailers in the city centre and electric powered vehicles (scenario 2); limited participation and fossil fuel powered vehicles (scenario 3) and limited participation and electric powered vehicles (scenario 4). All locations were evaluated for the criteria derived from the analyses. Table 3 shows a Multi Criteria Analysis of the performance of the mentioned locations.
The MCA shows that, in comparison with the current situation, all scenarios are on advantage on the vehicle kilometres and the air emissions. The SCC’s, which full participation, score positive on all criteria except financial viability. However the same remark as with the P&R facilities has to be made. Introducing an UCC diminishes the emissions by the freight traffic, but the remaining traffic, the emissions of the inhabitants and industry will nullify the result. Liveability demonstrates a difference between full and partial participation. The introduction of a new service, not used by every owner of a shop, will increase the inconvenience for the inhabitants as the new service runs parallel with the existing traffic. An UCC with partial participation has a negative effect on the liveability in the city.

In none of the calculated scenarios, the UCC will become financial viable. Due to the high yearly costs and the low amount of freight, which can be processed by the UCC, the UCC cannot gain enough revenues to cover the total costs.

With all aspects in mind, the principal research question: “How can liveability related with mobility for inhabitants of a relatively small, old municipality be improved in synergy with preservation of monumental buildings by redefining their function?” can be answered:

In a city mobility problems can be reduced and liveability can be improved by the introduction of a P&R facility and/or UCC. By bundling several transport flows, these facilities will reduce the vehicle kilometres in the city centre. In Gorinchem the liveability will also be improved. However, due to the relatively small size of the city and due to the relatively small amount of freight that can be bundled, the facilities will not have a financial viability. These recommendations hold only for the city council.

For the foundation ‘Behoud Erfgoed De Vries Robbé’ which intention it is to preserve the empty storage facility located at Linge II Zuid it has been investigated whether this location might be used as P&W facility and/or UCC. The calculations show that, although the construction of a P&W facility is feasible, the presence of a recently renovated, not frequently used garage Kweeklust, will prevent the council to subsidise the renovation of the storage facility. Although liveability will improve in the city, the location close to the city centre will make that the traffic in the city will not diminish, as the users have to travel through the city to reach the location. If the location will be renovated into an UCC, the freight traffic will also be forced to cross the city. In addition, the UCC will prove not to be financial viable, taking in account the limited amount of freight that can be serviced. However, in another circumstance, reference projects have demonstrated that industrial heritage can fruitfully be preserved by redefinition of its function.
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Chapter 1  INTRODUCTION

Gorinchem receives its town rights in 1382 and hence shares with many modern old cities the same problem: how to maintain the liveability of the inhabitants with their modern way of living and preserve the character of the old city.

In 2009 the city council of Gorinchem published their city plan for 2015. One of the sections in this plan concerns the current mobility problems within the city and the council described their vision on mobility in 2015. One of the main outlines is ‘effort on finding solutions for the increasing inaccessibility of Gorinchem and the negative consequences on the liveability of the city’. Current examples of solutions that improve the accessibility and liveability of a city are: Park & Ride (P&R) facilities and Urban Consolidation Centres (UCC). Their application in Gorinchem is investigated in detail in this report.

In 1881, the steel construction company ‘De Vries Robbé & Co’ established itself in Gorinchem. During the crisis of the 1970’s this company was declared bankrupt and its buildings became vacant. To preserve these buildings a foundation was started in 2010, named ‘Behoud Erfgoed De Vries Robbé’. In particular the foundation is investigating a new function for the storage facility of the steel construction factory. Both the city council and the foundation strive for the best solutions of their problems.

1.1 RESEARCH PROBLEM AND OBJECTIVE

In this report two problem owners, which have the intention to strive in co-operation for the best result, can be distinguished: the city council of Gorinchem with its mobility problems and the foundation ‘Behoud Erfgoed De Vries Robbé’, which likes to preserve industrial heritage. The principal problem owner is the city council.

The two problems come together in the new zoning plan for the inner city of Gorinchem. In this plan, area Linge II Zuid, which forms the main interest of the foundation, is marked as a development area. This means that everyone, including the foundation, can submit development plans for this area, which will be considered by the city council to redevelop Linge II Zuid.

This study investigates whether Gorinchem’s mobility problems can be solved by redeveloping the vacant storage facility on Linge II Zuid into a P&R facility and/or UCC. In addition, to make this report more applicable for other cities with a historical city centre and mobility issues, methodology is developed by which can be explored whether mobility problems can be solved by redefining the function of industrial heritage.

1.2 RESEARCH QUESTIONS

In order to successfully achieve the research objectives a main research question is composed:

“How can the liveability related with mobility for inhabitants of a relatively small, old municipality be improved in synergy with preservation of monumental buildings by redefining their function?”

To give a satisfying answer to the research question and an advice for the city council as well as for the foundation at the end of this master thesis, the following sub-questions are formulated. These sub-questions are redefined into a roadmap, which can be used by other cities with the same
problems: redefining the function of old buildings to solve mobility issues. The first step of the roadmap is to identify the problems in Gorinchem (Chapter 2).

- Which problems, originating from mobility, are currently present in Gorinchem?
- What is the objective of the foundation ‘Behoud Erfgoed De Vries Robbé’?
- Are there common grounds between the two problems to achieve the synergy?

The next step investigates the possible solutions (Chapter 3 and Chapter 4).

For the mobility problem in Gorinchem (Chapter 3) this means:

- Which transport flows can be distinguished in Gorinchem?
- What are potential possibilities to deal with the problems of mobility per transport flow?
  - What can be learned from the available literature?
  - What lessons can be taken from reference projects?

For the industrial heritage in Gorinchem (Chapter 4) this means:

- What types of monuments are there in the Netherlands and in Gorinchem?
- What lessons can be learned from past industrial heritage projects in the Netherlands?
- How can the lessons be applied on the industrial heritage from the foundation?

To following step identifies the locations applicable for the solution (Chapter 5). In Gorinchem this means:

- What common grounds are found in the analyses of the transport flow and industrial heritage?
- On what criteria can the case study in Gorinchem be assessed?
- Which locations are suitable for the possible solutions?
- Are there multiple conditions available to help in the assessment of the solutions?

The next step is the assessment of solutions (Chapter 6)?

- Which methods can be used to assess the possibilities?

For Gorinchem this means:

- What are the probabilities of the potential locations?
  - Is there a difference in the results between the methods used in chapter 6?
  - What is best location for a new service?
- How do the possible solutions score on the criteria following from the analyses?
- Are the new services viable or do the services need external subsidizes?

The last step focuses on conclusions and recommendations (Chapter 7):

For Gorinchem:

- What are the conclusions from the previous sub-questions?
- What specific recommendation can be given to the city council of Gorinchem and the foundation ‘Behoud Erfgoed De Vries Robbé’?

In general:

- What data are needed in the roadmap to calculate the possible effects in a city?
In order to answer the previous mentioned sub-questions, this master thesis study uses different methods. In the next section the methods are explained.

1.3 RESEARCH METHODS AND STRUCTURE

With the aim of finding an answer for the main research question, different methods will be used in this study. In order to give an advice for the city council of Gorinchem and the foundation ‘Behoud Erfgoed De Vries Robbé’ the study follows the steps of a basic design cycle (BDC) (Roozenburg and Eekels, 1995), which are shown in Figure 1.

![Figure 1, the structure of the Basic Design Cycle (Roozenburg and Eekels, 1995)](image)

In order to start with a BDC, the functions and specification of the problem, in this report the mobility problems and preservation of industrial heritage in Gorinchem, need to be specified, which is done in Chapter 2. With the results the analysis phase can start.

In Chapter 3 and Chapter 4 the analyses for the two problems are executed. To analyse the transport flows, Chapter 3 starts with an introduction of the different types of flows. In this chapter a literature review is given in which opportunities and learning’s from articles and books are discussed. The transport flows will have a SWOT analysis. The SWOT analysis is divided into the transport flow types. The final section of this chapter indicates the similarities and differences between the transport flows analyses.

Chapter 4 starts with a proposal for a framework to enable the characterization of the different types of monuments that exists in the Netherlands. A second method that is used in Chapter 3 is the application of reference projects. From these reference projects success and failure factors can be learned. These factors are then used in strengths, weaknesses, opportunities and threats (SWOT) analyses. The SWOT analysis will not only be specified on the Gorinchem’s case, it will be extended so that it can be applied more general for all future heritage projects.
Chapter 3 and Chapter 4 complete the analysis phase in the BDC. The outcomes from these two chapters are used to develop the criteria for the next phase in Chapter 5. In this chapter a provisional design is created. Possible locations for a P&R facility and/or UCC location are presented and scenarios based on literature are created to assess the possible solutions. The results of Chapter 5 are used in the next phase, the simulation phase (Chapter 6).

Chapter 6 holds an assessment, using multiple methods, for the provisional design. This gives insight in the behaviour and properties of the designed solution(s). A multiple criteria analysis (MCA) will demonstrate which location scores best on the criteria derived from the analysis phase. Finally a cost-benefit analysis (CBA) is made for different opportunities to find the best financial viable solution.

After the assessment of the possibilities the solutions are evaluated, whether the results are realistic or the model has to be adjusted. This will establish the quality of the provisional design. The evaluation leads to conclusions and recommendations for the city council of Gorinchem and the foundation ‘Behoud Erfgoed De Vries Robbé’. The conclusions and recommendations are discussed in Chapter 7.

The final phase, the decision, will not be part of this study. The research concerning Gorinchem ends with an advice for the two problem owners. These actors will decide, with the outcome of this research in mind, how to continue with this project in Gorinchem. An overview of all phases and the corresponding chapters is given in Figure 2.

This study ends with a roadmap, which enables other cities with a historical centre to apply the steps taken in this study in order to discover whether or not a P&R facility and/or UCC will be a possible viable solution given their situation.

Figure 2, the basic design cycle with the corresponding chapters used in this report
In this master thesis sub-questions are divided over different chapters and sections. The following figure gives the structure of the total report and the distribution of the sub-questions in this report.

Figure 3, structure of the report. In the structure every subject concerning the city council is on the left side. Subjects concerning the foundation are on the right side.
1.4 THE ADDED SOCIAL AND SCIENTIFIC VALUE

This study contributes social and scientific value to the nowadays applied solutions, which will be described in this section.

In the Netherlands there are numerous towns with a historical centre, similar to the situation in Gorinchem. Accordingly, many cities face the same problems: the growing amount of traffic within their border and a decreasing liveability. In large cities, for example Amsterdam, Enschede and Utrecht, the local government introduced traffic regulations and projects in order to reduce the congestion, emissions and improve the liveability, whereas smaller cities still search for solutions. This study investigates an alternative solution: merging mobility problems by redefining the function of industrial heritage.

Previous studies have researched both problems separately, thus finding a solution for traffic problems and another solution for heritage problems. This study combines the two, thus creating an opportunity for cities that have traffic problems and historical buildings with value for the city. This might create scientific value for the future. The second added social value of this study is the investigation of new employment for the old buildings in order to preserve the heritage. The third added value of this study is the research of the possibility for relative small cities to introduce traffic projects in order to reduce the problems caused by the increasing mobility.

The fourth added value of this report is to find out whether a new power technology is a feasible opportunity for a relative small city. An example is the e-motive option. The “e” stands electric powered vehicles. This could be of benefit for the city, due the reduction of emissions. Already now a has to be made: new powering options for vehicles are only green during their operations, but not their production nor their recycling or decomposition. This might mean that the production and/or recycling of e-power produce more emissions then the regular power technologies during their lifespan use.

Although the regulations are not always popular with the inhabitants, the residents have to deal with it in contrast to visitors of the city. The visitors have the option to still visit the city or visit another city with fewer regulations.

1.5 CONTEXT OF THE STUDY

There are numerous situations for city councils and foundations to co-operate with partners, in order to achieve a win-win situation for both actors. For example, co-operations between stakeholders can be created around the following contexts:

- Residential context;
- Employment context;
- Cultural/recreational context;
- Mobility.

This study tries to create synergy between transport and preservation of monuments and therefore focuses on mobility. This study gives an advice on whether or not synergy can be achieved. However, as the answer is just focused on mobility, the advice cannot be applied on other contexts, which are not under investigation such as employment.
Chapter 2  PROBLEM SPECIFICATION

This chapter specifies the relevant problems that were shortly presented in the previous chapter. The first section describes the history of Gorinchem, where the case study of this research will be performed. In the second section the mobility problems of the municipality of Gorinchem are discussed. It appears that the transport flows are the main cause of these problems. The third section elaborates on the problem of the second problem owner, the Foundation ‘Behoud Erfgoed De Vries Robbé’. The last section describes the common grounds of both problems and their possible merging.

2.1 THE HISTORY OF GORINCHEM

During this research a case study on the co-operation between mobility and industrial heritage is performed in the city of Gorinchem. Gorinchem started as a small establishment with fishermen and farmers. In the mid 13\textsuperscript{th} century the establishment had fallen in hands of the Van Arkel family. This family gave Gorinchem in 1382 its town rights and made the city the capital of the Land van Arkel, which was an independent area between Holland and Gelre. Over the years, the inhabitants were given more and more rights, for example the market law, which meant that they could organize markets to sell their products.

The city needed to be protected and therefore a canal was dug and a city wall constructed strengthened by wooden columns. In the mid 14\textsuperscript{th} century the wooden city wall was replaced by the constructions of a stonewall with towers. However, with the invention of gunpowder the stonewalls and towers became vulnerable. Therefore the municipality made a second row of walls behind the first and 11 bastions were made, in fact a bailey around Gorinchem was constructed. In the bailey four portals were constructed to reach Gorinchem. The bailey was built in such a way that the city could grow to double its size. As in other parts of the Netherlands, Gorinchem grew during the Golden Age. However, during the French revolution Gorinchem was conquered by the French and occupied till 1814. During the last three months of this occupation, Gorinchem was significantly damaged, so that the French surrendered to the Dutch.

During the industrialization period Gorinchem expanded rapidly. Facilities to produce tobacco, beer, candles and shipyards were created. In time, the number of inhabitants increased with the city expanding outside the fortress. First industrial areas were formed and later also residential areas. Nowadays this can still be seen in the layout of Gorinchem: an old city centre surrounded by industrial and residential areas. During World War II only a few bombs hit Gorinchem, which resulted in relatively small damage to the city. After WWII the city still expanded resulting in residential besides industrial areas. With the growth of the number of inhabitants and factories, the intensity of traffic increased in the entire city.

After this period of growth, the city of Gorinchem also had to deal with setbacks. During the crisis in the 1970’s the steel factory De Vries Robbé & Co, which was the largest employer in the region, had to be declared bankrupt and the factory sites became vacant.

Over time, two main problems in Gorinchem arise, namely the bundling of the transport flows on the main corridors creating inaccessibility, liveability issues and vacant industrial heritage, problems that will be discussed in the following sections.
2.2 GORINCHEM’S MOBILITY PROBLEMS

In the introduction Gorinchem’s mobility problems were mentioned. These can be divided into three categories: physical hindrance, emissions and traffic unsafety (liveability). In the city council’s city plans the problems are discussed in different (SAB, 2009). The mission statement of the mobility section is: “Finding solutions for the increasing inaccessibility of the city Gorinchem and negative consequences on the liveability of the city.” Furthermore in the environment section of the city plans is stated that the city council wants to directly formulate and develop a traffic environment map. This has to include an active plan to control the emissions (noise and air quality) (SAB, 2009). Overviews of the relevant problems, which are described in the city plans, are presented in the following subsections.

2.2.1 PHYSICAL HINDRANCE

The physical hindrances in Gorinchem are congestion and blockades on the streets. The congestion is the result of the road capacity versus the increasing intensity. In a town, road structure can be divided into different types, namely ’stroomwegen’ (SW), ‘gebiedsontsluitingswegen’ (GOW) and ‘erftoegangswegen’ (ETW) (CROW, 2000). SW roads are designed to unwind as much as possible traffic, conflict free. Examples of SW roads are the motorways in the Netherlands. GOW roads have two goals: first the flow of traffic and second the exchange of traffic. GOW streets are characterized by the separation of fast and slow traffic and similar level crossings. A distinction of GOW road types is made for the amount of lanes the GOW road has. GOW type I has a layout of 2x2 lanes and the GOW type II roads have a layout of 2x1 lane. The last category, ETW, consists of streets that are used to connect living areas and has a mix of all traffic (fast and slow) on the road. Another distinction that can be made between the road types is the construction method. The SW and GOW roads mostly have a base layer made from asphalt, whereas the ETW roads have a base layer from brick pavement. An overview of the different road types in Gorinchem is presented in Figure 4.

Figure 4, road types in Gorinchem (Black: SW, Red: GOW type II, Blue: Gow type I, Orange: ETW)

Another difference between the three road types is their capacity. The capacity does not only depend on the road type, it also depends on the design of the street and obstruction factors. In annex A the main roads in Gorinchem are characterized. For every main corridor and street the main
design and the obstruction factors are identified. If all factors are known, the capacity of the roads can be assigned. In the following table the capacities of the roads are shown.

Table 4, overview of the capacities of the main roads in Gorinchem (Pce = Passenger car equivalent)

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<td>3600 – 4000 pce/hour</td>
<td>Banneweg (connection A15), Spijsesteeg</td>
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<tr>
<td>1600 pce/hour/lane</td>
<td>Banneweg (Piazza Centre), Concordiaweg, De Lingebrug, Newtonweg, Nieuwe Wolferensedijk, Spijksedijk (crossing Newtonweg)</td>
</tr>
<tr>
<td>800 pce/hour/lane</td>
<td>Banneweg (Stadhuisplein), Lange Brug, Spijksedijk (crossing Lingebrug), Stationsweg</td>
</tr>
<tr>
<td>5000 vehicles/day</td>
<td>Korte Brug, Paardenwater, Spijksedijk, Streets in the city centre</td>
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With the capacities of the streets in mind, it is possible to look at the intensities of the roads. A study of the intensities was held in 2008 (Goudappel Coffeng BV, 2008). Figure 5 shows the results of this study.

Figure 5 shows the most recent data that is available regarding traffic intensities number per day in and around Gorinchem. The access roads, the motorways A15 and A27, has an intensity, which lies between 30,000 and 40,000 vehicles per day. The two motorways have a layout of 2x2 lanes each, with a capacity of 2200 pce/lane/hour. The results of the models conclude that the motorways around Gorinchem are congested during the peak hours. Taking in account the known growth of traffic numbers and the growing total vehicle kilometres (Centraal Bureau voor de Statistiek, 2012, Centraal Bureau voor de Statistiek, 2014), the assumption can be made that traffic numbers will also increase in the years to come. Therefore the highways around Gorinchem will be even more congested than the model indicates.
Not only around Gorinchem the roads are congested. Due to the many obstruction factors, the main corridors to the city centre are also congested, for example the Banneweg located near the Stadhuisplein (shown in Figure 5 as location 1). This road has an intensity of circa 1000 vehicles per hour (derived from figure 2), but has a capacity of 800 vehicles per hour due to the obstruction factors like the railroad crossing followed by traffic lights, pedestrian crossings and roundabout.

Another bottleneck is the junction of the Newtonweg and the Spijkesteeeg (marked as 2 in Figure 5), is also congested during peak hours and occasionally congested during the rest of the day. The traffic lights, which regulate the outgoing traffic from Gorinchem and Dalem, are the main reason for the congestion. Furthermore the traffic lights also control the incoming traffic towards Gorinchem and Dalem, which arrives from the motorway A15 and northern located surrounding municipalities. The traffic lights have a capacity in between 900 and 1350 vehicles per hour. However, during the peak hours the traffic lights have to deal with an intensity of circa 2000 vehicles per hour.

From the model that was used in 2008, a prediction for the traffic intensities in 2020 was made. The prediction is shown in Figure 6. The intensities in 2020 are increased on all roads compared to the results in 2008. The congestions around the bottlenecks will become larger and more inconvenience for the inhabitants, shopkeepers and suppliers of Gorinchem will arise.

![Figure 6, estimated traffic situation in 2020 (Goudappel Coffeng BV, 2008)](image)

However, with making the prediction of the intensities in 2020 the current economic situation was not taken into account. In 2008, there were no forecasts for an economic crisis. Therefore the prediction for 2020 might not represent the reality. In order to validate the prediction, numerous traffic counts were held in Gorinchem. The results of the counts conclude that the prediction of the intensities in 2020 is overestimated. The current intensities are closer to the 2008 results. Due to the limited growth of the intensities, the bottlenecks in the street layout did not grow. However, they still exist and the main corridors are still congested.

Figures 2 and 3 from the traffic model of Gorinchem specify the roads around and within the city border. However these roads can be differentiated based on the level of network with which these
roads connect. For example, the highways A15 and A27 connect Gorinchem to the national road infrastructure, while the Banneweg Gorinchem connects to regional roads. Within Gorinchem there is a third network level. Inside the city borders there are also roads that only connect to the local network, for example the roads in the historical city centre. On these local roads there also is hindrance caused by the traffic. The city council of Gorinchem held an inspection of the inner city in 2012. This demonstrated that loading/unloading from freight traffic formed the blockages in the narrow city streets. Two examples can be seen in Figure 7.

![Figure 7](image_url), examples of the hindrance in the city centre

In order to determine for this study the routes of the freight traffic inside the city, a license plate registration session was performed. This means that during the morning all freight traffic was counted and registered at multiple locations in the town. In annex B the license plate registration is explained. From the results of the license plate registration session several routes within the city borders can be distinguished. The most common route is to take the exit from the motorway A15 Gorinchem (Northwest at Gorinchem) and drive over the Banneweg to the city centre. After the Stadhuisplein the route differentiates for the different types of freight vehicle. The smaller vehicles travel towards the city centre using the Lange Brug and the Korte Brug. The larger vehicles enter the historical city centre by the Paardenwater. Several interviews with truck drivers, who deliver numerous times in Gorinchem, show that the larger vehicle cannot make the turns from the specific route that has been developed in the city centre. In order to reach the retailers, the truck drivers have to take a restricted street. After loading/unloading in the city centre the common route for exiting Gorinchem is to drive to Gorinchem-Oost by the Stationsweg, Concordiaweg, Spijksesteeg and the Newtonweg. The results from the license plate session show that this route is also taken visa versa.

From the license plate registration session it followed that a third option existed to enter the city from the motorway A27 by taking the exit at Avelingen. The vehicles that use this exit enter the city centre by the Korte Brug. After loading/unloading, the drivers take the same exit or drive towards the exit Gorinchem-Oost by the same routes as mentioned before. However, this route is the least taken in order to reach the centre of the town but the most often used exit of the three. It could be concluded that most of freight traffic, which took this exit of the A27, has a destination in the industrial park Avelingen. The most frequently used routes indicated by the license plate registration session are shown in Figure 8.
2.2.2 EMissions

The previous discussed problems are all physical hindrance (congestions and blockades). However, in the city plans for 2015, the municipality defines two other issues, namely the emissions and the traffic unsafety. The municipality has the intention to become more sustainable. However, due to the increasing amount of traffic, the sound level and air emissions will become an issue.

Air emissions can be divided into two categories, the global emissions (carbon dioxide (CO$_2$)) and local emissions (Nitrogen oxides (NO$_x$) and particulates (PM$_{10}$)). Within the Netherlands the guidelines from the European Union (EU) are followed. The guidelines for the local emissions, NO$_x$ and PM$_{10}$, are shown in Table 5.

<table>
<thead>
<tr>
<th>Air emissions</th>
<th>Focussed on</th>
<th>Standard</th>
<th>Value</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen oxides</td>
<td>Nature</td>
<td>Yearly average</td>
<td>30 μg/m$^3$</td>
<td>Limit</td>
</tr>
<tr>
<td>Particulates</td>
<td>People</td>
<td>Yearly average</td>
<td>40 μg/m$^3$</td>
<td>Limit</td>
</tr>
<tr>
<td>(PM$_{10}$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>People</td>
<td>Daily average: exceeding of maximum 35 times per year</td>
<td>50 μg/m$^3$</td>
<td>Limit</td>
</tr>
</tbody>
</table>

The city council ordered an air emissions study for the region Lingewijk-Noord (DHV Ruimte en Mobiliteit BV, 2006), with regard to the construction of a new living area in the city. This study showed that the yearly averages would not be exceeded in the future (2020). However, in certain areas the maximal daily average of 50 μg/m$^3$ will more often be reached than the allowed 35 times, as can be seen in Figure 9. Therefore the city council has to take actions in order to be consistent with the guidelines of the EU.
Apart from the physical hindrance and the emissions, other problems that are described by the city council are the traffic unsafety and inconvenience from loading/unloading traffic (van der Roest, 2015). The number of accidents increased in the past years (Willekens, 2001). An explanation for the unsafe traffic conditions may be found in the layout of the city Gorinchem, which is demonstrated in Figure 10.

The current layout of the city results from the history of the city as described in section 2.1. Due to the growth of the city, different layers with diverse functions were formed. The growth of the city resulted in the fact that living areas are situated next to industrial areas and vice versa. The industrial parks still operate and need their supplies and within the city the shopkeepers also need their supplies in order to keep their shop running. Therefore deliveries to all industrial areas and shopkeepers are made, which is done by various vehicles types including large trucks. All transport
flows are bundled and the main corridors, which connects the city to both motorways. These large trucks have to travel across the entire city and therefore will cause inconvenience to the inhabitants, for example damages to their façade (van der Roest, 2015). The narrow streets in the historical city centre cause the damages to the facades. Furthermore due to the layout of the infrastructure, dangerous situations with cyclists and hikers are created with the low agility and difficult visibility angles of the large trucks.

2.3 DE VRIES ROBBÉ & CO HERITAGE PROBLEMS

In Chapter 1, two stakeholders were mentioned. In the previous section the problems of the city council were discussed. In this section the foundation will be introduced and their problems explained.

The foundation ‘Behoud Erfgoed De Vries Robbé’ started in 2010 with the intention to maintain the heritage from the old steel construction company De Vries Robbé & Co. The company established in 1881 in Gorinchem and grew over the years to the largest employer in the region. Unfortunately, the factory had to be declared bankrupt during the crisis in the 1970’s. Due to the bankruptcy the factory buildings, spread across the municipality of Gorinchem, became vacant. The foundation aims to “preserve as much as possible from the ensemble value by keeping the broader context of historical, architectural, landscape, (social) economic, culture and regional values” (Stichting Behoud Erfgoed De Vries Robbé, 2010).

The first buildings from the company that were preserved are the old office building and the lunch/class room. These buildings have been moved to a new location, Linge II Zuid, and are now used as the office of the board from the foundation. However, within the municipality there are more locations with old company buildings from the De Vries Robbé & Co, for example the Arkelsedijk and Spijksedijk, shown in Figure 11. Some of these locations are already reused as storage facilities and/or stores.

Figure 11, overview of locations De Vries Robbé & Co

In particular a storage facility on Linge II Zuid has to be mentioned. A shield around this building has been constructed to protect the storage facility from weather conditions. Therefore this construction hall from De Vries Robbé & Co is one of the better-preserved buildings. In section 4.2 more renovated building are discussed as reference projects.
Although it is the intention of the foundation to preserve these buildings, co-investors have to be found in order to raise money to renovate and preserve the factory buildings. In order to find these co-investors, the foundation has to offer new functions for the old factory building at the location Linge II Zuid. This location is kept in mind with the most recent zoning plans for the inner city. The area Linge II Zuid is marked as a development area. Without specified plans at the moment, the city council is interested in concrete well-detailed plans for this location. One option that was/is in mind of the foundation, is to create a knowledge and technology centre regarding green technologies. A vision on the future is given in Figure 12.

![Figure 12, the new layout of Linge II Zuid](image)

On the left side of the figure, the old office building and the lunch/class room are situated. On the right side of the figure the current vacant construction hall is drawn after renovation, with a knowledge and technology centre inside. The renovation of the vacant storage facility can lead to extra employment in the region.

### 2.4 COMMON GROUNDS

In the previous sections the two main problems, the mobility problems of Gorinchem and the preservation of the De Vries Robbé storage facility, are explained. In this master thesis there is looked for a solution, which will serve both problems. The solution has to achieve synergy between mobility and industrial heritage. In order to find such a solution, the common grounds between the two problems and stakeholders have to be identified.

The first common ground between the problems is indicated in the new zoning plans of the inner city of Gorinchem. In this new zoning plan the area where the storage facility is situated is explicitly mentioned as a development area. The foundation ‘Behoud Erfgoed De Vries Robbé’ has the
opportunity to offer elaborated plans for the area, which then will be taken into consideration by the city council for possible redevelopment of the area and storage facility on ‘Linge II Zuid’. In Figure 13 the zoning plans are shown, the purple area at the top is the area ‘Linge II Zuid’, where the old De Vries Robbé facility is situated.

Figure 13, the zoning plans of the inner city of Gorinchem

The second common ground is the objective of the foundation. The foundation, like mentioned in the previous section, has the objective to preserve the storage facility of the old steel factory De Vries Robbé & Co. The foundation can therefore find co-investors and sponsors with the intention to preserve the storage facility. The city council can also help with the preservation of the facility. They can nominate the building and/or site as municipal/national heritage of the city Gorinchem. If the nomination is successful the building/site can receive subsidy, which can be used for maintenance of the building/site.

2.5 CONCLUSIONS

In Gorinchem two problems exists, which can be assigned to two principle stakeholders. The first problem concerns the city council and is formed by the mobility issues in the city, namely: congestion, emissions and traffic unsafety.

The second problem concerns the foundation ‘Behoud Erfgoed De Vries Robbé’. The foundation has the intention to preserve a former storage facility from the steel factory De Vries Robbé & Co. However, the foundation lacks the tools to preserve this facility on its own and therefore searches for partners enabling renovation.

Both problems have common grounds. The first one is the zoning plan of the city council. This plan designates ‘Linge II Zuid’ as development area. This offers the opportunity for the city council to reduce their mobility problems in the city centre and for the foundation it offers the possibility to redefine the function of the storage facility. This means that detailed plans for redevelopment will be taken into consideration by the city council.
The second common grounds between the city council of Gorinchem and the foundation ‘Behoud Erfgoed De Vries Robbé’ is that they both need partners in order to start a project to solve their problems. A co-operation might possibly be created between the city council and the foundation.

In summary: The subject of this thesis work is to find a solution for the mobility problems in the city Gorinchem by redefining the function of the vacant storage facility of the foundation ‘Behoud Erfgoed De Vries Robbé’ at the location Linge II Zuid.
Chapter 3  TRANSPORT FLOWS ANALYSIS

To find possible solutions for the mobility problems discussed in section 3.1 the existing different transport flows in Gorinchem are discussed in the first section. With the different types of transport flows in mind, a literature review for each type of transport flow is held in section 3.2. Section 3.3 discusses multiple reference projects dealing with these transport flows. To summarize the conclusions from these reference projects a SWOT analysis is presented in the fourth section. The last section of this chapter presents the similarities and differences between the analyses of the transport flows.

3.1 TYPES OF TRANSPORT FLOWS

The problems discussed in Chapter 2 are due to the different transport flows within the city of Gorinchem. These flows can be divided into two different types. The first kind of transport flow concerns transport of human beings, which can be divided in private and public transportation. Private transportation is a form of transportation, in which the passenger creates instantaneously his own transportation from door-to-door whether by car, bicycle and/or walking. Private transportation is the world largest form of transportation at this moment (Centraal Bureau voor de Statistiek, 2014). In Gorinchem this is also the case. From the counting in January 2015 (annex B), it can be concluded that the majority of vehicles that travel across the infrastructure is private transportation.

With public transportation, a third party is involved with the passengers’ trip from door-to-door at circumscripive time intervals. Public transport is any form of transportation, which is available for the general public, that charges fixed fare rates and run fixed routes. Examples of public transportation are buses, subways, ferries and trains. In public transport, also transport for selected groups might have been instituted. This means that it is not for public use, but only certain people can may use it once they meet certain criteria, for example transport for disabled people (Schoemaker, 2002). In order to reach Gorinchem, people may use buses from the surrounding or the train from the ‘Merwedelingelijn’. A train connects Gorinchem to Dordrecht and Geldermalsen and runs with intervals of 15 minutes.

Apart from to the train several bus lines can be used to travel to Gorinchem. These bus lines connect Gorinchem to the surrounding municipalities. An overview of the bus lines in and around Gorinchem is shown in Figure 14.

Figure 14, overview of the bus lines connecting Gorinchem (Arriva, 2015a)
A not often encountered form of public transport found in Gorinchem is a ferry service, which connects Gorinchem to Hardinxveld-Giessendam, Werkendam, Sleeuwswijk and Woudrichem. This service is only available for pedestrians and cyclists. From Gorinchem there is one special ferry service toward the fortress Loevestein.

The second kind of transport flow results from freight transportation. Freight transportation, whether by water, land or air, can be described as goods, cargo or bulk transported for compensation of the transport company. This transport can also be divided according to size or type of goods. The first differentiation can be made on ground of the size of freight transportation, as in relation with the size different vehicles have to be used for transport. For instance, trucks are used for the large type of freight and pallets orders, vans for packages and medium sized goods and cars for small packages. Freight can only be transported to Gorinchem by road. Although Gorinchem is connected to the railroad, this line cannot be used for freight transportation, due to the limited capacity. Within Gorinchem different companies transport their goods between multiple locations by using pulley drivers. Every employee can drive such a pulley and cross Gorinchem, which forms a threat to the liveability and safety in Gorinchem.

Another differentiation is based on the type of freight. The type of freight also determines the method of transport. Examples of different types of freight are bulk materials (oil, sand and coal), hazard materials (environmental dangerous goods) and parcels (commercial and/or private orders). In Gorinchem there is demand for all three types of cargo. Large factories, such as JéWéRET (a wood handle factory), needs unhandled wood supplies. The smaller retailers in the city centre and at the shopping malls located in Gorinchem create demand for parcels. Therefore different types of vehicles, large and small trucks (except the pulleys, which only transport freight internally), enter the city centre to deliver the goods.

3.2 LITERATURE REVIEW

In section 3.1 a separation is made between the transport flows of passenger and freight. For both flows a literature review has been performed to find solutions, which improve the mobility within municipalities. This section gives a selection of the literature.

3.2.1 PASSENGER’S TRANSPORT FLOW STUDIES

Numerous cities and governments faced and/or face the same problems as the city council of Gorinchem. The forecast of increasing traffic in urban areas results in numerous conflicts in a city. Figure 15 shows a conflict diagram, which gives an insight in the types of consequences, follows from increasing population and therefore increasing traffic. In past literature a common strategy for cities is to implement a Park and Ride (P&R) facility into the infrastructure. A P&R facility is a location where visitors can park private transportation and travel further with connecting public transport to their destination. These locations are often at the city border, as can be seen in in the section 3.3. Another opportunity of a P&R facility is to connect to multiple public transport modes and become a transfer hub in the current infrastructure. The findings from numerous articles are elaborated on and presented in this sub-section.
The conflict diagram in Figure 15 starts with two exogenous development, namely population and economic growth. These influence the number of traffic and therefore relate to the mobility problems. When the population grows and economy improves, the employment, visits to the shopping centre and the leisure activities increase, thus increasing the consumption spending and also the private, public and freight transport. This results in an increase in the three mobility problems in a city.

In the studies from (Bos, 2004) it is stated that industrialised countries face a permanent increase in car mobility. This increase in car mobility has consequences for the accessibility and liveability of urban area. One policy measure to enhance the existing infrastructure is to improve the multi-modal transport. However, multi-modal transport cannot be done without transfers. Rather, this is done at transportation nodes such as bus stops, train stations and/or P&R facilities. Here passengers can transfer to the public transport. Public transport services can be used to reduce the traffic intensity in urban area.

There are different types of P&R facilities. In (Lenten, 2011) a differentiation is made between an origin, middle and a destination P&R facility. The origin P&R facility is close to your home and has the advantage in achieving liveability and a widely used public transport market, because the largest part of a journey is made with public transport. However, the accessibility of origin P&R facilities is smaller in comparison with middle and destination facilities. The middle P&R is halfway your destination. Last, a destination P&R is close to your end destination and has the advantage of accessibility.

(Parkhurst, 2000) investigated the influence of a Park & Ride facility that uses buses on the behaviour of the car user. The research shows that in seven out of eight cases the distance travelled by the connecting bus service was less than the number of car kilometres of “parkers who would drive” to their destination. The users of the P&R facilities are mostly car users that are detouring to reach...
locations. The main effect of a P&R facility is traffic redistribution, instead of the traffic reduction policy.

(Dijk et al., 2013) mentioned that P&R facilities are often introduced as part of a local policy package with integrated measures that promote a more holistic approach towards sustainable mobility. One example of the measures is to increase the parking rates in the city centre. Due to the premium-parking prices of the city centre and cheap transport link prices between the P&R site and the city centre, the use of the P&R facility can be stimulated. However, P&R facilities do not have only positive effects. In (Mingardo, 2013) it is showed that P&R facility also have unintended effects, which means that the P&R also attracts users who did not use a car before in order to reach their destination. In the case of Rotterdam the abstraction of 34.3 per cent from PT and bicycle was established, in The Hague the abstraction from PT and bicycle was even larger, namely: 42.3 per cent. Both abstractions are larger compared to the intended abstraction from car users: 23.4 and 19 per cent.

Another finding in (Mingardo, 2013) is that an introduction of a P&R facility can achieve a reduction of the air pollution. A remark is that in this research the P&R facilities transfers are rail-based. Also in the research of (Gan and Wang, 2013) the impact of a P&R facility on air pollution is calculated. In this study the reduced emissions for CO\textsubscript{x}, NO\textsubscript{x} and HC are 21.7 ton, 1.2 ton and 1.8 ton for 250 workdays each year. Again, this reduction is achieved with a P&R facility with rail transit.

3.2.2 FREIGHT TRANSPORTATION STUDIES

The study of (Benjelloun and Crainic, 2009) identified the trends, challenges and perspectives concerning city logistics. City logistics appears to hold one of the keys to achieve a balance between moving freight within urban regions and the problems caused by urban transport. The results of this research are: after an initial period of “experimentation” certain concepts emerge with business models and system organization; many initiatives and innovations are introduced after 2000 and the help of information technologies (e.g. ITS) components for optimization an utilization are not very developed. The last conclusion of the research was that city logistics ideas are expanding, but not all countries are at the same level of analysis.

In section 2.2 three main problems are described in the mobility of Gorinchem’s municipality, namely physical hindrance, traffic emission and traffic safety. In (Van Binsbergen and Visser, 2001), these three problems were confirmed. In this research, the relationships between freight transportation and economic, demographic and spatial development are investigated. In Figure 16 a schematic presentation is shown of the most significant factors and relationships concerning freight transportation

Freight transport causes noise, air pollution, physical hindrance (including congestion) and a decrease in traffic safety. These are negative side effects from a vital aspect of inner cities, since urban freight distribution supplies shops, hotels and/or catering industry. Figure 16 is a conflict diagram. Central in the figure are three main developments, namely population, economic growth and shopping facilities. These developments cause several conflicts to urban areas. For example a growth in population can lead to extra traffic, which leads to more congestion and emissions. Economic growth can lead to more demand from the population at the shopping facilities, which therefore can lead to more freight transportation in the urban area. Freight traffic causes also more emissions, congestion and nuisance to civilisation.
In another paper (Van Binsbergen and Visser, 2000) possible solutions are mentioned ranging from relocating shopping facilities to traffic measures such as time windows. Most measures that are taken refer to the physical characteristics of distributing vehicles. However, more recently measures focus on logistical operations. The studies from (Boerkamps, 1998) and (Schoemaker, 2001) researched urban distributions methods and tried to find a modelling method for these complex systems. These studies focus on bundling services within the urban area and came to the conclusion that an Urban Consolidation Centre (UCC) is one possibility to accomplish more efficient freight transport. An urban consolidation centre is a logistics facility that is situated in relatively close proximity to urban areas and can support logistics of a city centre, an entire town or a specific site such as a shopping centre, airport, hospital or major construction site. In the sub-section 3.3.2 reference projects of UCC’s are discussed.

In (van Duin et al., 2010) a case study of the UCC in the Hague, the Netherlands, is performed. This research focused on giving an advice to the municipality of The Hague about the implementation of an UCC. Two difficulties with implementation of an UCC are the allocation of costs and benefits and the co-operation of the transportation companies. In this research four scenarios are evaluated, from the present situation to a scenario with full participation of the target group and medium trucks for transportation. In the developed scenarios the predicted reduction of freight kilometres vary between 30 and 45%. However, the only financial viable scenario is a service with full participation and medium trucks as transport vehicles. Of course, if the municipality wants it, it can subsidize the financial situation of the UCC in case of yearly losses.

In Nijmegen, the Netherlands, the city council introduced the Binnenstadservice.nl in 2008 (van Rooijen and Quak, 2010). The service focussed on the receivers, in contrast to other UCC’s who focuses on the carriers. The study investigated the effects on local air quality, noise nuisance, inconvenience for residents and the number of freight kilometres in the city. The number of freight kilometres driven in the city dropped. However, the effects on the air quality and noise nuisance are
limited. Figure 17 shows the results of NO₂ air emissions in Nijmegen. On the right it can be seen that a distribution service contributes to the emissions. The same result is found by the PM₁₀ particulars. These results can only be published with a remark. The results come from the combined freight transportation. The other traffic (public transport, private transportation) is still running as in the base scenario. Therefore the reduction of emissions is limited.

Figure 17, results of NO₂ emissions by the Binnenstadservice.nl in Nijmegen. On the left the base scenario is shown, on the right the difference between the base scenario and the maximal potential scenario is given (derived from (van Rooijen and Quak, 2010))

The results on the liveability are shown in Figure 18. If the new service runs parallel with the existing ones, the hinder for the residents increases. However, if the new service takes deliveries over from the other companies, as the number of participants increase, the hinder decreases. Figure 18 shows that when the maximum potential shopkeepers participate, the inconvenience will be reduced to almost zero.

Figure 18, overview of the amount of inhabitants with inconvenience due to loading/unloading activities by a service

Another possibility in order to reduce the general problems caused by urban transport is to share the passenger and freight transport as in (Trentini and Malhene, 2012). In this study this means that freight is transported on the current public transport routes. At specified stops on the route the freight is transferred to a transport vehicle, which drives a route along all committed retailers in the
service area. However results about the accomplishments are not available. In order to discover that this method successfully reduces the problems caused by urban transport, further study is needed.

3.3 REFERENCE PROJECTS

In this section reference projects will be presented. The reference projects can be divided into three categories, namely: Park & Ride facilities, freight transportation projects and heritage projects. The first two categories are described in this section. The heritage projects will be discussed in section 4.2.

3.3.1 PASSENGERS TRANSPORT PROJECTS

In this sub-section several Park & Ride (P&R) facilities are handled. The municipality of Gorinchem has a population of approximately 35,000 inhabitants. Therefore, the P&R facilities discussed in this sub-section are selected using the criterion that they serve the same size of population.

Another criterion to select reference projects is the presence of a historical or a small city centre. The municipality in Gorinchem has a historical centre, which means that the streets are narrow and the possibilities to adjust the infrastructure are limited. The reference projects that are chosen in this section face these same limitations dictated by the city centre/service area.

*Citybus project, Dordrecht, The Netherlands*

The Citybus project is part of a P&R facility in Dordrecht. The parking facility is next to the so-called ‘Energiehuis’, which will be discussed in section 4.2. It is located in the area ‘Stadswerven’, nearby the historical city centre. Users can travel with the bus for a reduced fare, paid per trip. The bus circulates between the P&R Energiehuis, the city centre and the train station of Dordrecht (Arriva, 2015b). Figure 19 shows the route of the bus line. From Monday till Friday the bus line provides a scheduled service of three times per hour in both directions. During weekends, the service is provided two times per hour.

![Figure 19, location and the route of the Citybus Dordrecht (Arriva, 2015b)](image)

The P&R facility in Dordrecht serves a three times larger city than Gorinchem, but has a historical city centre in common. The Park & Ride facility in Dordrecht could be compared with Gorinchem as it has a P&R facility located just outside the city centre (Figure 19). In addition, Dordrecht can be used as reference project because the city is located in the same region of Gorinchem and has a similar
layout with a historical centre. Due to their nature and their function both Dordrecht and Gorinchem attract the same kind of visitors.

**Delft, Netherland**

Delft does not have a Park & Ride facility to serve the city centre. However, the inner city is made car-free reducing the hindrance due to mobility. In order to enforce the car-free area the city council placed obstacles on the access roads to the city centre. Visitors of Delft with a destination within the city can place their car in one of the parking facilities located just outside the city centre and have to walk the final part of their trip. Figure 20 shows an overview of the parking locations in Delft.

![Figure 20, overview of the facilities in Delft](image)

In conclusion: Delft does only have a parking facilities and a car-free city centre has been created.

**Park and Ride facility Cowes, United Kingdom**

The P&R facility on the outskirts of Cowes on the Isle of Wight was launched in 2004. It was started as a co-operation between the Isle of Wright Council, Southern Vectis (bus operator) and Red Funnel (ferry operator) (Isle of Wight County Press, 2011). In the beginning, three bus lines served the P&R facility, but due to the limited number of passengers, two of these routes were cancelled. The route that is still available, is a bus line from Newport to Cowes. The route stops at the P&R facility near Cowes and travels from the P&R facility to the Cowes Pontoon, the harbour of Cowes. Although the bus line runs through the city centre of Cowes, the main function is to service the Red Jet Terminal. This terminal is the main connection form the Isle of Wright to the main land. Due to cancellation of the two bus lines, the frequency of the still existing bus line was upgraded to five buses per hour. Figure 21 shows the location of the P&R facility, the bus route and the destination.
The users of the P&R facility can buy a ticket for £ 2.50. For this fare the user receives a round trip journey between the Park & Ride facility and the harbour of Cowes.

In summary: Lesson learned from the situation in Cowes is to limit the number of bus lines executed with short time intervals.

**Park and Ride facility Dorchester, United Kingdom**

The P&R facility nearby Dorchester is located off the main road between the motorway and the city centre of Dorchester. The P&R facility facilitates one bus line, which travels to the city centre of Dorchester as can be seen in Figure 22.
The P&R facility offers all day parking for a fare of £1.00. The bus trip to the city centre from the P&R is free of charge for traveling groups up to seven persons. The P&R facility is open during weekdays and runs four buses during peak hours. At all other times, the service is once every 30 minutes, starting at 7:15am and ending 6:15pm (Dorchester Council, 2015). The facility is about 77% occupied with an amount of circa 220 parking spots and is even used more on market days.

As regards to the size of the community, the most comparable situation with Gorinchem is Dorchester. The P&R facility serves the city centre and keeps the private vehicles outside the city.

In order to enable the comparison between the presented different P&R facilities, the projects are summarized in Table 6.

Table 6, overview of the P&R facilities reference projects

<table>
<thead>
<tr>
<th>Reference project</th>
<th>Population size</th>
<th>Location facility</th>
<th>Connecting public transport</th>
<th>Serving function</th>
<th>Number of bus lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>The case study Gorinchem</td>
<td>± 35,000</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>P&amp;R facility Dordrecht</td>
<td>± 119,000</td>
<td>Just outside the city centre</td>
<td>Bus lines</td>
<td>City centre</td>
<td>1</td>
</tr>
<tr>
<td>Car-free inner city Delft, Netherlands</td>
<td>± 100,000</td>
<td>Multiple on the city centre borders</td>
<td>Not available</td>
<td>City centre</td>
<td>Not available</td>
</tr>
<tr>
<td>P&amp;R facility Cowes</td>
<td>± 10,000</td>
<td>Suburb of the city Cowes</td>
<td>Bus lines</td>
<td>Red Jet Terminal</td>
<td>1</td>
</tr>
<tr>
<td>P&amp;R facility Dorchester</td>
<td>± 19,000</td>
<td>Suburb of the city Dorchester</td>
<td>Bus lines</td>
<td>City centre</td>
<td>1</td>
</tr>
</tbody>
</table>

Conclusions

General conclusions that can be made from the P&R facility reference projects is that, in order to be successful, a limited number of bus lines is advisable. In all cases of a P&R facility, only one bus line transfers the users to their destination. The P&R facility service has to serve a specified location, which attracts the most visitors. If the P&R facility serves a location which is not attractive, it will not be used and a vacant parking location is left. In addition, to promote a P&R facility regulations, like parking fees, short allowed parking times or a car-free zone, can be introduced by the city council. Another possibility is the introduction of a discount. Users of the P&R facility can get a discount when they visit certain shops, restaurants and cafés in the service area. The city council can do this in cooperation with the owners of the shops, restaurants and cafés.

3.3.2 FREIGHT TRANSPORT PROJECTS

In this last sub-section of the reference projects freight transportation projects are discussed. All projects have the intention to bundle freight transport in order to reduce the number of freight transportation kilometres and hindrance from freight transportation.

The reference projects have been chosen on multiple grounds. The first reason for their selection is the objectives of the city council, which are the same as in Gorinchem: reduce the amount of congestion and pollution in the city centre. The second reason is that all cities have a restricted city centre. This means that in order to enter the city centre or a specified area, the transporters have to meet certain requirements, such as maximum weight, height, width and/or emissions or can only
unload/load at specified times during the day. In addition, the reference projects use ‘green’
technology powered vehicles. The ‘green’ powered vehicles are introduced in order to meet the
restrictions that are placed on the service area. For example, the city of Utrecht has introduced a
‘milieuzone’. Diesel-powered vehicles that were produced before 1 January 2001 are not allowed to
enter a restricted area since the beginning of the year. From 1 July 2013 similar restrictions were
introduced for trucks.

**La Rochelle, France**

The city of La Rochelle in France has a historical centre with narrow streets. In order to reduce the
amount of freight transport kilometres and hindrance, the city council started an Urban
Consolidation Centre (UCC), which is based on 3 main goals:

- Reduce the amount of traffic congestion and pollution in the city centre;
- Rationalize the transport of urban goods;
- Become a financially viable stable operation.

To meet the objectives of the UCC, the municipality of La Rochelle introduced regulations to access
the historical city centre. To reduce the amount of emissions, the city council only allowed electric
vehicles to be used. It enforced the new service by limiting the time window during which other
delivery services are allowed to enter the city centre in contrast the full 24 hours of the UCC’s service
(Browne et al., 2005) (City Ports Project, 2005).

**Nuremberg, Germany**

In Nuremberg, Germany, there is a pedestrian-only area in the city centre. The majority of
shopkeepers in this area took the initiative to start an UCC. Not only to regulate the supply, but also
to reduce the costs of distribution. In addition, to keep the project on-going the shopkeepers pay a
monthly fee (City Ports Project, 2005).

In the beginning of the project, there was not enough commitment of the shopkeepers. In order to
keep the project running, few services were cancelled. The UCC held activities such as parcel and
pallet pick-up/delivery, storage services, reverse logistics, home shopping deliveries. After redefining
the service, it solely offered a parcels consolidation and delivery service (Browne et al., 2005).

Three lessons can be learned from the situation in Nuremberg, Germany. First, the initiative does not
have to lie in the hands of the city council. In this case the shopkeepers took the initiative. Second: without support from the shopkeepers a distribution service is not viable. Third: limit the services
during the start up of new service. A new service first task is to become financial viable with enough
consignees in the service area. When this task is completed, the service could investigate possibilities
to extend their services and reach more potential participants.

**Cargohopper, Netherlands**

The Cargohopper is an initiative from multiple transport companies. The project started in the
municipality of Utrecht and is currently extended to Amsterdam and Enschede. The Cargohopper
uses electricity-powered vehicles to deliver the contents in the city centre. Due to the historic nature
of Utrecht, Amsterdam and Enschede, the vehicles have a narrow layout to be agile and prevent
hindrance for other traffic using the roads.

The first project, in Utrecht, was started to reduce the hindrance of the freight transport flow and to
reduce the amount of traffic emissions in the city. The project created an urban consolidation centre
just outside the city centre. From this location, the Cargohopper delivers goods to the shopkeepers who joined the service.

Two conclusions can be taken from this reference project. A similar conclusion as that in Nuremburg is that the initiative can be taken by someone else then the city council. As shown in the three cities where the Cargohopper is operating, the transport companies took the initiative. The other conclusion is similar as in La Rochelle, France. To enforce the use of the Cargohopper service the city of Utrecht introduced stricter regulations about accessing the city centre for freight transportation vehicles.

**Leiden, Netherlands**

In Leiden there were three initiatives to start an UCC. These city council led initiatives were initiated in 1989, 1994 and 1997. The objectives of all initiatives were the same; reducing congestion and decreasing the distribution costs. However, all projects had to be cancelled. The main reason was that there was not enough commitment from companies in the city centre of Leiden due to the fact that the local government wanted a monopoly in the urban distribution. This was not in line with the existing distribution arrangements with the companies (Browne et al., 2005).

Another reason that the UCC in Leiden was not successful, was its poor location. The UCC was located too far away from the motorway and therefore not accessible by trucks. Due to the extra transfer and monthly costs of the UCC the companies preferred their own arrangements. Lastly, UCC received a bad ‘media image’ during the initial stages and from that moment onwards was confronted with an up-hill battle (City Ports Project, 2005).

Learned from the situation in Leiden is that creating stricter regulations does not always lead to success of an UCC initiative. The city council took three initiatives, which all had to cancel their service. The location plays an important role in the success of an UCC. When the transport companies have to travel further than the initial situation, the support will be limited due to the extra transport costs. The most important conclusion is that without sufficient support (of the shop owners), an UCC cannot survive by lack of revenues.

**Basel, Switzerland**

The last reference project in this sub-section is the UCC in Basel, Switzerland. The municipality wanted to reduce the number of commercial vehicles visiting the city, without reducing the delivery service. The project is known as the Basel City Logistik (BCL) (Browne et al., 2005) (City Ports Project, 2005).

The trial project was terminated in 1997. As the BCL project had failed to meet its main goals. The project did not achieve the expansion in number of participants, and the service did not achieve a doubling of the amount of deliveries. In addition, the reduction of the energy consumption was too small for a sufficient reduction of the pollution.

The lessons from the last reference project can be compared with the lessons of Nuremburg, Germany. When a new service cannot achieve the required target of support, the service has to reduce or cancel its service. In this case the service had also limited success in achieving the other objectives of reducing the emissions, which means that the city council did not see enough potential for subsidizing the service so that it could continue its operation.

An overview of the comparison between the different freight transportation projects is shown in the Table 7.
Table 7, overview of the freight transportation reference projects

<table>
<thead>
<tr>
<th>Reference project</th>
<th>Founding principles</th>
<th>Operational/ Cancellation</th>
<th>Service area</th>
<th>Type of customers serviced</th>
</tr>
</thead>
<tbody>
<tr>
<td>La Rochelle, France</td>
<td>Local administration and ELCIDIS</td>
<td>Operational</td>
<td>Medieval centre</td>
<td>Companies in the service area</td>
</tr>
<tr>
<td>Nuremberg, Germany</td>
<td>Public participation in the Directional Committee of ISOLDE</td>
<td>Operational</td>
<td>Pedestrian-only area</td>
<td>Haulers and shopkeepers in the service area</td>
</tr>
<tr>
<td>Cargohopper, Netherlands</td>
<td>Municipalities of Utrecht and transport companies</td>
<td>Operational</td>
<td>City centres</td>
<td>Shopkeepers in the service area</td>
</tr>
<tr>
<td>Leiden, Netherlands</td>
<td>European funding and municipality Leiden</td>
<td>Cancellation</td>
<td>City centre</td>
<td>Companies in the service area</td>
</tr>
<tr>
<td>Basel, Switzerland</td>
<td>Municipality of Basel</td>
<td>Cancellation</td>
<td>Pedestrian-only area</td>
<td>Companies in the service area</td>
</tr>
</tbody>
</table>

**Conclusion**

The five discussed freight transportation projects have different success. The main reason of success of the initiatives is the support from the shopkeepers in the service area. When the support is not sufficient enough the service will operate with losses and has to cancel the service on the long run.

Regulations can contribute, but they can also have a negative influence on the initiative. In most cases the regulations consists of stricter rules to access the city centre, such as time windows for loading/unloading, size restrictions for vehicles and/or powering restrictions for vehicles.

Also the location proves to play an important role in the success of an UCC. If the transport companies have to take a detour bigger than the initial route towards their destination, the transport companies will not take part of the UCC. The UCC therefore should be located on the initial route towards the service area.

One more lesson more can be learned is that the costs of the new service have to be limited, such that the UCC’s service can compete with the current transport companies. When the service becomes too expensive the support of the shopkeepers will be limited, due to the fact that the shopkeepers still prefer their initial situation because the lower costs.

3.4 SWOT ANALYSIS

In this section a strengths, weaknesses, opportunities and threats (SWOT) analysis is made from the observations made in literature review and the reference projects. Like the previous sections the SWOT analysis is divided over the two kinds of transport flows: passengers en freight.

3.4.1 PASSENGER’S FLOW SWOT ANALYSIS

In this sub-section all four sections of a SWOT analysis are elaborated on, to start with the strengths of passenger flow projects, i.e. P&R facilities.
**Strengths**

Strength of using a passenger flow project in the city is that there is less private transport, which enters the city centre. The P&R facilities from the reference projects are located in the suburb of the cities. This means that visitors using the P&R facility, park their car in the suburb and transfer to public transport or special shuttles to transport them to the city centre, keeping the city centre free from private vehicles. In addition, it results in an increased utilization of the public transport.

An additional strength is the reduction of the mobility problems handled in section 2.2 and a reduction of air emissions and congestion is achieved.

**Opportunities**

A passenger's transport flow project results in opportunities for the city. One opportunity is to combine the passenger and freight traffic transportation flows. This can lead to a further reduction of the air and noise emissions and an improvement to the liveability. Due the combination of the two transport flows less traffic kilometres will be made within the city boundaries, reducing the risks of accidents.

Another opportunity for the city is the location choice. For example, the P&R facility in Dordrecht at the Energiehuis has two functions. First is actually the parking location for the users of the Energiehuis, second is parking of the Park & Ride users. This means that city council has a co-investor for the redevelopment of the area.

In order to support the use of a P&R facility, the city council can tighten the regulations in the city centre or increase the parking fees. This can influence the decision of visitors to use the P&R facility located in the suburb of the city or the parking facility just located outside the city centre. This contributes to the decrease of the traffic in the city centre and improves the liveability of the residents.

**Threats**

In contrast to choosing a location with potential co-investors, a chosen location can lead to high investment costs for redevelopment, which might be reimbursed by the revenues from the project. If the facility is not successful, the city council has a potential high loss in the financial balance.

Low usage of the project results in a large vacant location. The location may become neglected, which can lead to a dangerous location within the city border.

Another thread is making the regulations stricter. Although it is also mentioned as opportunity, it can also works as a threat. The potential visitors want to use their transportation to reach their destination. Due to the increase of the parking fees or stricter regulations, the visitor may decide to visit another city with lower parking fees and less regulations.

The visitors wish a frequent transfer between the facility and the city centre, resulting in an expensive operation.

**Weaknesses**

The main weakness of a P&R facility is the transfer from private transport to public transport. The access time needed for parking, the P&R facility fee, waiting time and transfer time and the reverse route makes it less attractive for the general public. This means that the visitor has to add this extra time to his own time schedule.
Users P&R facility is that the users depend on public transport. This means that the users cannot travel to their destination or start with the return journey when they want it. The users have to keep in mind the schedule of the public transport and/or shuttle service between the city centre and the P&R facility.

In the following figure a summary of all arguments discussed in this sub-section are shown per category.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Less private transport vehicles within the city;</td>
<td>• Extra transfer;</td>
</tr>
<tr>
<td>• Public transport utilization;</td>
<td>• Extra travel time;</td>
</tr>
<tr>
<td>• Contributes to solving mobility problems.</td>
<td>• Dependent on the public transport.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Combinend passenger and freight transportation;</td>
<td>• Location choice can lead to high investment cost;</td>
</tr>
<tr>
<td>• Location choice can lead to co-investors;</td>
<td>• High investment costs and</td>
</tr>
<tr>
<td>• Regulations.</td>
<td>• Low usage of the facility leads to high losses;</td>
</tr>
<tr>
<td></td>
<td>• Possibility to vacant location;</td>
</tr>
<tr>
<td></td>
<td>• Regulations;</td>
</tr>
<tr>
<td></td>
<td>• High frequency leads to high costs.</td>
</tr>
</tbody>
</table>

Figure 23, passenger’s SWOT analysis summary in general

3.4.2 FREIGHT DISTRIBUTION PROJECTS SWOT ANALYSIS

Like the previous sub-section the arguments are categorized. At the end the arguments are summarized in a figure.

**Strengths**

Combining freight reduces the amount of vehicle kilometres. This in turn results in less physical hindrance, less traffic emissions and better traffic safety and thus leads to an improvement in liveability within the serviced community.

Drivers of an UCC are familiar with the area, which leads to fewer blockades. Unfamiliar drivers do not always know the traffic regulations and limitations of their vehicle given the street layout, leading to obstructions.

New employment is created in the region by the introduction of an UCC. To operate the facility different employees are needed, such as drivers, managers and cleaners.

**Opportunities**

These projects will provide a better liveability. For instance, with the introduction of green-powered vehicles the emissions (air and sound) are reduced. However, a remark needs to be made with regard to green-powered vehicles. Depending on the kind of drivetrain, emissions do not exist (electrical powered) or are reduced (hybrid or alternative fuels powered) during usage. Although there is less traffic emission per usage: the assembly of green-powered vehicles is not an
environmental friendly one. On the other hand, when new vehicles are ordered, their characteristics can be specified in order to match the exact constrains of the street layout thereby reducing traffic hinder.

Different regulations can be introduced to further reduce traffic hinder. Time windows for loading/unloading can be introduced or the current time windows can be reduced. Therefore the freight traffic is present in reduced time, and thus the inhabitants may have less inconvenience. In order to support the use of the UCC, the vehicles of the UCC that deliver the goods of the UCC are allowed to deliver their goods outside the time window. This leads to a better demand – supply handling. Time slots can be chosen in such a way that shopkeepers do not have to have employees working outside the opening hours of the shop. This saves the employer money.

The decision for the location of the new UCC is a very important factor. It forms an opportunity, because a location that is situated on the route to the destination has a higher success rate compared to locations that can only be reached with a detour.

Flexibility is also an opportunity. An option is to introduce vehicles that can be used for transport flows of passengers or freight. If the distribution vehicle can change its cabin type from passenger transportation to freight transportation, when passenger flow is low, it might lead to lower investment costs for the project owner, increasing the projects chance of success.

**Threats**

The location can also be a threat, because a wrong location will hardly be used, reducing the positive effects. An incorrectly placed UCC leads to investment costs that will never be paid back. If the number of users is too low, the service cannot reach a financial viable condition and has to be stopped or slimmed down, leading to vacant buildings.

By making the regulations stricter, a monopoly could be created for the new service, which in turn may lead to obstruction from users in the service area. For example, large retailers, such as Albert Hein and Jumbo, have their own transportation methods that are optimized for their own shops. If their private transport of supplies is rejected from the service area, the chance might be that these retailers leave and relocates to other neighbouring municipalities. This reduces the economic value of the city centre. The nowadays often used e-commerce changes the function of inner cities over time (Klop, 2014). Retailers relocate outside the ‘expensive’ city centre or transform themselves to an e-commerce shop.

Regarding the changing functions of inner cities or service areas, the important question is how flexible a transport service can be. Is the offered service flexible enough to accommodate the changing demands of the service area? For instance, in Nuremberg the service had to cancel parts of the offered services over time in order to keep the service running.

**Weaknesses**

A new service with an extra transfer does not only have benefits. All transfers leads to extra costs and delivery times. With respect to freight transportation services, the extra delivery time originates from the extra unloading of the original transport to the storage and loading of the dedicated distribution vehicles for the service area. For this service, extra employees are needed, which increase costs. However, the higher the number of shops that are committed to the service, the more the costs per shop will decrease. In Figure 24 a summary of the previously presented arguments is shown per category.
3.5 SIMILARITIES AND DIFFERENCES BETWEEN THE TRANSPORT FLOWS

In the previous sections both types of transport flow were analysed. From both SWOT analyses similarities and differences become clear and are discussed in this section.

**Similarities**

In order to combine the current private transportation and the many freight transporters within the municipality, a facility has to be constructed which serves as a transfer location. Visitors and/or freight with a destination within the city are bundled at a single location and transferred to a service, which will transports visitors and/or freight to the city centre. At the moment there is not such a facility in Gorinchem. In section 5.3 different locations are investigated in order to see, which can be used to house a transport service for Gorinchem. From the analyses it can be concluded that most of the transfer locations are positioned in a suburb of a city, for example the P&R facility in Dorchester (United Kingdom), Cargohopper (multiple cities in the Netherlands) and Leiden (the Netherlands). But there are also successful facilities located closer to the city centre, for example Dordrecht (the Netherlands) and La Rochelle (France).

Another similarity between the two transport flows is that investors are needed in order to realize a new transport service. Both main stakeholders regarding this study need a co-investor in order to realize their objectives. In order to have a financial stable transport service, the service has to have the necessary amount of committees in order to be successful. In that case the service does not have to be subsidized from the local government and/or other institutions.

The transport flows have the potential to be combined. A possibility is to use the same transport vehicles. To transport passengers, a cabin with couches and standing locations is needed. In order to transport the freight, the passenger cabins have to be replaced by cabins that have a layout for freight. The combination of the flows means that a suitable location can be shared by the passenger and the freight transport flow. One large facility can be created with integration of a Park & Ride facility and an Urban Consolidation Centre. As mentioned during the literature review, even the

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reduction of physical hindrance, emissions and traffic unsafety;</td>
<td>• Extra transfer leads to:</td>
</tr>
<tr>
<td>• Area known drivers in service area;</td>
<td>o extra delivery costs;</td>
</tr>
<tr>
<td>• Creating employment.</td>
<td>o extra delivery times.</td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td><strong>Threats</strong></td>
</tr>
<tr>
<td>• ‘Green’ powered vehicles in order to further reduce the emissions;</td>
<td>• To few commitments leads to non-used high investment costs facilities;</td>
</tr>
<tr>
<td>• Better demand-supply levels due to continuous service;</td>
<td>• With no extra delivery regulations chance to create opportunities for third parties;</td>
</tr>
<tr>
<td>• Combining the transport flows (passengers and freight) can lead to less vehicles needed</td>
<td>• Creating a monopoly</td>
</tr>
<tr>
<td>• Stricter regulations in order to restrain third parties;</td>
<td>• Changing functions of the service area;</td>
</tr>
<tr>
<td>• Location choice;</td>
<td>• Location choice;</td>
</tr>
<tr>
<td>• Flexibility;</td>
<td>• Lack of flexibility;</td>
</tr>
<tr>
<td>• Regulations.</td>
<td>• Regulations.</td>
</tr>
</tbody>
</table>

Figure 24, SWOT analysis of freight distribution projects
transport itself can be shared with one remark. In the article from (Trentini and Malhene, 2012) the freight is transferred to other vehicles at the certain passengers stops. From the stops, the passenger transport and freight transport travel to different directions.

**Differences**

The cabins in which the passengers and freight are transported form the main difference between both transport flows. The difference between the two is that the cabin, which is used to transport passengers, contains couches to enable passengers to sit. Cabins for freight transportation need lots of free space, for pallets or shelves in order to organize packages.

Another difference between the two transport flows is the partners that are interested in the project. The partners of the freight transportation project are transport companies, the shop owners in the city and retailers, although for the shopkeepers the flow of passengers is also important. These partners have influences on the project. For example, if shop owners do not participate in the project, the service will not be sufficiently supported. This will lead to a financial loss. For the passenger projects the partners are visitors, commuters and the public transport company. Both projects have the city council and the foundation ‘Behoud Erfgoed De Vries Robbé’ in common. Both stakeholders of this study have an interest in the services. The city council has as goal to reduce the three mobility problems, mentioned in section 2.2, therefore the two services (P&R facility and UCC) might help to achieve their goal. The foundation has the goal to redevelop the storage facility in order to preserve industrial heritage. This facility might be an opportunity to become a transfer station in the passenger and/or freight flow.

In (Trentini and Malhene, 2012) it is mentioned that the two transport flows, passengers and freight, can be combined. In the article, freight is transferred to special vehicles, which are present at the stops for passengers. As the stopping time for public transport is around one minute and the delivery of one package is one minute, the truck driver cannot do the deliveries from the freight. If multiple packages have to be delivered at one stop, the passengers have to wait several minutes during their trip.

In the previous paragraphs different similarities and differences between the two transport flows were summarized. An overview of all aspects is shown in the following enumeration:

- **Similarities**
  - Location in/near the city;
  - Investors needed;
  - Opportunity to combine the two transport flows;

- **Differences**
  - Cabin layout: *coaches and standing facilities versus shelves and/or free space*;
  - Partners: *transport companies, shop owners and retailers versus public transport companies and visitors/commuters*.
  - Stopping times: *packages delivery times versus access and egress times*

### 3.6 CONCLUSIONS

The problems can be divided between two kinds of transport flow. The first kind of transport flow results from transport of human beings. This flow is then differentiated into private transportation (creating own transportation) and public transport (third parties involved in the journey). The second kind of transport flow is the freight transportation. Freight transportation, whether by water, land or air can be described as goods, cargo or bulk transported for compensation of the transport company.
From literature and reports, possible solutions can be derived. The search for opportunities in Gorinchem was done with the division of the transport flows in mind. To reduce the amount of passenger flow, a Park & Ride facility can be introduced. P&R facilities are usually located in the suburbs of a town. However, the reference project in Dordrecht, the Netherlands, shows that also P&R facilities closer to the city centre are successful too.

To reduce the amount of freight transport in a city, an Urban Consolidation Centre can be introduced in the city logistics. Such a centre collects, stores and delivers multiple shipments with a destination in the service area (in the case study the service area is the city centre). An UCC bundles multiple shipments from retailers and delivers the freight with their vehicles, improving the occupancy rate of the freight vehicles reducing the amount of freight vehicle kilometres.

Bundling the incoming and outgoing transport flows for specified areas, is the common strategy of a P&R facility and an UCC. A P&R facility focuses on bundling visitors for a city centre, while an UCC focuses on bundling goods. However, both services cannot be combined due to the differences in access/egress times from passengers and unloading/loading times from freight.

In Chapter 5 multiple suitable locations are proposed for the P&R facility and UCC. Furthermore scenarios are formed in order to assess the services in combination with their location. The assessment of the case study in Gorinchem is done Chapter 6, which shows the feasibility of the two services in the city.
Chapter 4  INDUSTRIAL HERITAGE ANALYSIS

In the introduction the main problems of this project have been presented, whereby the two problems owners also have been introduced. In the second chapter the problems and the common grounds are specified. This chapter will discuss in depth the problem of the foundation ‘Behoud Erfgoed De Vries Robbé’. In the first section different types of monuments are identified and their financing. In the second section reference projects regarding industrial heritage are presented. In the final section of this chapter a SWOT analysis is made for industrial heritage projects in general.

4.1  MONUMENT’S FRAMEWORK

In the Netherlands there are different types of monuments. The hierarchy in the Netherlands is: national-, provincial-, municipal monument and protected town sight. The difference between each type of monument is explained in this section.

A national monument is heritage, which is assigned by the government to be kept and protected for its historical and/or cultural value. The national government funds the owners of the monument in order to protect the building from deterioration. However, the owners cannot demolish or rebuild parts of the monument. In order to change parts of the building, owners have to get a permit from the government. In the municipality of Gorinchem there are around 200 entries on the national monument list with houses, churches and the historical city wall (Rijksmonumenten.nl, 2015, Monumenten.nl, 2015).

If an area does not contribute to the national value, but does contribute to a municipality, the city council itself can decide to put this region on a municipal monument list. In the past the city council of Gorinchem did not have a satisfactory monument policy, as in 2012 and 2013 there was economized on the areas of archaeology and municipal monuments (Gorcumse Courant, 2014). However, in the newly assigned zoning plan for the inner city, the council mentioned that the policy is updated and there will become a budget (Monumenten.nl).

Two provinces in the Netherlands, Noord-Holland and Drenthe, have provincial monuments next to national and municipal monuments. The Provincial State assigns monuments to a list that apply on buildings, dikes, landmarks and municipal exceeding border’s objects. A monument on this list is protected by the province and can count on subsidize funds (Monumenten.nl, 2015).

The final type of monuments in the Netherlands is a protected town sight. These sights contribute to the cultural value of the nation and/or city. A protected town sight has national recognition of its cultural value. By becoming a protected town sight, the sight has to be taken into account when the surrounding is being redeveloped. A protected town sight can receive subsidy of a province and/or municipality (Monumenten.nl, 2015).

All the described types of monuments are national heritage of the Netherlands. However, international heritage exists too, called UNESCO heritage. A location, which is on the UNESCO heritage list, is the Dutch Waterline. The Dutch Waterline was a defence line existing out of forts, dikes and rivers. During the Second World War, the Dutch Waterline lost a big part of its military function, in spite of the fact that most forts were still intact. A section of the Dutch Waterline crosses Gorinchem. The fortress of Gorinchem is positioned at a junction of two rivers: the Merwede and the Linge. The fortress had multiple buildings with a military function, comprising (artillery) barracks (Monumenten.nl, 2015, Nationaal Project Nieuwe Hollandse Waterlinie, 2015). Because the UNESCO
heritage is international, it should be on top of the framework. The following figure shows the framework.

![Monuments Framework](image)

**Figure 25, monuments framework with international status**

Currently, the old storage facility of De Vries Robbé on the Linge II Zuid, which is the main objective of the foundation ‘Behoud Erfgoed De Vries Robbé, is neither a national/municipal monument nor an international monument. However, the so-called ‘Rotonde’, the former offices and lunchroom of the steel factory, is a national monument and is situated next to the storage facility. To be recognised as a monument, the storage facility has to be redeveloped. Neither the foundation does not have the resources nor the storage facility has a new function. In order to find opportunities for the storage facility, reference project will be investigated in the next section.

### 4.2 HERITAGE REFERENCE PROJECTS

The foundation ‘Behoud Erfgoed De Vries Robbé’ is searching for a new function for the old storage facility of De Vries Robbé building on Linge II Zuid. In this sub-section recently pursued actions by other local Dutch governments/projects groups with respect to vacant industrial heritage are explored.

Two reference projects that are discussed in this section, the ‘Lijm & Cultuur’ in Delft and the ‘Lichttoren’ in Eindhoven, are old factory buildings designed and constructed by ‘De Vries Robbé & Co’, such as the storage facility in Gorinchem. These buildings also became vacant after serving their original owners Philips and van Marken. The large glass windows and the steel skeleton of these buildings form the characteristic construction type used by ‘De Vries Robbé & Co’.

The mentioned reference projects were also vacant locations until a project group or local government invested in the location. Each of the reference projects has evolved into buildings, which facilitates new functions in contrast to the original purpose of the facility.

One reference project, the ‘Energiehuis’ in Dordrecht, is specially chosen in relations to the situation in Gorinchem. Dordrecht has located a Park & Ride facility next to the old power plant of the city. The building has been transformed in a culture studio, but visitors for the inner city of Dordrecht can park their private transportation on the P&R facility located at the ‘Energiehuis’ and travel further with a dedicated bus service.
**Rohm and Haas factory, Amersfoort**

In 1850 the company Rohm and Maas built a glue/soap factory in Amersfoort. This factory building was redeveloped in 2009. Figure 26 shows the new layout. The factory, together with new buildings, forms the basis for a Grand Café. The Grand Café contains numerous workspaces, lounges, studios and exhibition spaces. The Grand Café is a project from three artists in co-operation with Poolen Architekten and BOEi (Z33P Architekten, 2009). BOEi is a non-profit organisation that has the intention to maintain industrial heritage, while Poolen Architekten is an architect company. In addition to the above-mentioned functions, the redesigned factory now also houses the office of the architect company and the three artists.

![Figure 26, the new layout of the old glue/soap factory from Rohm and Maas](image)

**Lijm & Cultuur, Delft**

In 1885, Jacob Cornelis van Marken started a glue & gelatine factory in Delft. The factory had to stop their productions in 2002 due to the Bovine Spongiform Encephalopathy (BSE) disease. After the production of glue and gelatine stopped, the location was redeveloped into a production site for culture events, named ‘Lijm & Cultuur’ (Lijm en Cultuur, 2014). Currently, the location is used for music festivals, restaurants and other social events as can be seen in Figure 27 on the right image. The factory building is a preserved location built by ‘De Vries Robbé & Co’.

![Figure 27, Lijm & Cultuur in Delft, the Netherlands. The left image shows a general view of the buildings, the right image shows the main facility in use during a music event](image)
**Energiehuis, Dordrecht**

The Energiehuis in Dordrecht was a power plant for the municipality. The first part was commissioned in 1905, while the last section of the power plant was constructed in 1928 (Energiehuis, 2015). The function of the buildings changed over the years. First between 1955 and 1980 it was changed in an office buildings. The last renovation, started in 2010, replaced the offices for a culture centre (de Architect, 2015). The Energiehuis facilitates a theatre room, a practice room and studio’s for dance and culture. The parking location is the same Park & Ride facility that is also used by passengers that travel to the city centre of Dordrecht, as discussed in section 3.3.1.

![Figure 28, the Energiehuis in Dordrecht, the Netherlands. The left image shows the culture centre, the right image shows the P&R facility](image)

**Lichttoren, Eindhoven**

In Eindhoven the electronic company Philips gave the order to construct the Lichttoren. The tower connected several factories of Philips Lightning. The factories were constructed in parts during the years 1909 and 1921. The steel constructions came from ‘De Vries Robbé & Co’. The tower was taken into service in 1911. Due to relocation of production activities, the tower became vacant. The following figure shows the Lichttoren in Eindhoven.

![Figure 29, the left image shows the old Lichttoren, The right image shows the renovated situation](image)

The municipality of Eindhoven wanted to preserve the building as symbol for the Eindhoven’s’ industrial past, but also as a monument for its particular architecture. In 2003 a company bought the Lichttoren complex (TRUDO, 2015). The company started to renovate the complex into a housing corporation, consisting of apartments, a hotel, offices and shops. As a result, the Lichttoren still attracts people, thereby being a lively location in the centre of Eindhoven.
**Rozendaalcomplex, Enschede**

In 1907, a new textile factory was commissioned by the Rozendaal company. The resulting ‘Rozendaalcomplex’ has recently been redeveloped from 2003 till 2008. Due to numerous years of vacancy, parts of the Rozendaalcomlex could not be preserved nor renovated. The remaining buildings were transformed into a culture centre named ‘Twentse Welle’. This is a fusion of three museums, namely the nature museum, the Museum Jannink and the ‘Van Deinse Institute’ (Industrieel Erfgoed Twente, 2015). Figure 30 shows the new layout of the Rozendaalcomplex.

![Figure 30, layout of Twentse Welle in the Rozendaalcomplex, Enschede](image)

**Conclusions**

The reference projects discuss factory buildings that were abandoned due to different factors. All buildings were preserved, but have now a different function after their renovation. The following table gives an overview of the projects.

<table>
<thead>
<tr>
<th>Reference project</th>
<th>First function</th>
<th>New function</th>
<th>Location in municipality</th>
<th>Project owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rohm and Maas, Amersfoort</td>
<td>Glue &amp; Soap factory</td>
<td>Offices and studios</td>
<td>Suburb in Amersfoort, near city centre</td>
<td>Architect, artists and BOEi</td>
</tr>
<tr>
<td>Lijm &amp; Cultuur, Delft</td>
<td>Glue &amp; Gelatine factory</td>
<td>Centre for culture &amp; restaurant</td>
<td>Industrial area and University campus in Delft</td>
<td>Multiple companies</td>
</tr>
<tr>
<td>Energiehuis, Dordrecht</td>
<td>Power plant and later offices</td>
<td>Centre for culture and dance &amp; P&amp;R facility</td>
<td>Suburb of Dordrecht, near city centre</td>
<td>Multiple organisations</td>
</tr>
<tr>
<td>Lichttoren, Eindhoven</td>
<td>Factory and office</td>
<td>Homing, hotel, shops &amp; offices</td>
<td>Centre of the city Eindhoven</td>
<td>Property company</td>
</tr>
<tr>
<td>Rozendaalcomplex, Enschede</td>
<td>Textile factory</td>
<td>Museum</td>
<td>Suburb in Enschede</td>
<td>Multiple organisations and municipality</td>
</tr>
</tbody>
</table>

A common ground of the reference projects is their location within city centres. Although the factories were originally built on the outskirts of city limits, the old factory buildings are currently surrounded by new suburbs due to the growth of the cities.
A main difference between the reference projects and the situation of the foundation ‘Behoud Erfgoed De Vries Robbé’ is that the reference projects have multiple stakeholders involved in the renovation of the old factory buildings. Although the foundation has actively explored other participants to join, it currently is still the only stakeholder that is concerned with the renovation of the factory building of the steel construction company ‘De Vries Robbé & Co’ in Gorinchem.

4.3 SWOT ANALYSIS

From the literature and the reference project strengths, weaknesses, opportunities and threats (SWOT) analysis can be made. In the following figure the analysis is shown. In the following paragraphs the arguments per aspect are discussed.

Strengths
In section 4.2 observations from the discussed reference projects are shown. The historical value of the industrial heritage projects is preserved. Preserved monuments have as result lower investment costs by receiving subsidies.

For the case study in Gorinchem, Linge II Zuid may enforce the historical value from the Hollandse Waterlinie and other historical places in Gorinchem.

A well-developed business plan forms a strength for a dilapidated area, leading to its gentrification.

Opportunities
Renovation of heritage leads to new and possible multiple functions, which might be of interest for potential partners. With the help of co-investors the project owner will not carry the entire financial consequences.

Another opportunity from reusing an industrial location is the conservation of nature. Gorinchem is situated at the border of the ‘Groene Hart’, which is marked as a national park in the Netherlands and must be preserved as much as possible. It forms the central green area of the ‘Randstad’ functioning as a recreation park.

Weaknesses
Owners focussing on only one function. After its first redevelopment, the ‘Energiehuis’ in Dordrecht was strictly used to host offices. Due to insufficient commitments, many of these offices became vacant and new functions had to be found. Accordingly, a heritage project can profit from focussing on multiple functions chosen in relation with the background of the region. For example, it may have an economical, social, cultural and/or industrial function. These new functions create the basis for the business model of a particular heritage. If the business model is not formulated correctly or lacks a solid foundation for potential users, the preservation is difficult to succeed.

Solitary support may lead to incomprehension of those who initiated the project.
**Threats**

If the local inhabitants do not support the new function, they will not use it and the project will never become financially stable. Another threat is that the condition of the building might be too bad in order to be redeveloped. In this case the building need to be demolished prior to rebuilding.

If the new function is killed by its own success, the whole project is unsatisfactory. For example, when the location is inaccessible and the capacity of the location is insufficient for the number of visitors, the project will not be a success. The following figure gives an overview of all discussed arguments.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Preserving historical value;</td>
<td>• Being focused on one goal;</td>
</tr>
<tr>
<td>• Reuse instead of new leading to:</td>
<td>• Solitary support;</td>
</tr>
<tr>
<td>o Lower investment costs;</td>
<td>• Insufficient business model.</td>
</tr>
<tr>
<td>o Gentrification of heritage.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Finding co-investors to preserve heritage;</td>
<td>• Location offers no additional values;</td>
</tr>
<tr>
<td>• Multi-functional building:</td>
<td>• Demolishing heritage due to condition;</td>
</tr>
<tr>
<td>o Residential;</td>
<td>• New function unsatisfactory for the region.</td>
</tr>
<tr>
<td>o Mobility;</td>
<td></td>
</tr>
<tr>
<td>o Cultural;</td>
<td></td>
</tr>
<tr>
<td>o Industrial;</td>
<td></td>
</tr>
<tr>
<td>• Conservation of nature.</td>
<td></td>
</tr>
</tbody>
</table>

Figure 31, overview of the SWOT analysis for heritage projects

All aspects of the SWOT analysis can be categorized in the values of the project, the involved actors, the integration of the project and the location. The values of the industrial heritage have to be clear before the preservation starts, otherwise the project can lead to failure due to lack of commitment/visitors/income. The actors have to be committed to the project, although these same actors can have different interests and objectives with the project. Accordingly, different wishes and requirements have to be managed in order to get a successful renovation. To be a successful project, integration with the local region and social network are very important aspects for which three features can be formulated:

- Logistics; is the accessibility and capacity of the location sufficient enough?
- Demographically; does the location attract sufficient number of users/visitors?
- Geographically; is the location unique or are there other locations in the region like the involved project?

### 4.4 CONCLUSIONS

In the Netherlands there are five types of monuments, from international to municipal monuments. Although Gorinchem has multiple types of monuments, the storage facility, which is main objective of the foundation, has to receive a new function in order to be recognised as a monument.

The successful reference projects from industrial heritage shows that multi-functionality is an opportunity to find co-investors for redevelopment of industrial heritage. Another important aspect
is the business plan. If the business plan is elaborated in detail before the redevelopment begins, the project is more lightly to succeed then forming the business plan alongside the redevelopment.

However, there are threats concerning redevelopment of industrial heritage formed by logistic, demographic and geographic aspects in order to be successful. Inaccessibility, being killed by its own success or redundancy are topics that has to be kept in mind once one would like to start heritage project.

For the foundation ‘Behoud Erfgoed De Vries Robbé’, the three mentioned features have to be answered in order to determine whether the heritage can successfully be integrated into the mobility problems of the municipality. In the following chapter the similarities and differences between the analysis of transport and industrial heritage will be discussed, followed by a discussion on the assessment criteria for the case study. In order to find a suitable location for the mobility projects, the heritage location, Linge II Zuid, and other locations are analysed whether or not they can be used as a solution.
Chapter 5  MERGING THE ANALYSES

In Chapter 1 a joined objective has been stated: “Can Gorinchem’s mobility problems be solved by redeveloping the vacant storage facility on Linge II Zuid into a P&R facility and/or UCC?” The analyses of transport flows (Chapter 3) and the utilization of industrial heritage (Chapter 4) were independently made form each other. Chapter 3 concluded that transport flow could be divided in two types, namely passengers and freight. For the two types of flow, the analysis was summarized in a SWOT analysis. Chapter 4 concluded that industrial heritage could be multifunctional. Also this analysis was summarized in a SWOT analysis. In section 2.4 the common grounds of the two problems were specified. Chapter 5 starts with a discussion of the overlapping aspects of these analyses (section 5.3) and shows the criteria on which a solution has to meet (section 5.2). In the section 5.3, possible locations, among which industrial heritage Linge II Zuid, for a P&R facility and UCC are considered that fulfil the conclusions made in Chapter 3.

5.1 COMMON GROUNDS

The first common ground that both projects share is the assignment of a location for the new function. A transfer facility will hold the function of a Park & Ride facility and/or an Urban Consolidation Centre as mentioned in Chapter 3. This facility can be situated at the town’s border or at specified locations on the road leading to the city centre (similar to the reference projects in the Chapter 3). This provides an opportunity for the city council as well as the foundation ‘Behoud Erfgoed De Vries Robbé’.

The foundation searches for a new function for the vacant storage facility, located at Linge II Zuid. From the analysis in Chapter 4, different opportunities for this location came forward, for example: a museum, a culture centre or a P&R facility. A merging of the wishes of both the city council and the foundation might result in a redevelopment of the storage facility into a P&R facility or UCC.

Both stakeholders need partners and/or co-investors enabling them to proceed with the projects. The group of potential partners differ for both stakeholders. This may lead to public private partnerships. The mentioned potential partners in section 3.5 and 4.2 are shown in the following table.

Table 9, potential partners of both stakeholders

<table>
<thead>
<tr>
<th>Potential partners of the city council</th>
<th>Potential partners for heritage projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Public) transport companies</td>
<td>Industrial heritage project groups</td>
</tr>
<tr>
<td>Shop owners/retailers</td>
<td>Cultural project groups</td>
</tr>
<tr>
<td>Visitors/commuters</td>
<td>Museums</td>
</tr>
</tbody>
</table>

5.2 CRITERIA FOR THE ASSESSMENT

A synergistic solution for the mobility problems of the city council of Gorinchem and the preservation of the storage facility of the foundation located on Linge II Zuid, is to redefine the function of Linge II Zuid as a P&R facility or UCC. In order to evaluate this and other alternative locations, different criteria have to be developed, which are explained in this section. From the analyses four criteria can be derived:
The first criterion is environmental effects, which represents the emissions that are caused by traffic within a city. Section 2.2 showed that in Gorinchem the number of daily limits for fine particulates, \( \text{PM}_{10} \), is exceeded. However, when the possible solution has been introduced not only the fine particulates will be reduced, but also other air emissions as carbon dioxide. An additional advantage when using “green technology” like e-motive mentioned in section 1.5 is, that it can reduce the noise emissions from traffic, hence improving the liveability.

The second criterion, vehicle kilometres in the city, gives an indication in the number of vehicles kilometres that will be reduced by the alternatives. Due to the current number of vehicles kilometres in the city, physical hindrances occur. From section 2.2, it can be concluded that within the city different bottlenecks are present, which cause congestions. The loading/unloading activities of cargo form another physical hindrance in the city centre. The analysis in Chapter 3 concluded that the usage of new, narrower vehicles leads to less obstacles in the traffic flow. As a result the rest of the traffic has no interference when passing the freight transportation while they load/unload.

The third criterion, liveability, contains numerous aspects like the number of accidents and damage to façades caused by traffic. From section 2.2, it can be concluded that the predictions for the number of traffic accidents increases over the years, just like the traffic intensity.

The final criterion, financial feasibility, holds for both stakeholders. The city of Gorinchem and the foundation ‘Behoud Erfgoed De Vries Robbé’ have to find co-investors in order to start this project. If the project is financial viable, the city and the foundation have a project, which returns the investment to the financial partners. Financial viable means that the project costs are covered by the incoming fees, without the help of European, national and/or local subsidies. The potential stakeholders for the project have to deal with the following costs:

- **Investment costs;**
  - Real estate costs;
  - Infrastructure costs;
  - Vehicles costs
- **Yearly costs;**
  - Maintenance costs;
  - Personnel costs;
  - Insurance.

In contrast to the expenses, the revenues of the project can be divided into two kinds of revenues: First the saving of the shop owners and the savings of the transport company. The shop owners, who participate in the UCC, can receive their goods during opening hours. This saves them the excess work time of their employees.

The transportation companies’ benefit results from their timesaving on deliveries and planning. Planning means that the transportation companies do not have to take into account the time windows set by the city council.
Secondly, there are social revenues, which are less environmental pollution, less vehicle kilometres in the city and less inconvenience for the inhabitants. In contrast to first type of benefits the second type of benefits is hard to express in financial values.

5.3 LOCATION ANALYSIS

Looking at the reference projects in section 3.3 and 4.2, success and failure points for locations become clear. The successful reference projects are located near a large throughput road, such as a motorway and/or national roads that lead to the city centre. It can also be concluded from the reference projects that a location in the suburb of a municipality might be favourable.

Another aspect is the location’s zoning plan of the areas. All reference projects had zoning plans that contributed to the development of P&R facilities/UCC near the city. Most projects are situated in an industrial park or in a suburb of the municipality where new facilities can be constructed. Examples are the Cargohopper in Utrecht, which is located in an industrial park and the P&R facility of Cowes, which is located near the border of the city.

Suburb located locations

The above-mentioned aspects reduce the potential locations in Gorinchem. In Gorinchem there are multiple industrial parks where (re)development is currently possible, namely: Gorinchem Oost I & II, Avelingen and Gorinchem Noord. Also Stalkaarsen is a potential location, which is not an industrial park and is located on the way to the city centre. However, with the zoning plans of these locations and the connecting routes from the motorways to the city centre in mind, several of these locations can be excluded. For numerous years the city of Gorinchem wants to create a new industrial park to the North of the motorway A15 and to the East of the A27. With the current infrastructural connections, this location is difficult to reach. The provincial government is still thinking about an exit from the motorway A27 towards location Gorinchem Noord, but there is no exact planning for this exit at the moment. The second reason to exclude Gorinchem Noord is that the location is not located near a connecting route between a motorway and the city centre. Therefore, Gorinchem Noord is excluded as a suitable location for a P&R facility/UCC. The second location that can be expelled is industrial park Gorinchem Oost I. This area is currently fully constructed and there are no plans for redevelopment in the near future. Therefore Gorinchem Oost II, Avelingen and Stalkaarsen are left as possible locations for this project.

The first potential location is the industrial park Gorinchem Oost II. In the past, the municipality of Gorinchem owned this location. However, the municipality sold this land to a company, which is still the current owner of this location. The industrial park at this location is expanding toward the East. One of the main attractions of Gorinchem Oost II is the ‘Evenementenhal Gorinchem’. This location organizes multiple events during the year. In order to facilitate the visitors of these events, the hall has his own parking facility. In order to reduce the costs of the P&R facility, a co-operation between the municipality and the hall might be considered. If the co-operation is not successful another parking facility has to be created elsewhere within this location.

The second location that can be taken into account is the industrial park Avelingen. This industrial park is situated near the city centre and has a full connection with the national road, the A27, which divides this industrial park into two sections. Currently the industrial park is fully constructed, however the city council is looking for possibilities to widen the motorway bridge of the A27 across the Merwede River. In order to accomplish this, the industrial park has to be redeveloped. This redevelopment could render an opportunity to design a Park & Ride facility. Other studies
investigated the possibilities for a heliport in this area (Project Group 9, 2013), which can be included in an optional P&R facility.

The third location, Stalkaarsen, is currently used as a hotel. The zoning plan for this location describes that the hotel remains and a new parking facility will be created for the hotel. In the past, the zoning plan also included a casino on this location. However, the inhabitants were against a casino, and accordingly a new zoning plan was introduced including an area for residences.

**City Centre locations**

From the reference projects in section 3.3 and 4.2 it can be concluded that locations near the city centre also have to be taken into account. The difference between a suburb and city centre located area is that the suburb locations must have connecting public transport to transfer the users from the P&R facility to the centre. Numerous locations are available near the city centre: Paardenwater, Stationsweg, Linge II Zuid and ‘Mercon Steel Structures’ BV’ parking facility. However, also here multiple locations have to be excluded when looking at the zoning plans and/or historical background. The Paardenwater location is a protected town sight in Gorinchem. Hence new facilities have to be in rule with restrictions set by the city council. Another location that can be excluded is the Stationsweg. Although there is already a parking facility available, it is restricted as there are no expansion possibilities available due to the surrounding buildings and railroad. Furthermore, the zoning plans limits the construction heights on the locations, preventing the parking facility to expend in the air. With two locations excluded from the potential areas, only two locations near the city centre are left.

The first location, Linge II Zuid, is the facility of the foundation ‘Behoud Erfgoed De Vries Robbé’. This location features a vacant storage facility of the steel construction factory, which can be redeveloped in order to attract visitors to Gorinchem. The area also facilitates two other buildings, a boat construction factory and a building owned by a project manager. Both last-named facilities are being relocated in the near future and this area can totally be redeveloped, foreseeing opportunities for the distribution projects in Gorinchem.

The second location, Avelingen, is also discussed in the previous sub-section. This industrial park extends towards the city centre. From van der Roest (van der Roest, 2015) a possible large parking facility can be used in co-operation with ‘Mercon Steel Structures BV’. The company facilitates their employees, but, during closed hours, the parking facility is vacant. In order to use the parking facility, the city council has to make an arrangement with the factory.

In the previous paragraphs all potential locations for a Park & Ride facility and/or Urban Consolidation Centre were discussed. The mentioned city centre locations will be compared to an already existing parking facility, namely Kweeklust, which is just located within the city walls in contrast to Linge II Zuid and ‘Mercon Steel Structures BV’. Kweeklust has recently been renovated (van der Roest, 2015).

From this sub-section it becomes clear that six potential locations are available:

- Stalkaarsen;
- Gorinchem Oost II;
- Avelingen Motorway exit;
- Linge II Zuid;
- Avelingen ‘Mercon Steel Structures BV’;
- Kweeklust.
However, only four of these locations are suitable for an UCC as Kweeklust and ‘Mercon Steel Structures BV’ are existing places, which cannot be redeveloped. Three of these locations are located near the border and three are located near the city centre. In Figure 32 all locations are shown.

Figure 32, overview of the possible locations

5.4 CONCLUSIONS

Environmental effects, vehicle kilometres in the city, liveability and financial feasibility can be distilled as criteria for the assessment of the P&R facilities and UCC. In order to assess the situation in Gorinchem, six different locations could be selected for the potential services of the P&R facility from which four locations can also be used as UCC. Three out of the six locations are located in the suburbs of Gorinchem, namely: Avelingen, Gorinchem Stalkaarsen and Gorinchem Oost II and three locations are near the city centre: Mercon’ Steel Structures BV’ parking facility, Linge II Zuid and Kweeklust.

In Chapter 6 the six locations will be scored on the criteria discussed in section 5.2.
Chapter 6 ASSESSMENT OF THE ALTERNATIVES

In this chapter the viability of the alternatives discussed in Chapter 5 is calculated and described. In section 6.1 the methods are explained that are used to calculate the effects of the P&R facility and UCC. As the grounds differ on which a P&R facility and an UCC can exist, the assessment of their viability is differentiated. The method for the assessment for a P&R facility will be discussed in section 6.1.1 and the method used for the UCC is described in section 6.1.2. In section 6.2 the effects of the possible P&R facility/UCC on the mobility problems are discussed. Section 6.3 shows the financial feasibility of the project.

6.1 METHODS USED FOR ASSESSMENT

For the assessment of the P&R facility logit models are used and the assessment of the UCC will be performed with help of scenarios.

6.1.1 ASSESSMENT FOR P&R FACILITY

The objective of this quantitative analysis is to calculate the potential number of P&R facility users. In order to calculate the effects on the traffic flows a logit model is used. This model takes into account that all possible transport modes are influenced by an extra-introduced transport mode. A logit model calculates the probability that a mode is chosen.

To calibrate the model, the current modal splits from passers-by studies are used. Two options are available for calculating the effectiveness. The first option is creating a multinomial logit (MNL) model, in which 5 choices are available for the users. In the second option called the nested logit (NL) model, the options involve two levels. In the upper level, the user needs to make a choice between car, bike, public transport or another transportation method. In the lower level an extra option is made for the users who choose the car in the upper level. This extra option allows the visitor to choose between driving the car the entire trip or using the car combined with the P&R facility. The probability that an alternative is chosen is determined by the product of the probability of the alternative within the nest times the probability of that nest. To represent the attractiveness of the alternatives, the concept of utility is used. The observable utility is usually defined as a linear combination of attributes and is represented by $V$ (de Dios Ortúzar and Willumsen, 2011). An example of the formula of an observable utility is:

$$V = \sum \theta \cdot x$$

(6.1)

where:

$V$ = Observable utility, which is a function of measured attributes $x$;

$\theta$ = Parameter which is constant for all individuals in a set, but can differ between the alternatives;

$x$ = The attributes of an alternative.

The utility of the alternative must be weighted against the other utilities of all alternative options in order to predict whether the alternative is chosen. The value has to be transformed into a probability between 0 and 1. In this study the alternatives that can be chosen are transport modes, such as car, bike and public transport. In the following formulas the transport modes are represented collected in the vector $N = \{car, bike, ..., n\}$. In the formulas below, an alternative, for example car, is shown as $i$. The following formula is used for this calculation.
where:

\[ P_i = \text{Probability of alternative } i; \]
\[ V_i = \text{Observable utility of alternative } i; \]
\[ \eta = \text{The alternatives of transport modes;} \]
\[ \beta = \text{Scale parameter.} \]

In this the study, the potential users can choose a second option during their trip, for example the P&R facility, to the city centre of Gorinchem. In order to calculate the probability of this option a Nested Logit model (NL) is used instead of the Multinomial Logit Model (MNL) as in (6.2). A general NL structure with two levels is shown in the following figure.

**Figure 33**, a general Nested Logit structure with two levels

In a NL the probability of the alternative is calculated by the product of the probability of the nest times the probability of the alternative within the nest. In the context of mobility, a nest represents a moment of decision making between transport modes that are interdependent of each other.

\[ P_i = P_k \cdot P_{i|k} \quad (6.3) \]

where:

\[ i = \text{Designation of a transport mode;} \]
\[ k = \text{Designation of a nest;} \]
\[ P_i = \text{Probability of alternative } i; \]
\[ P_k = \text{Probability of the nest } k; \]
\[ P_{i|k} = \text{Probability of alternative } i \text{ within the nest } k. \]

In (6.3) the probabilities of the nest and the alternative are given. The following formulas are used in order to calculate the probabilities.

\[ P_k = \frac{e^{\beta(V_k + (k)\eta)}}{\sum_{i=1}^{k} e^{\beta(V_i + \eta)}} \quad (6.4) \]

with

\[ I_k = \frac{1}{\lambda} \ln \sum_{j \in k} e^{\lambda \eta_j} \quad (6.5) \]
where:

\[ I_k = \text{Logsum of the nest } k; \]
\[ Y_j = \text{Utility of alternative } j \text{ within the nest } k; \]
\[ V_k = \text{Utility of the nest } k; \]
\[ V_i = \text{Utility of all nests } l; \]
\[ I_l = \text{Logsum of all nests } l; \]
\[ \lambda = \text{Logsum coefficient.} \]

The last formula in the equation that is needed to compute the probability is:

\[
P_{ijk} = \frac{e^{\lambda Y_i}}{\sum_{n \notin k} e^{\lambda Y_n}}
\]

(6.6)

where:

\[ Y_i = \text{Utility of alternative } i \text{ within the nest } k; \]
\[ n = \text{Number of alternatives within a nest; } \]
\[ Y_n = \text{Utilities of all alternatives } n \text{ within the nest } k. \]

With the usage of a NL model, a remark has to be made. In the NL there are two scale parameters, namely \( \beta \) and \( \lambda \). The two scale parameters define a structural parameter:

\[
\mu = \frac{\beta}{\lambda}
\]

(6.7)

For the structural parameter holds \( 0 \leq \mu \leq 1 \) at all times. Therefore the following rule applies to the scale parameters \( \beta \leq \lambda \) for all alternatives.

The data used in this nested logit model are derived from passer-by studies held in 2011, 2012 and 2013 in Gorinchem. The other used information (travel times, access and egress times, parking costs and transfer penalties) has been derived from traffic simulations and literature.

In the model five modes are distinguished. The first mode is the car. In all cases, this is the most chosen transport mode. The second largest transportation mode that is taken into account is the bike; especially for the surroundings northern of the Boven Merwede River the bike is a possibility to travel with. The third transport mode is the public transport. Gorinchem has multiple public transport (PT) connections with a train station and bus platform for multiple bus lines. The fourth transport mode that is applied in the models is the mode ‘other’. This mode is a united term for multiple transport modes, such as walking or the ferry. The last mode that is taken into account is the new service of the P&R facility. This will be added after calibration of the model as an extra opportunity to reach the city centre.

6.1.2 ASSESSMENT OF UCC

To determine the financial feasibility of an UCC and what its effects are on traffic hindrance, emissions and liveability, multiple scenarios are developed in which different aspects are varied like location, type of distribution vehicle and participation of the shopkeepers.

One aspect that varies is the type of vehicles used for the distribution. Currently there are numerous powering options for vehicles, such as fossil fuel, electricity and hydrogen. From the reference projects mentioned in section 3.3, the most common used technologies at the moment are fossil fuel and electricity powered vehicles. The fossil fuel powered vehicle is the most common used
distribution vehicle. The common technology makes this type of vehicle the most reliable and most affordable. However, the disadvantage of this technology is the emissions of the engine. In Gorinchem the limit of fine particulars is exceeded. To reduce the emissions the city council could choose electric powered vehicles. Electric powered vehicles produce no emissions during operation. The total reduction of emissions can be derived from the total travelled distance by the electrical vehicle what depends on among others of the lifespan of the battery. However, the making of and the recycling/demolition of the battery packs do produce large amount of emissions. The question is whether the first outbalances the second.

A second aspect, which varies among the scenarios, is the percentage of consignees. The number of shop owners is an important factor for success or failure of the project. This also could be concluded from the discussed reference projects in section 3.3. When there are little users of the service, the service generates little income. With the fixed yearly costs, the service needs a minimum income per year to be viable. In order to determine whether the service has a change to be viable numerous articles use percentages in their assessments. In two Dutch cases, (van Duin et al., 2010) and (van Rooijen and Quak, 2010), the maximum potential number of consignees are taken; this can be called the upper bound of the project. In (van Duin et al., 2010) only ten per cent consignees is taken to calculate whether or not the case study could be financial viable. In (van Rooijen and Quak, 2010) the assessment is performed after one year of service of the UCC. In the first year ca. 15 per cent of the maximum potential has joined the service. Next to the maximum potential, the study takes a plural of the number of consignees of the first year.

The last aspect that can vary between the alternatives is the location. In section 5.3 the potential locations were discussed. During the assessment of a possible P&R facility the locations in a suburb are compared with each other and the same is performed for the locations near the city centre. During the assessment of an UCC, the mobility problems in the city centre of Gorinchem are compared between the scenarios. All locations, which are located in a suburb of the city, are around 3.5 kilometres of the city centre. Therefore the amount of kilometres that has to be travelled from these locations to the city centre is the same. A location that is much closer, ca. 700 metres, to the city centre, is Linge II Zuid. This location near the city centre means that transport companies still have to travel a long way from the motorway to the facility. As only the effects on the mobility problems in the city centre mentioned in section 2.2 will be assessed, the locations of the UCC are disregarded in the scenarios.

The amount of freight kilometres in the city centre depends on the number of freight vehicles that is needed for distribution. Due to the dissimilar types of vehicles, with their different capacity, the number of vehicles that is required for a sufficient service will vary.

The previous paragraphs describe the aspects, which will be adjusted in the scenarios. In a graph, disregarding the location aspect renders only two axes on which the scenarios can differ. Figure 34 shows these axes and the numbered dots represent the developed scenarios. In addition Table 10 shows all scenarios that will be assessed in the next chapter. The paragraphs below the table discuss the differences between the scenarios.
Figure 34, the axes of variation in the scenarios

Table 10, scenarios overview

<table>
<thead>
<tr>
<th>Scenario characteristics</th>
<th>Scenario 0</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base scenario</td>
<td>Full fossil fuel powered</td>
<td>Full electric powered</td>
<td>Limited fossil fuel powered</td>
<td>Limited electric powered</td>
</tr>
<tr>
<td>UCC introduced</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Type of distribution type</td>
<td>Current situation</td>
<td>Fossil fuel powered light trucks</td>
<td>Electric powered light trucks</td>
<td>Fossil fuel powered light trucks</td>
<td>Electric powered light trucks</td>
</tr>
<tr>
<td>Participation shop owners</td>
<td>Current situation</td>
<td>100 %</td>
<td>100 %</td>
<td>15 %</td>
<td>15 %</td>
</tr>
</tbody>
</table>

**Scenario 0, base scenario**

Scenario 0 is the base scenario. In this scenario Gorinchem maintains operating without the UCC. The other scenarios will be compared to the current situation in order to show the benefits and/or losses of the project.

**Scenario 1, full, fossil fuel powered scenario**

In this scenario all shop owners in the city centre of Gorinchem are consignees of the UCC. The UCC use light trucks to make the deliveries. One of the benefits of light trucks is that there are more agile than the larger trucks. Therefore the light trucks can cope with the layout of the city centre. Another benefit of the light trucks is their narrower design in contrast to the larger trucks. This means that the light trucks do not form an obstacle while loading/unloading.
Scenario 2, full, electric powered scenario

In this scenario all shop owners participate with the UCC. In contrast to scenario 1 the UCC uses electric trucks for the distribution. These trucks have fewer emissions compared to the fossil fuel powered trucks and therefore contribute to the liveability of the city.

Scenario 3, Limited, fossil fuel powered scenario

In this scenario only 15 per cent of the shop owners participate with the project. Light trucks as in scenario 1 will do the distribution of the UCC. Light trucks are chosen in order to reduce the yearly costs of the project and therefore have a better chance to be financial viable.

Scenario 4, Limited, electric powered scenario

This scenario is similar to the previous one. A limited percentage of shopkeepers are committed to the UCC, but in contrast to the previous scenario electric powered vehicles are used instead of fossil fuel powered trucks.

The above standing scenarios are developed to assess the potential effects of the UCC. The effects of the UCC on the mobility problems will be focused on the effects in the city centre. Therefore the results can be compared over the four locations that are suitable for an UCC.

6.2 PROJECTS ASSESSMENT

From section 2.2 different network levels can be distinguished. Within the borders of the municipality of Gorinchem two types of network levels can be separated; namely regional and local network levels. In section 3.1 it is shown that in both network levels problems occur. The problem in the regional network level influences the accessibility and liveability of the city, due to the high amount of traffic on the roads. On the local network level the same problems occur. A part of the local network is the city centre. Due to the layout of the city centre, among others the narrow streets and the sharp corners, large vehicles have difficulties to manoeuvre. Another issue of the local network level is the lack of loading/unloading locations in the city centre. Due to these issues, different transport flows form blockades. In order to reduce the hindrances a quantitative analysis is performed. During the analysis both network levels are applied.

6.2.1 PASSENGERS TRANSPORT OPPORTUNITIES

To reduce the mobility problems caused by passengers transport, a Park & Ride facility can be introduced in the city. A P&R facility bundles the incoming traffic of visitors, who normally use their private car to reach their destination. The user of the P&R facility park their car and travel further with the connecting service to their destination. This could reduce the traffic intensity i.e. congestions, traffic emissions and might improve the liveability of the inhabitants. Lenten (Lenten, 2011) has shown that more effectiveness is obtained by a low number of P&R facilities serving the same location. Therefore the effects of the P&R facilities will be calculated separately and only one facility per analysis. Inhabitants of Gorinchem are not taken into account in the effect calculations. Eighty per cent of the inhabitants travel by bike or another mode to the inner city, but do not use the car nor the public transport. In order to use the service from the P&R facility, the inhabitants have to make a detour, which results in a more time-consuming trip to the inner city. This makes it a less attractive alternative for them.

For each separate location, the described logit models are used to calculate the probabilities that a transport mode will be used. The same differentiation is made as in section 5.3 between the
locations, namely the suburb and city centre locations. From the probabilities of the transport modes, the potential number of users of the P&R facility per location will be calculated. The users of a suburb location are withdrawn from the traffic flow in the city and are replaced by public transport. The users of a city centre location still travel on the main corridors, like the Banneweg, but are withdrawn from the traffic in the city centre.

In this research, considering transport modes, five different aspects are taken into account, namely: access time, in-vehicle time, egress time, parking fee and transport fare. These so-called attributes represent the variables of a particular transport mode. The assessment takes into account these attributes, which can vary between the transport modes. By assigning values to the attributes, the utility of each transport mode can be calculated given the formula (6.1). However, to compare the new transport mode with the current transport modes, the model has to be calibrated. The model is calibrated to the current modal split found in the passer-by studies from 2011, 2012 and 2014 (Nicasie, 2011, Nicasie, 2012, Nicasie, 2013). The calibration starts with assigning a value to the scale parameter $\beta$, which is adjusted until the current model split is found. This completes the calibration of the model. After the calibration, the new transport mode is introduced in the model and the probability can be calculated.

The passer-by studies show the current modal split from the visitors of Gorinchem’s city centre. A differentiation is made between visitors from the surrounding municipalities, the province and the Netherlands. An overview of the scale parameter $\beta$ after the calibration is shown in Table 11.

Table 11, overview of the scale parameter $\beta$

<table>
<thead>
<tr>
<th>Location</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giessenlanden</td>
<td>0.1195</td>
</tr>
<tr>
<td>Hardinxveld</td>
<td>0.184</td>
</tr>
<tr>
<td>Lingewaal</td>
<td>0.131</td>
</tr>
<tr>
<td>Werkendam</td>
<td>0.1215</td>
</tr>
<tr>
<td>Woudrichem</td>
<td>0.1705</td>
</tr>
<tr>
<td>Zuid-Holland</td>
<td>0.04125</td>
</tr>
<tr>
<td>Nederland</td>
<td>0.01021</td>
</tr>
</tbody>
</table>

The scale parameter for the surrounding communities has a value between the 0.1195 and 0.184, and for the province Zuid-Holland and the Netherlands the value is smaller. These differences can be explained by the fact that for visitors from the surrounding municipalities the difference in travel time factors are more important than for the visitors from a origin further away. The explanation is that the added travel time caused by an extra stop and/or transfer, has a smaller influence on the percentage of the total travel time for visitors from far away.

**Suburb locations**

The assessment of the potential P&R facility locations starts with the Multinomial Logit model. The outcomes of the MNL model are shown in Figure 35. In this model the visitors can use five transport modes instead of the four current modes. The new mode in this model is the introduced Park & Ride facility that is located near motorway exits.
Figure 35, results of the Multinomial Logit Model for the regional network

Figure 35 shows the probabilities for the regional network facilities. The highest probability, which means that the location of the P&R facility has the highest chance to be used by the visitors, is for Avelingen, with second best Stalkaarsen. From the findings in the passer-by studies (Nicasie, 2011, Nicasie, 2012, Nicasie, 2013) can be concluded that the majority of the visitors of Gorinchem have an origin West or to the North of Gorinchem and hence pass by these locations. Therefore the visitors have the smallest detour when using the two locations Avelingen or Stalkaarsen. The industrial park Oost II will create detours for the majority and is therefore the least interesting location concerning the access time.

A second reason is that from the location Avelingen one needs the shortest transfer time to the city centre in comparison with the other locations, making Avelingen the most appealing location for a P&R facility. The location with the second smallest transfer time is Stalkaarsen. In the calculations the most favourable conditions are used. As indicated in formula (6.1) each attribute has an individual parameter $\theta$. This parameter $\theta$ scales in a study the attractiveness of a certain transport mode and can be acquired by the usage of questionnaires. Due to the allocation of such a parameter to the attributes, a difference in one parameter can make that the influence of that particular attribute becomes larger, changing the utility for this location. This might have a negative influence on the final probability. For instance, as demonstrated in section 2.2 the roads between Stalkaarsen and the city centre are often congested. This has a negative influence on the parameters for the attributes of this location.

A similarity between the three locations is that most potential users of the P&R facilities currently use the car first before they switch to another mode of transportation. This explains why in Figure 35 the P&R facility has the most influence on car users. For users of other modes, it means that they have to change totally from mode. Therefore it is less attractive to use the P&R facility.

The MNL gives the upper bound results. This means that the most positive situation is given. However, two options, car and using the P&R facility, have a correlation, which is not taken into account when using the MNL model. To reckon with the correlation, the NL Model can be used. This correlation can be calculated by deducting the factor $\mu$ from equation 6.7 from 1. When the structural parameter $\mu$ is equal to 1 and therefore $\beta = \lambda$ there is no correlation between the options in a nest thus making the NL model similar to the MNL model. If $\mu$ is equal to zero, there is a perfect correlation, which means that the options in a nest are dependent and influence each other. The maximum bandwidth from the NL model therefore is given by:

$$\mu \in [0,1]$$

(6.8)
From equation 6.8 another rule can be stated concerning the logsum coefficient $\lambda$. To fulfil the rule of 6.8 the coefficient has to lay between $\beta$ and $\infty$, making the following rule:

$$\beta \leq \lambda < \infty \quad (6.9)$$

Figure 36, the bandwidth of the Nested Logit model

Figure 36 shows the bandwidth of the probability for the P&R facility. It can be concluded that when the structural parameter equals zero, the probability of the P&R facility also equals to zero. Therefore the results become the current modal split. The conventional transport mode, in this case using the car to the destination, dominates the new mode, the service of the P&R facility.

In order to predict the specific bandwidth of what produces the most credible probabilities, literature is taken into account. From (Koppelman and Bhat, 2006) and (Bekhor and Shiftan, 2010) it can be concluded that a correlation exists within the nest. Therefore the logsum coefficient has a value between 0,4 and 0,8. The following table shows the probability bandwidth for the P&R service in Gorinchem per location.

Table 12, the bandwidths of the probabilities per location using the NL model

<table>
<thead>
<tr>
<th>Location</th>
<th>Upper bound ($\mu = 0.8$)</th>
<th>Lower bound ($\mu = 0.4$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avelingen</td>
<td>5.8 %</td>
<td>3.4 %</td>
</tr>
<tr>
<td>Gorinchem Oost II</td>
<td>3.9 %</td>
<td>2.2 %</td>
</tr>
<tr>
<td>Gorinchem Stalkaarsen</td>
<td>4.9 %</td>
<td>2.6 %</td>
</tr>
</tbody>
</table>

Similar to the MNL model the location Avelingen scores the highest probabilities. Although the results from the NL model are lower compared to the MNL model, the P&R facility will have users and therefore will reduce the amount of private transportation in the city. One similarity between the two models is that the largest reduction can be seen in the car transport mode. Therefore the P&R facility will reduce the intensity on the road. However, due to the limited percentage of the
probabilities of the service, the reduction will be barely measurable. This remark can also be said about the emissions and for the liveability of the city.

From (de Dios Ortuzar, 1983) a general conclusion about NL models in relation with MNL model can be learned. This general conclusion is that the NL model is more complex to estimate and use, but the NL model should be preferred to the MNL model. The model produces more credible predictions in contrast to the MNL model.

**Effects on the mobility problems**

The bandwidth calculated with the NL model, will be taken into account during the calculation of the number of potential users of the P&R facility in Gorinchem. Annex C gives a detailed description of the calculation of the number of visitors to the city centre of Gorinchem. In Table 13 the results of this calculation are given.

**Table 13, potential market of users for the P&R facility**

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential market from passer-by studies per week</td>
<td>3,544</td>
<td>2,141</td>
<td>3,180</td>
<td>2,955</td>
</tr>
<tr>
<td>Potential market after correction per week</td>
<td>5,201</td>
<td>3,142</td>
<td>4,666</td>
<td>4,231</td>
</tr>
<tr>
<td>Potential market per year</td>
<td>263,575</td>
<td>158,989</td>
<td>237,404</td>
<td>219,989</td>
</tr>
</tbody>
</table>

From the report (Mol, 2007) follows that in 2007 an estimated number of 200,000 visitors travel to Gorinchem. The estimation in Table 13 is therefore realistic. Given the bandwidth of the NL model, the potential users of the P&R facility per year and per day are shown in Table 14 and Table 15. For the calculation the number of visitors per year is set to 220,000 visitors per year.

**Table 14, potential users per year**

<table>
<thead>
<tr>
<th>Location</th>
<th>Upper bound</th>
<th>Lower bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avelingen</td>
<td>12,760</td>
<td>7,480</td>
</tr>
<tr>
<td>Oost II</td>
<td>8,580</td>
<td>4,840</td>
</tr>
<tr>
<td>Stalkaarsen</td>
<td>10,780</td>
<td>5,720</td>
</tr>
</tbody>
</table>

**Table 15, potential users per day**

<table>
<thead>
<tr>
<th>Location</th>
<th>Upper bound</th>
<th>Lower bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avelingen</td>
<td>35</td>
<td>20</td>
</tr>
<tr>
<td>Oost II</td>
<td>24</td>
<td>13</td>
</tr>
<tr>
<td>Stalkaarsen</td>
<td>30</td>
<td>16</td>
</tr>
</tbody>
</table>

The calculated potential users indicate that only a small percentage of the total traffic per day will be withdrawn from the roads in Gorinchem. Therefore the impact on the liveability in Gorinchem will be barely measurable. The calculated users will be deducted from the main corridors to the city centre and from the city centre itself.
Due to the small number of potential users per day, the total reduction is also small. Furthermore, with the still remaining traffic and the emissions from the residents and industry, the reduction is barely measurable.

**City centre locations**

To calculate the probabilities of the transport modes per city centre locations only the MNL model is used in contrast to both MNL and NL models, which were used in the calculations of the suburb locations. The reason to not use the NL model in this case is that the locations are so close located to the centre of the city that the users can walk towards their destination. Therefore no transfer is needed in contrast to the suburbs locations.

The three possible city centre locations discussed in section 5.3 for parking facilities are all taken into account with the calculations. The result from the MNL method is presented in Figure 37.

![Figure 37, results from the multinomial logit model for the local network](image)

In contrast to the suburb locations the Park & Ride facility is replaced by a Park & Walk (P&W) facility. Linge II Zuid has a better probability compared to the suburb located sites in the MNL and/or NL model. This location is easy to reach for visitors and is close to the city. For all three locations the egress time between the parking facility and city centre is comparable with the in-vehicle time of the P&R facilities.

The second best probability of the P&W facility has location Kweeklust. However, the attributes for the Kweeklust parking facility differ from the other two locations. The results of the probabilities from the other models are calculated with the attributes from the access trips. However, the parking facility Kweeklust has a significant difference between the access and exit route due to the traffic circulation rules in the city centre. To adjust for this time delay during the exit, the access time attribute is modified (access time attribute = (access time + exit time) /2). This will result in a more credible probability for Kweeklust.

The last location, which is located near the city centre, is ‘Mercon Steel Structures BV’ parking facility. This location has the best access times. However, the location is the furthest from the city centre and therefore has the highest egress time. This results in the lowest probability compared to all other P&W facilities.
**Effects on the mobility problems**

Similar to the suburb location, the number of potential users of the P&W facilities can be calculated with the results of the MNL model. With the previously described number of visitors of Gorinchem per year, namely 220,000 the potential users for the city centre locations are shown in Table 16.

<table>
<thead>
<tr>
<th>Location</th>
<th>Potential user per year</th>
<th>Potential users per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kweeklust</td>
<td>17,600</td>
<td>48</td>
</tr>
<tr>
<td>Linge II Zuid</td>
<td>20,240</td>
<td>55</td>
</tr>
<tr>
<td>‘Mercon Steel Structures BV’ parking facility</td>
<td>15,180</td>
<td>42</td>
</tr>
</tbody>
</table>

Due to the higher probability of the city centre locations, the potential users number are also higher compared to the users of the suburb locations. However, if the effects on the liveability and emissions are calculated, the reductions of the P&W facilities only concerns the city centre in contrast to the entire city from the P&R facilities located in the suburb, which means that the users of the city centre locations still travel on the main corridors that lead to the city centre.

Similar to the effects of the P&R facilities, the P&W facility also reduces the emissions and the vehicle kilometres from private transportation. However, the effects are also barely measurable due to limited number of users compared to the twenty-four hours’ period intensities.

**Remarks on the logit models**

The presented results were collected with multinomial and nested logit models. Some remarks are necessary regarding the calculations.

The current used modal splits are derived from passer-by studies performed in Gorinchem. Due to scale parameter $\beta$, the modal splits in these models are almost similar to the original modal splits. However, in some cases there are slight differences between the original and model modal splits. These differences influence the results slightly. The difference in the calculated modal split is however hard to predict, due to the fact that the users behaviour cannot be predicted.

To use the current parking facility visitors have to pay a parking fee. The same parking fee is applied to the new P&R and P&W facilities. As mentioned in section 3.4 the city council can adjust the regulations in the city. To support the use of the P&R and/or the P&W facility and thus reducing the amount of traffic in the city centre, the city council could increase the parking fees of the parking facilities. By making the parking fees in the city centre higher compared to the total fees of the P&R and/or P&W facilities, the visitors could be influenced to use the new facilities instead of using the current parking facility in the city centre.

The last remark regarding the used models is that future opportunities are not taken into account. This can lead to more potential users for the new facilities. An example for a future opportunity is a train station situated near the location Avelingen. In the past, several studies investigated the possibility for a train connection between Utrecht and Breda. If this connection is constructed, the train will pass Gorinchem at Avelingen, so, a train station could be a future opportunity.
6.2.2 FREIGHT TRANSPORTATION OPPORTUNITIES

In this sub-section the potential Gorinchem’s UCC is assessed on the mobility problems (physical hindrance, emissions and liveability) debated in section 2.2. The financial viability of the UCC is discussed in the next section.

Annex B mentioned a license plate registration session for freight transport, which was performed with this research in mind. This session gives insight in the current freight transport vehicles, which enter the city centre. However, not all vehicles have to deliver freight, for example trucks from a moving company. From (DHV B.V., 2010) can be concluded what percentage of vehicles deliver freight per type deliver in city centres. The study of (DHV B.V., 2010) was held in Bergen op Zoom in the Netherlands. It investigated the supply profile of Bergen op Zoom, which can be compared in size and layout to Gorinchem. Another important factor is the average load factor. The average load factor for freight transportation vehicles is 45 per cent (DHV B.V., 2010). With this number and the number of transport vehicles the amount of freight that can be calculated. For Gorinchem is expected that 26,832 m$^3$ of freight is delivered each year to the target shops in the city centre.

**Liveability**

The liveability of a city is hard to measure due to the fact that it has no financial or economic value. The liveability is currently measured by the inconvenience and traffic safety. Looking at the literature review about Nijmegen’s Binnenstadservice.nl (van Rooijen and Quak, 2010) in section 3.3 the inconvenience of loading/unloading activities is reduced. Due to the increasing number of deliveries and activities from one overall service, the number of activities from other services is reduced. This leads to the reduction of inconvenience of the inhabitants. However, if the maximum potential, i.e. every shop participates, is not achieved by the service, the inconveniences will only by slightly reduced in contrast to the base scenario.

Another item that concerns the residents in the city centre is the damage from the large trucks, which deliver goods in the city. Due to the narrow streets and sharp corners from the historical city centre in Gorinchem, the large trucks cannot make the turns (van der Roest, 2015). Therefore the trucks may hit the façades of houses and shops. The owners face the consequences of these damages and therefore want less traffic in the city centre. The potential UCC facilitates the wishes of the residents by intercepting most freight transportation vehicles and transfer the freight in smaller vehicles that can cope with the layout of the historical centre.

**Physical hindrance**

As stated in the previous paragraph, there will be fewer vehicles in the city centre after the introduction of the potential UCC. This means that less vehicles travel over the main roads in Gorinchem, therefore reducing the intensities on the roads. Because the intensities drop, the intensity on the main roads will come in line with their capacity. Table 17 shows the percentages of reduction the total freight traffic kilometres in the city centre for the scenarios.

Table 17, overview of the differences freight kilometres between the scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Base scenario</th>
<th>Full fossil fuel powered scenario</th>
<th>Full electric powered scenario</th>
<th>Limited fossil fuel powered scenario</th>
<th>Limited electric powered scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total difference in kilometres</td>
<td>0</td>
<td>- 16.5 %</td>
<td>- 16.4 %</td>
<td>- 2.3 %</td>
<td>- 2.3 %</td>
</tr>
</tbody>
</table>
All scenarios, apart from the base scenario, result in a reduction of the amount of freight vehicle kilometres. Two types of freight vehicles and their amount of kilometres are fully replaced by the UCC's transport vehicles. These two types are the vans and the large trucks. The third category, light/medium trucks are used by the UCC, as is presented in the scenarios in section 6.1.2. Therefore the percentage of reduction of the amount of freight traffic kilometres in the category light/medium trucks depends on the number of consignees in the city centre. A detailed overview of the reduction per category can be found in annex D.

A reason for the reduction of the freight transport kilometres in Gorinchem is the occupancy of the distribution vehicles. In the current situation, many vehicles travel to the city centre. However, these vehicles only have an average of 45 per cent of their capacity occupied by freight (DHV B.V., 2010). The shipments of the retailers in the city centre are now separately distributed. After the introduction of the UCC in Gorinchem shipments will be combined with other shipments, thus increasing the occupancy rate of distribution vehicles.

A possible explanation for the differences between the scenarios is the different type of distribution vehicles that is used. In scenario “the fossil fuel powered”, vehicles are used with a higher load capacity compared with the load capacity of the vehicles used in the “electric powered” scenarios. Accordingly the number of required vehicles is less. This leads to a slight better result in the reduction of the amount of freight kilometres between the first two scenarios, shown in Table 17. In the following table an overview of the required number of vehicles per scenario is given (scenario 0 is neglected in the overview because the UCC is not implemented in this scenario). Due to the limited participation of the consignees in the last two scenarios, only 1 vehicle is sufficient to deliver the amount of freight.

Table 18, the required number of vehicles

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Full fossil fuel powered scenario</th>
<th>Full electric powered scenario</th>
<th>Limited fossil fuel powered scenario</th>
<th>Limited electric powered scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of vehicles required</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Another reason for the difference between the reductions is the amount of consignees in the city centre. The first two scenarios have full participation of the shop owners in city centre compared to only 15 per cent in the third and fourth scenario. Due to the full participation, more freight has to be distributed in the city centre and the vehicles have to travel more between the UCC and the city centre. Due to the low number of consignees in the third and fourth scenario, fewer vehicles are needed and those vehicles have to travel less due to the lower amount of freight passing through the UCC.

**Emissions**

In section 2.2 three mobility problems were debated. One of these problems is the environment. The vehicles produce emissions during their operations. These emissions can be divided in air and noise emissions. A study in Gorinchem shows that the number of daily limits is exceeded for fine particulars in the air emissions. Therefore the potential UCC has to reduce the amount of emissions in the city. Related with the reduction of the number of freight kilometres, the air emissions are also reduced. An overview of the reduction due to the UCC can be seen in Table 19.
Table 19, the reduction overview of air emissions after implementing the UCC

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Base scenario</th>
<th>Full fossil fuel powered scenario</th>
<th>Full electric powered scenario</th>
<th>Limited fossil fuel powered scenario</th>
<th>Limited electric powered scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ emissions</td>
<td>0</td>
<td>- 18.8 %</td>
<td>- 20.4 %</td>
<td>- 2.3 %</td>
<td>- 3.1 %</td>
</tr>
<tr>
<td>PM₁₀ emissions</td>
<td>0</td>
<td>- 27.4 %</td>
<td>- 27.6 %</td>
<td>- 4.0 %</td>
<td>- 4.1 %</td>
</tr>
</tbody>
</table>

Table 19 shows that all scenarios result in a reduction in the total emissions. The best reduction gives in the full electric powered scenario. This is due the electric powered vehicles and the full participation of the consignees in the city centre in this scenario. These vehicles do not produce any emissions during operations compared to the fossil fuel powered vehicles. However, in section 6.1.2 it is explained that the electric powered vehicles do have a problem.

The second best scenario is the full fossil fuel powered scenario. Similar to the full electric powered scenario all shopkeepers in the service participate with the UCC. Therefore all external freight transportation is combined by the UCC and is substituted by the vehicles of the service centre.

In the limited participation scenarios a reduction of the emissions is still accomplished. The reason for the difference between the percentages of the full and limited participation scenarios is that next to the delivery vehicles of the UCC’s service, transport companies of shopkeepers, which are not committed to the new service, are still running.

Another question that has to be answered is whether the reduction due to the implementation of the central distribution service is large enough to fulfil the daily limits. In Nijmegen the effects in the air emissions is barely measurable as can be concluded from section 3.2 and (van Rooijen and Quak, 2010).

In order to reduce the emissions more, the city has to take measurements against the emissions form shops and residential areas. To keep the warmth in the building and producing meals the inhabitants/shop owners use gas and/or electricity. This produces also emissions, which are ejected in the cities air. These emissions are also measured in the air quality of the city.

The second type of emissions is the noise. Most produced noise is made on the throughput roads in the city. In Gorinchem these roads are the Banneweg, Stationsweg, Concordiaweg, Lingegrug, Spijksedijk and the Newtonweg. On these roads host the most traffic and therefore produces the most noise emissions. In the city centre most traffic results from public transport and freight transportation. In this area the noise reduction can be measured as can be seen in (van Rooijen and Quak, 2010). The noise is reduced with the implementation of an UCC due to the fact that the distribution vehicles of the service replace a large quantity of the freight vehicles. In scenario 2 the noise is even more reduced by the silent electric powered vehicles.

However, the remark made by the air emissions holds for sound reduction. The sound reduction only results from the reduction of freight transport vehicles. The other transportation methods will still run next to the UCC. Therefore the noise reduction is hard to measure.

6.3 FINANCIAL FEASIBILITY

In this section the financial feasibility of this case study is tested. To measure the financial results for the municipality of Gorinchem, the calculations are separated in two cost categories. In the first
category, the yearly costs are determined. The second category in the determination of the financial viability is the revenues of the case study.

6.3.1 PARK & RIDE FACILITIES

In the previous section the probability of the Park & Ride facility was calculated. From the calculations and the passer-by studies, the number of potential users can be estimated. Table 20 shows the number of visitors from the passer-by studies outside Gorinchem. This number is the maximum potential for the P&R facility.

Table 20, potential market overview

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential market per week</td>
<td>5,201</td>
<td>3,142</td>
<td>4,666</td>
</tr>
<tr>
<td>Potential market per year</td>
<td>263,575</td>
<td>158,989</td>
<td>237,404</td>
</tr>
</tbody>
</table>

The average number of visitors in Gorinchem over the passed years lays around 220,000, making this value the maximum potential market for the P&R facility. The users of this new facility have to make enough revenue to compensate the yearly costs of the facility. From the CROW factsheets (CROW, 2006a, CROW, 2006b) it can be derived that the investment costs per 100 parking places in total is: €740,000 euros. In Table 21 the specified costs are shown. The constructing costs contain every expense needed to create a parking facility. Upgrading costs consist of the expenses of the hardware (gates, barriers, payment facilities).

Table 21, costs overview of a P&R facility per 100 parking places

<table>
<thead>
<tr>
<th>Costs exploitation</th>
<th>Constructing costs</th>
<th>Upgrading costs</th>
<th>Total costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building costs</td>
<td>€166,500</td>
<td>€71,000</td>
<td>€237,500</td>
</tr>
<tr>
<td>Real estate costs</td>
<td>€400,000</td>
<td>Not available</td>
<td>€400,000</td>
</tr>
<tr>
<td>Engineering</td>
<td>€20,000</td>
<td>€8,500</td>
<td>€28,500</td>
</tr>
<tr>
<td>Additional costs</td>
<td>€3,500</td>
<td>€1,500</td>
<td>€5,000</td>
</tr>
<tr>
<td>Unforeseen costs</td>
<td>€59,000</td>
<td>€8,000</td>
<td>€67,000</td>
</tr>
<tr>
<td>Total costs</td>
<td>€650,000</td>
<td>€90,000</td>
<td>€740,000</td>
</tr>
</tbody>
</table>

The depreciation period for parking facilities is 30 years (Gemeente Rotterdam, 2013). Therefore the yearly costs for the city council are the total investment costs as shown in Table 21 divided by the depreciation period, €24,700. In (CROW, 2006a) and (CROW, 2006b) yearly maintenance costs are mentioned €9,500. This renders the total costs per year €34,200. In the following calculations the ‘Mercon Steel Structures BV’ parking facility is neglected. This is already a parking facility and thus does not have to be constructed. However, in order to use this facility, the city council of Gorinchem has to agree on a yearly fee. Another possibility is that users of this location pay a parking fee, which cover the extra investment and maintenance costs that, ‘Mercon Steel Structures BV’ has to make due to the extra usage of their parking facility.

Furthermore the location Kweeklust is also neglected from the following calculations. This parking facility was recently renovated. The visitors of this location therefore do not have to cope with the yearly costs and can pay the parking fee, which is currently established.
In section 6.2.1 an estimation of the yearly users has been calculated. The calculated probabilities differ per parking facilities, therefore the number of parking spaces that is required differ. In the following table the number of required parking places is shown.

Table 22, overview of the yearly costs per parking facility

<table>
<thead>
<tr>
<th>Parking facility</th>
<th>Estimation of yearly users</th>
<th>Parking places required</th>
<th>Yearly costs</th>
<th>Parking costs per place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avelingen</td>
<td>12,760</td>
<td>35</td>
<td>€13,680</td>
<td>€1.08</td>
</tr>
<tr>
<td>Oost II</td>
<td>8,580</td>
<td>24</td>
<td>€10,260</td>
<td>€1.20</td>
</tr>
<tr>
<td>Stalkaarsen</td>
<td>10,780</td>
<td>30</td>
<td>€13,680</td>
<td>€1.27</td>
</tr>
<tr>
<td>Linge II Zuid</td>
<td>20,240</td>
<td>55</td>
<td>€20,520</td>
<td>€1.02</td>
</tr>
</tbody>
</table>

Table 22 shows the calculated yearly costs of the different locations derived from the calculations in section 6.2.1. In the table, the yearly costs are calculated by adding 10 per cent to the required number of parking spaces and then rounding the number to the nearest plural of 10. For example, the Avelingen parking places is rounded to 40. Therefore the total yearly cost are 0.4 times €34,200. With the yearly estimation of the number of users, the parking fee can be calculated in order to compensate the investment costs and maintenance costs. From Table 22 it can be derived that the fee must be between €1.02 and €1.27 in order to compensate for the yearly costs of the P&R facility, whereby the location Linge II Zuid has the lowest fee and the Stalkaarsen the highest.

However, a Park & Ride is not only a parking location, it also gives the users a ride towards the city centre. The city border locations need additional transportation to transfer the users. The users need to compensate these costs also. Currently there are several local bus lines in Gorinchem. The bus lines have to be subsidized in order to maintain these services (van der Roest, 2015), due to the low usage. An opportunity to increase the usage of the buses is to connect the bus lines to the new P&R facility, thus extra revenue for the bus lines.

Another remark about the results in Table 22 can be made. As mentioned before, the city council just invested in the parking facility Kweeklust, which currently has a low usage (van der Roest, 2015). Due to the financial situation of the city council, it is not likely that they will invest in a new parking facility just outside the city centre, like Linge II Zuid. It can be concluded that the city council will not investigate new parking facilities around the city centre until the current parking facilities, including the just renovated Kweeklust, have reached maximum capacity.

6.3.2 URBAN CONSOLIDATION CENTRES

As stated in the opening of this section, there are two categories in order to determine the financial viability of the UCC. The first category is the yearly costs. The yearly costs can be divided in numerous types. An overview of the aspects and the specification can be seen in the following table.
Table 23, overview of the costs for an Urban Consolidation Centre

<table>
<thead>
<tr>
<th>Type</th>
<th>Object</th>
<th>€/%</th>
<th>Per</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td></td>
<td>€ 375</td>
<td>Square metres (m²)</td>
</tr>
<tr>
<td>Real Estate</td>
<td>Building</td>
<td>€ 875</td>
<td>Square metres (m²)</td>
</tr>
<tr>
<td></td>
<td>Infrastructure</td>
<td>€ 50</td>
<td>Square metres (m²)</td>
</tr>
<tr>
<td>Vehicles</td>
<td>Fossil fuel powered truck</td>
<td>€ 18,732</td>
<td>Lease per annum</td>
</tr>
<tr>
<td></td>
<td>Electric powered truck</td>
<td>€ 21,189</td>
<td>Lease per annum</td>
</tr>
<tr>
<td></td>
<td>Forklift truck</td>
<td>€ 15,120</td>
<td>Lease per annum</td>
</tr>
<tr>
<td>Transport energy costs</td>
<td></td>
<td>€ 0.085</td>
<td>Kilometre</td>
</tr>
<tr>
<td>Personnel</td>
<td></td>
<td>€ 41,000</td>
<td>Person per annum</td>
</tr>
<tr>
<td>Insurance</td>
<td></td>
<td>€ 0.25</td>
<td>Cubic metres (m³)</td>
</tr>
<tr>
<td>Maintenance costs</td>
<td></td>
<td>2.5</td>
<td>% per annum</td>
</tr>
</tbody>
</table>

Table 23 shows that the costs are divided over seven costs types. The first type of costs is the land that has to be acquired in order to construct the UCC. The total square metres of land that is needed for an UCC, is the same as the floor service area of the real estate. The real estate is split up into two sub types, namely the building itself and the infrastructure. The building comprises the outer shell and the construction inside the building, for example the stack shells and office. The infrastructure consists of the intern and connecting infrastructure of the building. The numbers that are presented in Table 23 represent the investment costs. In order to determine the yearly costs concerning the land and real estate the depreciation is taken into account. The depreciation period of real estate is 20 years. Therefore the yearly costs of real estate are the total amount of real estate (land, building and infrastructure) divided by the depreciation term (Gemeente Rotterdam, 2013).

The number of square metres required for storage is calculated by taken the amount of freight in cubic metres that is expected to pass through per day divided by the stacking height, which is 1.2 metres (TINS Brandpreventie Specialist, 2015). The total required space, thus including space required for movement, loading/unloading and offices is the amount of required of storage times 2 (Lewis et al., 2010). The infrastructure consists of the groundwork needed inside the building and the infrastructure that is required to connect the new facility to the current infrastructure.

An UCC uses two types of vehicles while distributing freight towards the destination. The first type of vehicle that is used by an UCC is a truck that makes the deliveries between the UCC and the consignees in the service area. In this case study, two types of distribution vehicles are used as explained in section 6.1.2, namely fossil fuel powered light trucks and electric powered trucks. From (Leltz, 2015) the information is come to mind that most consolidation centres currently lease there vehicles in order to reduce the insurance costs of the operation. The trucks used in the case study can be leased for € 18,732 (fossil fuel vehicles) and € 21,189 (electric powered vehicles) per annum (Lewis et al., 2010).

The second type of vehicle that is used in an UCC are forklifts trucks. Forklift trucks are used to position and stack up the freight transported and stored at the facility. The forklift trucks lease price is € 15,120 per annum. The number of forklift trucks in an UCC is 1 per 500 square foot (372 m²) (Lewis et al., 2010).
The fourth type of costs is the transport energy costs, which is € 0.085 per kilometre (Kloppers, 2008). Both type of vehicles use energy during the distribution of the freight toward the service area. In case of the fossil fuel powered trucks, the fuel is the energy and in the case of the electric powered trucks it is electricity.

The fifth type of costs concerning an UCC is the personnel costs. This consists of their salary, insurance and taxes. The personnel of an UCC consist out a general manager, operations manager, shift supervisors, marketing/recruitment staff, forklift drivers/warehouseman, delivery driver and cleaner (Lewis et al., 2010). The average costs for personnel is € 41,000 per annum.

The sixth type of costs is the insurance of freight and building. In order to be protected from high claims when freight is not delivered or broken in the UCC, the UCC needs insurance. The cost per annum of the insurance is calculated by a fast price per cubic metres the UCC handles per year, which is € 0.25 per cubic metre of freight (Kloppers, 2008). The yearly insurance costs of the vehicles are included in the fee per annum.

The last type of costs is the maintenance costs. The maintenance costs are calculated in order to protect the UCC owners from high expenses if something malfunctions during operations. The maintenance costs are predicted to be 2.5 per cent of the real estate costs and the vehicles (Kloppers, 2008).

In order to be financial viable the UCC has to have revenues. The revenues can be derived from the savings in personnel costs of the consignees in the service area and the cost savings of transport companies. The personnel savings for consignees are €3.32 per m³ (Kuiper, 2006). The cost savings due to the UCC for transport companies are € 7.02 per m³ (Kuiper, 2006).

An expense that is not mentioned in Table 23 is the overhead costs. These costs represent the costs concerning the marketing, IT services, office equipment, personnel expenses, etc.. These costs fluctuate yearly, therefore to take them into account during the calculations, an overall of 10% of the total costs is estimated.

With all costs and revenues explained, the different scenarios from section 6.1.2 can be calculated. Table 24 shows the outcome of the calculations. In annex E a detailed explanation can be found of the calculations for the financial viability of the UCC.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Base scenario</th>
<th>Full fossil fuel powered scenario</th>
<th>Full electric powered scenario</th>
<th>Limited fossil fuel powered scenario</th>
<th>Limited electric powered scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total losses/revenues</td>
<td>-</td>
<td>€ - 181,054</td>
<td>€ - 260,33</td>
<td>€ - 334,992</td>
<td>€ - 337,992</td>
</tr>
</tbody>
</table>

From the table above it can be concluded that all scenarios are not financial viable. Due to the small amount of freight that has to be transported in Gorinchem, the UCC cannot achieve enough revenues to deal with the costs. However, there is a potential trend that contributes the UCC. The shops that sell large products, for example refrigerators, washing machines, etc. are moving out of the city centre, more closer to the motorways (Klop, 2014). These shops have their own transport logistics network and mostly do not participate with Consolidation Centres. By replacing these shops
with possible retailers, which might participate with centralized deliveries, the market for the UCC increases and more revenues can be collected.

The total costs and revenues can be plotted per cubic metres freight serviced per year. This graph will indicate if the UCC can operate without losses for some potential amount of cubic metres freight handled per year. In Figure 38 the graph of benefits versus the yearly costs is given.

![Graph of benefits versus yearly costs](image)

**Figure 38**, the costs versus revenues for the UCC in the case study. The vertical steps indicate the extra costs related with the investment of an extra truck. The step up at 69264 m³ indicates for an extra forklift truck.

In Figure 38 the blue lines represents the benefits, which can be collected from each cubic metre serviced by the UCC. The benefit per cubic metre has been discussed in the beginning of this section. The purple line represents the costs for an UCC with fossil fuel powered vehicles. Each step signifies an additional truck. The same can be said over the green line, which symbolizes the costs for an UCC with electric powered vehicles. One step (close to 75,000 cubic metre freight per year) represents another forklift truck. This step occurs in both cost lines at the same position, because this number depends on the size of the UCC.

The two vertical lines represent the cubic metres of freight that currently can pass through the UCC. The first red line indicates 15 per cent participation, whereas the second orange line represents 100 per cent participation. It can be concluded that Gorinchem has to increase the amount of freight per year to develop a financial viable UCC.

There are potential situations where the UCC can make revenues. These situations are located in the figure where the blue line (the benefits) is higher value compared to the black line (fossil fuel powered UCC). The revenue that is earned each year is the difference between the blue and black line.

Figure 38 shows that the costs of the UCC are always higher for the option of electric powered vehicles. One reason for the higher cost is that the technology for powering is still being investigated, meaning that the maintenance and the lease prices are higher in order to cover the potential replacement costs.
In Figure 38 the line between the steps slightly increases. This represents that for every cubic metre of freight that is serviced by the UCC, the UCC increases in size. However, in reality, Consolidation Centres do not increase with small steps. If an UCC has to expend, the facility will grow in such a way that the facility can handle a certain amount of more freight before it needs expending again. The UCC can therefore process more freight, before expending a second time. A measurement for the expansion can be the number of loading/unloading docks for trucks. When a new dock has to be constructed, the facility will grow the entire length of the building. In contrast to Figure 38, this will deform the lines between the steps to horizontal lines, but the vertical steps are bigger. Therefore the financial result in Gorinchem may differ. In Figure 39 the results are adjusted according to the mentioned remark.

There are differences between Figure 38 and Figure 39, besides the manner of growth. In the first calculation the costs were closer to the revenues. Due to new manner of growth, the lines between the steps are horizontal, but the ‘steps’ become bigger. Therefore the gaps between the lines become larger and thus the break-even point is only reached at a higher amount of cubic metres of freight per year.

Another difference between the two costs versus revenues graphs is that the extra step due to a second forklift truck is merged with the step for an extra truck. This is related with increase in building size.

Apart from the differences between Figure 38 and Figure 39, there are similarities. The quite obvious similarity is that in both graphs the case study runs with losses both in full and in limited participation. The losses in the limited participation are the same compared with the first calculation. However, the losses in the case of full participation are larger. This is due to new method of calculation.

![Figure 39, the costs versus revenues with the adjusted manner of expansion](image)

A remark that applies to both methods of calculation focuses on the revenues calculation. The revenue number per cubic metre of serviced freight is taken from a former performed master thesis.
This thesis was about introducing city distribution using infrastructure dedicated to public transport. The region of this study was Amsterdam and Haarlem, which are cities with more residents compared to Gorinchem. Therefore the question rises, whether the same values of revenues can be taken for Gorinchem as in Amsterdam or Haarlem.

As the savings for the shopkeepers as well as the savings for the transport companies are unknown, due to the fact that their salary and expenses are not known, the current coefficient of revenue has been derived from (Kuiper, 2006). Therefore, the current coefficient of the revenues line might represent the upper bound, meaning that this is the maximum potential for the UCC Gorinchem. A more realistic line has a less steep coefficient. This will make the gap between the revenues and costs even larger, thus increasing the amount of cubic metres freight serviced per year necessary to reach the break-even point, even higher. In contrast if, the current is the lower bound, this could mean that the UCC could increase his revenue per cubic metre of freight. For example, unemployed inhabitants of Gorinchem may find a job in the UCC, which saves the municipality unemployment benefit. This will make the line steeper, thus decreasing the amount of cubic metres serviced per year to reach the break-even point.

6.4 CONCLUSIONS

The assessment of the two services has been focussed on the criteria elaborated in section 5.2, which are environment effects, vehicles kilometres in the city and liveability. Furthermore both services are being evaluated on their financial feasibility. In this section a score cart is made from the evaluations on both services and overall conclusions per facility is given.

6.4.1 CONCLUSIONS ON THE PARK & RIDE FACILITY

In section 6.2.1 and 6.3.1 the P&R facilities in Gorinchem were assessed. From the assessment a scorecard i.e. a Multi Criteria Analysis (MCA) can be made based on the four criteria described in section 5.2. The following table gives the MCA.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Suburb located P&amp;R facilities</th>
<th>City centre located P&amp;W facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avelingen</td>
<td>Oost II</td>
</tr>
<tr>
<td>Environmental effects</td>
<td>0/+</td>
<td>0/+</td>
</tr>
<tr>
<td>Vehicle kilometres in</td>
<td>0/+</td>
<td>0/+</td>
</tr>
<tr>
<td>the city</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liveability</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Financial feasibility</td>
<td>-/0</td>
<td>-/0</td>
</tr>
</tbody>
</table>

The MCA for the P&R/P&W facilities in Gorinchem shows that in all cases, the facilities score neutral on the three mobility problems. Due to the small number of potential users, which are withdrawn from the traffic flow in Gorinchem, the effects on the mobility problems are barely measurable.
Four facilities score neutral on their financial feasibility. These facilities have to be constructed from ground up. The users have to pay a fee between € 1.02 and € 1.27 to cover the yearly costs. For the limited amount of users, the investments could be seen as too large. The Kweeklust and ‘Mercon Steel Structures BV’ parking facility already exist, therefore the city council does not have to pay investment costs. To enable a P&R facility at ‘Mercon Steel Structures BV’, the city council has to negotiate with the owners. From this negotiation depends what a user has to pay to make this P&R facility financial viable.

6.4.2 CONCLUSIONS ON THE URBAN CONSOLIDATION CENTRE

The UCC is assessed on four criteria, namely the environmental effects, vehicle kilometres in the city centre, liveability and the financial feasibility. This sub-section presents a MCA in order to demonstrate how the UCC scores on the criteria. The scorecard is shown in Table 26.

Table 26, outcomes of the UCC on the criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Base scenario</th>
<th>Full fossil fuel powered scenario</th>
<th>Full electric powered scenario</th>
<th>Limited fossil fuel powered scenario</th>
<th>Limited electric powered scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental effects</td>
<td>0</td>
<td>0 / +</td>
<td>0 / +</td>
<td>0 / +</td>
<td>0 / +</td>
</tr>
<tr>
<td>Vehicle kilometres in the city</td>
<td>0</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Liveability</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Financial feasibility</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Table 26 concludes that the UCC in Gorinchem has positive scores on the criteria that concern the mobility problems in the city, apart from the liveability in the two limited participation scenarios. This can be explained by the findings in literature. The extra service, which makes deliveries in the city runs besides the already existing services, creating more inconvenience for the inhabitants. If the new service makes all deliveries, in other words has 100 per cent participations of the shopkeepers, the residents may experience less inconvenience, creating a positive score for the full participation scenarios.

All scenarios score negative on the criterion of financial feasibility without the help of financial grants.

On the criterion of environmental effects, the UCC has a neutral to slight positive score. There is a reduction of emissions. However, the reduction from the freight traffic only is barely measurable in the city, due to emissions from the other remaining traffic, industry and the residents self.

On the vehicle kilometres in the city, the UCC scores positive in all scenarios. Due to the higher occupancy rate of the vehicles of the UCC, the UCC service needs fewer vehicles to make the deliveries to the shopkeepers and therefore the vehicle kilometres are reduced.
Chapter 7  CONCLUSIONS & RECOMMENDATIONS

This master thesis focuses on the mobility problems of the city council of Gorinchem and the preservation of industrial heritage of foundation ‘Behoud Erfgoed De Vries Robbé’. In order to combine the power of the two problems also for other relatively small municipalities, the principal research question has been formulated as: How can the liveability related with mobility for inhabitants of a relatively small municipality be improved in synergy with preservation of monumental buildings by redefining their function?

In order to find a satisfying solution to the principal question, different sub-questions were formulated. By means of literature, reference projects, SWOT analysis and a quantitatively analysis, answers were formulated. In this chapter the conclusions from the study are summarized. Section 7.2 gives advice for the two stakeholders of this research. Section 7.3 makes the used methods applicable for other cities with a mobility and/or heritage problem.

7.1 CONCLUSIONS

In urban areas the problems concerning mobility proved to be physical hindrance, emissions and liveability, whereby physical hindrance is formed by congestion and blockades, emissions are air and noise and liveability is the inconvenience of the residents and their unsafety.

There are two kinds of transport flow: flow resulting from transport of human beings and flow resulting from freight transportation. The solution for the mobility problems is the reduction of traffic flow. To reduce the amount of passenger flow to a city centre, a Park & Ride facility can be introduced. In order to reduce the amount of freight transport in a city, an Urban Consolidation Centre can be introduced in the city logistics. Both have a common strategy: bundling the incoming and outgoing traffic flows for specified areas. A P&R facility focuses on bundling visitors for a city centre, where an UCC focuses on bundling goods with a destination in the UCC’s service area.

Vacant industrial heritage with a historical value for the surrounding, in Gorinchem Linge II Zuid, may form a problem in cities. The successful reference projects concerning industrial heritage show that redefining the function of the heritage may turn the building into a useful object. Multi-functionality is an opportunity to find co-investors for redevelopment making the chance for financial viability bigger. Threats concerning redevelopment of industrial heritage can be assigned on three aspects, namely their inaccessibility, the building cannot be adjusted to its new function and the new function is already present in the environment.

Four criteria have been distilled for the assessment of the case study Gorinchem, which are: environmental effects, vehicle kilometres within the city, liveability and financial feasibility. In order to assess the situation in Gorinchem, suitable locations, among which Linge II Zuid as industrial heritage, and four assess scenarios are investigated. Six locations in Gorinchem were investigated of which four have to be constructed and two already exist. The possible existing locations are: Kweeklust and ‘Mercon Steel Structures BV’ and the four new to develop locations are Avelingen, Oost II, Stalkaarsen and Linge II Zuid. Linge II Zuid forms the industrial heritage in Gorinchem that has to receive a new function.

The 4 scenarios constructed in order to assess the possibilities of an UCC are: the current situation (base scenario); full participation of the retailers and fossil fuel powered vehicles (scenario 1); full participation of the retailers in the city centre and electric powered vehicles (scenario 2); limited
participation and fossil fuel powered vehicles (scenario 3) and limited participation and electric powered vehicles (scenario 4).

The assessment of the P&R facilities was divided into P&R facilities located in the suburb of Gorinchem and P&W facilities, which are located near the city centre. The difference between a P&R and P&W facility forms that the users need a transfer at the P&R to reach the city centre and from the P&W the users can walk to the city centre. Using the relatively simple MNL model, the P&R/P&W facilities score a probability, i.e. the chance that one facility is used, between 5.0 and 9.2 per cent. However, using a more realistic NL model, the probability scores vary between 2.6 and 5.8 per cent. From these probabilities can be derived that the P&R facilities receive between the 13 and 35 users per day and the P&W between 42 and 55 users. To be financial stable, the users of the P&R or P&W facilities have to raise the yearly costs. From a financial viewpoint, the most favourable price per parking place has location Linge II Zuid while the most expensive one is location Stalkaarsen. Although the facilities reduce the emissions and vehicle kilometres in the city centre, due to the limited number of uses, the effect of the P&R/P&W facilities will barely be measurable within the three criteria: environment effects, vehicles kilometres in the city and liveability.

In all scenarios, an UCC reduces the vehicle kilometres of freight distribution and emissions in the city centre. Only in the two full participation scenarios, the UCC will also reduce the inconvenience of the inhabitants. In the two limited participation scenarios the inconvenience will slightly increase, as the new service will function besides the remaining traffic. The same remark as made for the P&R/P&W facilities have to be made, the reduction of emissions will barely be measurable due to the still running industry and living situations.

All scenarios score negative on the criterion of financial feasibility. Due to the high investment and operations costs, which are converted into yearly costs, and the low amount of freight demanded in Gorinchem, the UCC’s would run with losses.

With all conclusions in mind, the principal research questions can be answered. With the introduction of a P&R facility and/or UCC the mobility problems may be improved for the inhabitants of Gorinchem. The calculations show that P&R and UCC facility will decrease the amount of traffic kilometres and emissions. However, the question remains whether this small reduction is worth mentioning and will be noticed by the residents.

According to the calculations, a P&R/P&W facility will be used by maximal 55 visitors per day, which have to raise the investment costs and the yearly costs, turning this into a unattractive proposal. Also an UCC is not achievable in Gorinchem as in all cases the UCC will operate with losses. The high investment costs cannot be outbalanced by the revenues due to the low amount of freight, which can be processed by the UCC. (One remark has to be made: the revenue used is derived from a former study that concerned a central distribution in Haarlem and Amsterdam, the Netherlands. In contrast to Gorinchem, this are much larger cities; therefore the savings in Gorinchem may differ from the results of that study).

With the conclusions and remarks about the P&R facility and UCC in mind, it has to be said that these potential solutions are not realistic for Gorinchem. The barely measurable benefits do not surpass the high investment costs and financial losses.

A last remark that has to be made is that the function of the inner city is constantly changing. Shops are relocating and the vacant buildings will get a new function. This may contribute to the use of an UCC but may also be a disadvantage if the new owners do not participate in the UCC.
7.2 SPECIFIC RECOMMENDATIONS FOR GORINCHEM

Park & Ride facilities and Urban Consolidation Centre are used in general to reduce the problems involved in city mobility. However, the effects of a P&R facility are hard to measure. In the case of Gorinchem the P&R facility creates a small probability that it will be used. Based on the calculations, the users have to pay a parking fee for the total day, which is comparable with the current rate per hour in the city centre. This fee may cover the yearly costs of the parking facility but does not cover the expenses made for an additional transfer to the city centre. For the P&W facilities, which already exist, the city council have to negotiate about an yearly lease price with the owners. From this negotiation the parking fee of the users can be calculated.

In the calculations used in this study, the regulations of the inner city have not been adjusted to improve the results. In order to stimulate the use of a P&R facility or parking facilities outside the city centre, the parking price can be changed. By increasing the parking fee in the city centre, the visitors might chose the P&R facility instead of the parking facilities in the city centre. Other regulations, such as total car-free restrictions or environmental restrictions could also be applied.

In this thesis work travel time, parking and travel fee, access and egress time are used to calculate the utilities. Other aspects that can be influenced by the city council and that may be important for the potential users are not incorporated in the model, such as the services offered on the P&R facility. In order to know the importance of these aspects, inquiries could be held under the visitors of Gorinchem.

From the calculations in this work it became clear that an UCC helps in improving the liveability within the city. The noise and air emissions will be reduced and the amount of freight transportation kilometres will also be reduced. However, the financial viability is not met in any scenario mainly due to the low amount of freight that will be processed by an UCC located in Gorinchem. As the amount of freight is estimated, the chance to be financial viable will increase if it turns out to be higher. This may also be investigated by inquiries.

For now the advice for the city council of Gorinchem is, do not introduce a P&R facility and/or an UCC. Both facilities may contribute to solve the mobility problems, but the results from previous studies and this study indicate that the savings in physical hindrance, emissions (air and noise) and liveability are hardly measurable and, with the financial results in mind, the facilities are not favourable.

The previous paragraphs concluded with an advice for the city council. The foundation ‘Behoud Erfgoed De Vries Robbé’ has the objective to preserve a vacant storage facility on Linge II Zuid. This location is taken into account with the calculations of a new parking facility and/or UCC. From the calculations it can be concluded that location Linge II Zuid, may be used as a P&W facility. However, the Kweeklust parking facility is just renovated and currently not often used. Therefore the city council will probably not invest in a new parking facility near the city centre. If the location is used as UCC, it will improve the liveability in the city, but, due to its location near the city centre, the suburbs still have to deal with the traffic flow through the city. Furthermore, the UCC operates with losses with the current estimated numbers. However, the financial situation is not the main criterion concerning the renovation of the industrial heritage.

The two previously mentioned conclusions indicate that a win-win situation between mobility problems and monuments cannot be achieved in Gorinchem. Therefore the foundation may have to investigate other functions to redevelop the storage facility.
In the Netherlands there are more municipalities like Gorinchem, characterized by a historical city centre that combines different functions. The given advice, do no create a P&R facility or an UCC holds for the municipality of Gorinchem. In other cities with a historical city centre and other conditions, the research may result in a positive advice. This section gives a roadmap for general application of this thesis work allowing other city councils, either alone or in combination with the city councils surrounding them, to calculate the feasibility of a Park & Ride facility and/or Urban Consolidation Centre within their city/community. To accomplish this, several steps have to be made and data have to be known regarding the city/community, the visitors and all types of transport flow. In the following paragraphs the data that are needed are mentioned per step.

The first step of the roadmap is to identify the problems. If the problems concern only one type of transport flow or only concern industrial heritage, the problem owner has to search for specific solutions in his situation. The investigation of the mobility problems in the municipality requires an overview of the intensities and capacities of the roads in the town. An overview of the emissions in the city is required, to identify the possible exceeding of restrictions. A summation of the potential partners is needed to investigate whether there exists enough support to become viable. From this step it can be concluded what is needed: P&R and/or UCC. Furthermore criteria to evaluate the success of the solutions have to be formed.

Step two is to investigate the possibilities in the city. If only mobility problems are involved, locations that can house a P&R facility and/or UCC have to be found. Industrial heritage can be involved in this phase. In that case a new suitable function has to be defined to preserve the locations value. When the alternatives are known, assessment methods have to be formed.

There are several methods to investigate the viability of the solutions, such as MNL model, with the advantage of its relatively ease of application but less reliable predictions, NL model, more complicated to use but its predictions are often more reliable. The appropriate use of these models requires background information of the potential users. Inquiries about their origin and destination, usage of bikes, car, busses, taxis; how important is waiting time, what is the expected comfort at the location, is it important to have other facilities at the location

Step four is the assessment of the alternatives. In the assessment the viability of the alternatives is evaluated and the alternatives are scored against criteria, made in step one. From this assessment the feasibility of the alternatives can be derived.

The final step of the roadmap concerns the conclusions of the research. If the conclusions result in a positive advice for the project, the problem owner(s) can make the decision to proceed with the construction/renovation of the project. If the results are negative, the problem owner(s) can decide to change/redefine the alternatives and to restart the assessment or they can cancel the project.
ARRIVA 2015b. Citybus, Dagje Dordt? Pak de Citybus!


CROW 2006b. Factsheet 12B: Transferbevordering - Opwaarderen voorzieningenniveau bestaande P+R.


INTERVIEWS


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ANNEX A  CATEGORIZATION OF GORINCHEM’S ROADS

In this annex, the main corridors, the access roads and the city centre roads are categorized in order to determine the capacities. The following figures and tables demonstrate the type of road and the obstruction factors in Gorinchem. The final capacities of the roads are shown in section 2.2.

A.1  MAIN CORRIDORS

In this section the main corridors of Gorinchem are discussed, which are: Banneweg, Stationsweg, Concordiaweg, Lingebrug, Spijksedijk, Newtonweg and the Spijksesteeg.

Banneweg

The Figure 40 shows the Banneweg near the A15 and the Piazza Center. De Banneweg has the same design for these sections, however the speed limit differs: near the A15 80 kilometres per hour is allowed and at the Piazza Center 50 kilometres per hour. Table 27 and Table 28 summarize the characteristics and obstacle factors per section.
Table 27, the evaluation of the Banneweg near the A15

<table>
<thead>
<tr>
<th>National guidelines EHK GOW Bibk type II</th>
<th>Characteristics</th>
<th>Obstacle factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lanes</td>
<td>2x2 lanes</td>
<td>Pedestrian crossings</td>
</tr>
<tr>
<td>Speed limit 80 km/hour</td>
<td>80 km/hour</td>
<td>Traffic lights</td>
</tr>
<tr>
<td>Side marking or kerb</td>
<td>Side marking</td>
<td></td>
</tr>
<tr>
<td>Centre marking or median island</td>
<td>Median island</td>
<td></td>
</tr>
</tbody>
</table>

National guidelines VK GOW type II

| Characteristics | |
|-----------------||
| Bicycle lanes   | Separated bicycle lanes |
| Priority rules  | Priority road |
| Road surface    | Asphalt |
| Traffic regulations | Traffic lights |

The Banneweg changes in design near the Stadhuisplein. The roundabout characterizes this section, because this creates congestion in the traffic flow. Figure 41 shows the design of the Banneweg at the Stadhuisplein.

![Figure 41, the Banneweg at the Stadhuisplein with in the background a row of vehicles waiting.](image-url)
Table 29, the evaluation of the Banneweg near the Stadhuisplein

<table>
<thead>
<tr>
<th>National guidelines EHK GOW type II</th>
<th>Characteristics</th>
<th>Obstacle factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lanes</td>
<td>2x1 lane</td>
<td>Pedestrian crossing</td>
</tr>
<tr>
<td>Speed limit 50 km/hour</td>
<td>50 km/hour</td>
<td>Roundabout</td>
</tr>
<tr>
<td>Side marking or kerb</td>
<td>Side marking</td>
<td>Intersection</td>
</tr>
<tr>
<td>Centre marking or median island</td>
<td>Median island</td>
<td></td>
</tr>
<tr>
<td>National guidelines VK GOW type II</td>
<td>Characteristics</td>
<td></td>
</tr>
<tr>
<td>Bicycle lanes</td>
<td>Separated bicycle lanes</td>
<td></td>
</tr>
<tr>
<td>Priority rules</td>
<td>Priority road</td>
<td></td>
</tr>
<tr>
<td>Road surface</td>
<td>Asphalt</td>
<td></td>
</tr>
<tr>
<td>Traffic regulations</td>
<td>Roundabout &amp; rail crossing</td>
<td></td>
</tr>
</tbody>
</table>

**Stationsweg**

The Stationsweg is the next section of the main corridor in Gorinchem, which connects the train station with the city centre. Figure 42 shows the design of the Stationsweg and Table 27 gives the characteristic.
Table 30, the evaluation of the Stationsweg

<table>
<thead>
<tr>
<th>National guidelines EHK GOW type II</th>
<th>Characteristics</th>
<th>Obstacle factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lanes</td>
<td>2x1 lane</td>
<td>Pedestrian crossing</td>
</tr>
<tr>
<td>Speed limit 50 km/hour</td>
<td>50 km/hour</td>
<td>Intersection</td>
</tr>
<tr>
<td>Side marking or kerb</td>
<td>Kerb</td>
<td></td>
</tr>
<tr>
<td>Centre marking or median island</td>
<td>Center marking</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>National guidelines VK GOW type II</th>
<th>Characteristics</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Bicycle lanes</td>
<td>Separated bicycle lanes</td>
<td></td>
</tr>
<tr>
<td>Priority rules</td>
<td>Priority road</td>
<td></td>
</tr>
<tr>
<td>Road surface</td>
<td>Asphalt</td>
<td></td>
</tr>
<tr>
<td>Traffic regulations</td>
<td>Pedestrian crossings</td>
<td></td>
</tr>
</tbody>
</table>

**Concordiaweg**

The Concordiaweg follows after the Stationsweg. The design can be seen in Figure 43 and the characteristics in Table 28.

![Figure 43, the Concordiaweg after connecting bridge to the Stationsweg](image-url)
Table 31, the evaluation of the Concordiaweg

<table>
<thead>
<tr>
<th>National guidelines EHK GOW type II</th>
<th>Characteristics</th>
<th>Obstacle factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lanes</td>
<td>2x1 lane</td>
<td>Pedestrian crossing</td>
</tr>
<tr>
<td>Speed limit 50 km/hour</td>
<td>50 km/hour</td>
<td>Roundabout</td>
</tr>
<tr>
<td>Side marking or kerb</td>
<td>Kerb</td>
<td>Intersection</td>
</tr>
<tr>
<td>Centre marking or median island</td>
<td>Centre marking</td>
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<table>
<thead>
<tr>
<th>National guidelines VK GOW type II</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td>Bicycle lanes</td>
<td>Separated bicycle lanes</td>
</tr>
<tr>
<td>Priority rules</td>
<td>Priority road</td>
</tr>
<tr>
<td>Road surface</td>
<td>Asphalt</td>
</tr>
<tr>
<td>Traffic regulations</td>
<td>Roundabout</td>
</tr>
</tbody>
</table>

Lingebrug

Figure 44 shows the design of the Lingebrug section of the main corridor. The road’s characteristics have been summarized in Table 29.

Figure 44, the Lingebrug shown from the roundabout located between the Lingebrug and Spijksedijk
Table 32, the evaluation of the Lingebrug

<table>
<thead>
<tr>
<th>National guidelines EHK GOW type II</th>
<th>Characteristics</th>
<th>Obstacle factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lanes</td>
<td>2x1 lane</td>
<td>Roundabout</td>
</tr>
<tr>
<td>Speed limit 50 km/hour</td>
<td>50 km/hour</td>
<td></td>
</tr>
<tr>
<td>Side marking or kerb</td>
<td>Side marking</td>
<td></td>
</tr>
<tr>
<td>Centre marking or median island</td>
<td>Centre marking</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>National guidelines VK GOW type II</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bicycle lanes</td>
<td>Separated bicycle lanes</td>
</tr>
<tr>
<td>Priority rules</td>
<td>Priority road</td>
</tr>
<tr>
<td>Road surface</td>
<td>Asphalt</td>
</tr>
<tr>
<td>Traffic regulations</td>
<td>Roundabout</td>
</tr>
</tbody>
</table>

**Spijksedijk**

The Spijksedijk connects the city centre to Gorinchem Oost. Figure 45 shows the design of the Spijksedijk and Table 30 gives the characteristics.

Figure 45, the Spijksedijk shown from the roundabout located between the Lingebrug and Spijksedijk
Table 33, the evaluation of the Spijksedijk

<table>
<thead>
<tr>
<th>National guidelines EHK GOW type II</th>
<th>Characteristics</th>
<th>Obstacle factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lanes</td>
<td>2x1 lane</td>
<td>Roundabout</td>
</tr>
<tr>
<td>Speed limit 50 km/hour</td>
<td>50 km/hour</td>
<td>Intersection</td>
</tr>
<tr>
<td>Side marking or kerb</td>
<td>Kerb</td>
<td></td>
</tr>
<tr>
<td>Centre marking or median island</td>
<td>Median island</td>
<td></td>
</tr>
<tr>
<td>National guidelines VK GOW type II</td>
<td>Characteristics</td>
<td></td>
</tr>
<tr>
<td>Bicycle lanes</td>
<td>Separated bicycle lanes</td>
<td></td>
</tr>
<tr>
<td>Priority rules</td>
<td>Priority road</td>
<td></td>
</tr>
<tr>
<td>Road surface</td>
<td>Asphalt</td>
<td></td>
</tr>
<tr>
<td>Traffic regulations</td>
<td>Roundabout</td>
<td></td>
</tr>
</tbody>
</table>

*Newtonweg*

The Newtonweg is the first section of the main corridor for visitors from the East. The design of the Newtonweg is shown in Figure 46 and Table 31 gives the characteristics.

Figure 46, the Newtonweg design
Table 34, the evaluation of the Newtonweg

<table>
<thead>
<tr>
<th>National guidelines EHK GOW type II</th>
<th>Characteristics</th>
<th>Obstacle factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lanes</td>
<td>2x1 lane</td>
<td>Intersection</td>
</tr>
<tr>
<td>Speed limit 50 km/hour</td>
<td>50 km/hour</td>
<td>Bus stop</td>
</tr>
<tr>
<td>Side marking or kerb</td>
<td>Kerb</td>
<td></td>
</tr>
<tr>
<td>Centre marking or median island</td>
<td>Median island</td>
<td></td>
</tr>
<tr>
<td>National guidelines VK GOW type II</td>
<td>Characteristics</td>
<td></td>
</tr>
<tr>
<td>Bicycle lanes</td>
<td>Separated bicycle lanes</td>
<td></td>
</tr>
<tr>
<td>Priority rules</td>
<td>Priority road</td>
<td></td>
</tr>
<tr>
<td>Road surface</td>
<td>Asphalt</td>
<td></td>
</tr>
<tr>
<td>Traffic regulations</td>
<td>Traffic lights</td>
<td></td>
</tr>
</tbody>
</table>

Nieuwe Wolpherensedijk

The last main corridor, which connects the city centre with the motorway A27 is the Nieuwe Wolpherensedijk. Figure 47 shows the design of this road and Table 35 gives the characteristics.

Figure 47, the design of the Nieuwe Wolpherensedijk

Table 35, the evaluation of the Nieuwe Wolpherensedijk

<table>
<thead>
<tr>
<th>National guidelines EHK GOW type II</th>
<th>Characteristics</th>
<th>Obstacle factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lanes</td>
<td>2x1 lane</td>
<td>Intersection</td>
</tr>
<tr>
<td>Speed limit 50 km/hour</td>
<td>50 km/hour</td>
<td>Roundabout</td>
</tr>
<tr>
<td>Side marking or kerb</td>
<td>Kerb</td>
<td>Pedestrian crossing</td>
</tr>
<tr>
<td>Centre marking or median island</td>
<td>Centre marking</td>
<td></td>
</tr>
<tr>
<td>National guidelines VK GOW type II</td>
<td>Characteristics</td>
<td></td>
</tr>
<tr>
<td>Bicycle lanes</td>
<td>Separated bicycle lanes</td>
<td></td>
</tr>
<tr>
<td>Priority rules</td>
<td>Priority road</td>
<td></td>
</tr>
<tr>
<td>Road surface</td>
<td>Asphalt</td>
<td></td>
</tr>
<tr>
<td>Traffic regulations</td>
<td>Traffic lights and roundabout</td>
<td></td>
</tr>
</tbody>
</table>
In this section the access routes of the city centre are discussed. These roads have a lower capacity compared to the main corridors. The designs and the characteristics are shown in the following figures and tables.

**Lange Brug**

The Lange Brug connects the Banneweg and Stationsweg with the city centre, through the Korte Brug. Figure 48 shows the layout and Table 36 summarizes the characteristics.

<table>
<thead>
<tr>
<th>National guidelines EHK GOW Bibk type I</th>
<th>Characteristics</th>
<th>Obstacle factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lanes</td>
<td>2x1 lane</td>
<td>Pedestrian crossings</td>
</tr>
<tr>
<td>Speed limit 50 km/hour</td>
<td>50 km/hour</td>
<td>Roundabout</td>
</tr>
<tr>
<td>Side marking or kerb</td>
<td>Kerb</td>
<td>Bicycle lanes</td>
</tr>
<tr>
<td>Centre marking or median island</td>
<td>No separation</td>
<td></td>
</tr>
<tr>
<td>National guidelines VK GOW type II</td>
<td>Characteristics</td>
<td></td>
</tr>
<tr>
<td>Bicycle lanes</td>
<td>Bicycle lanes</td>
<td></td>
</tr>
<tr>
<td>Priority rules</td>
<td>Priority road</td>
<td></td>
</tr>
<tr>
<td>Road surface</td>
<td>Asphalt</td>
<td></td>
</tr>
<tr>
<td>Traffic regulations</td>
<td>Roundabout</td>
<td></td>
</tr>
</tbody>
</table>
Korte Brug

The Korte Brug is last section of the connecting route towards the city centre from the Lange Brug. The design is shown in Figure 49 and the characteristics are given in Table 37.

Figure 49, the design of the Korte Brug with in the background the Lange Brug

Table 37, the evaluation of the Korte Brug

<table>
<thead>
<tr>
<th>National guidelines EHK GOW Bibk type I</th>
<th>Characteristics</th>
<th>Obstacle factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lanes</td>
<td>1x1 lane</td>
<td>Narrow layout</td>
</tr>
<tr>
<td>Speed limit 50 km/hour</td>
<td>50 km/hour</td>
<td>Bicycle lanes</td>
</tr>
<tr>
<td>Side marking or kerb</td>
<td>Kerb</td>
<td>Exits</td>
</tr>
<tr>
<td>Center marking or median island</td>
<td>No separation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>National guidelines VK GOW type II</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bicycle lanes</td>
<td>Bicycle lanes</td>
</tr>
<tr>
<td>Priority rules</td>
<td>Priority road</td>
</tr>
<tr>
<td>Road surface</td>
<td>Brick pavement</td>
</tr>
<tr>
<td>Traffic regulations</td>
<td>Roundabout</td>
</tr>
</tbody>
</table>

Paardenwater

The Paardenwater is the Northern access street in of the city centre. Figure 50 shows the design of this street and the Table 38 gives the characteristics.
Figure 50, the design of the Paardenwater

Table 38, the evaluation of the Paardenwater

<table>
<thead>
<tr>
<th>National guidelines EHK GOW Bibk type I</th>
<th>Characteristics</th>
<th>Obstacle factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lanes</td>
<td>1x1 lane</td>
<td>Bicycle lanes</td>
</tr>
<tr>
<td>Speed limit 50 km/hour</td>
<td>50 km/hour</td>
<td>Exits</td>
</tr>
<tr>
<td>Side marking or kerb</td>
<td>Kerb</td>
<td></td>
</tr>
<tr>
<td>Center marking or median island</td>
<td>No separation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>National guidelines VK GOW type II</th>
<th>Characteristics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bicycle lanes</td>
<td>Bicycle lanes</td>
<td></td>
</tr>
<tr>
<td>Priority rules</td>
<td>Priority road</td>
<td></td>
</tr>
<tr>
<td>Road surface</td>
<td>Brick pavement</td>
<td></td>
</tr>
<tr>
<td>Traffic regulations</td>
<td>Roundabout</td>
<td></td>
</tr>
</tbody>
</table>

**Spijksedijk / Vijfde Uitgang**

The Spijksedijk can be divided in a main corridor (discussed in the previous section) and an access route for the city centre. The Spijksedijk changes into the Vijfde Uitgang at the city centre. The difference between the Spijksedijk and the Vijfde Uitgang is the method of pavement (asphalt versus brick pavement) and the speed limit (50 versus 30 kilometres per hour). Figure 51 shows the Spijksedijk at the roundabout located between the Spijksedijk (main corridor) and the Lingebrug. Table 39 gives the characteristics of the Spijksedijk and the Vijfde Uitgang.
Figure 51, the design of the Spijksedijk towards the Vijfde Uitgang

Table 39, the evaluation of the Spijksedijk and the Vijfde Uitgang towards the city centre

<table>
<thead>
<tr>
<th>National guidelines EHK GOW Bibk type I</th>
<th>Characteristics</th>
<th>Obstacle factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lanes</td>
<td>1x1 lane</td>
<td>Bicycle lanes</td>
</tr>
<tr>
<td>Speed limit 50 km/hour</td>
<td>50 km/hour</td>
<td>Exits</td>
</tr>
<tr>
<td>Side marking or kerb</td>
<td>Kerb</td>
<td></td>
</tr>
<tr>
<td>Center marking or median island</td>
<td>No separation</td>
<td></td>
</tr>
<tr>
<td>National guidelines VK GOW type II</td>
<td>Characteristics</td>
<td></td>
</tr>
<tr>
<td>Bicycle lanes</td>
<td>Bicycle lanes</td>
<td></td>
</tr>
<tr>
<td>Priority rules</td>
<td>Priority road</td>
<td></td>
</tr>
<tr>
<td>Road surface</td>
<td>Brick pavement</td>
<td></td>
</tr>
<tr>
<td>Traffic regulations</td>
<td>Roundabout</td>
<td></td>
</tr>
</tbody>
</table>
ANNEX B  MONITORING THE TRAFFIC

Annex B explains the counting and the license plate session. The first section discusses the traffic counting and the second explains the license plate registration session held in March 2015.

B.1  CHECKING THE TRAFFIC INTENSITIES

In the first weeks of February 2015 the traffic intensity in Gorinchem was estimated in order to validate the traffic model from 2008. The sessions, during which all incoming and outgoing vehicles were counted, were held on different days of the week in order to determine the average traffic flows and to assign a representative day to count the freight traffic intensity in the city, which is explained in the next section.

B.2  LICENSE PLATE REGISTRATION SESSION

During the license plate registration session the license plate numbers of freight transportation vehicles were counted in order to find out what kind of freight vehicles enter Gorinchem and what their destination was within the city. In order to discover the number of freight transportation vehicles that entered the city, three persons had been placed at strategic point at the city borders, near a motorway exit towards Gorinchem. On the Banneweg, Nieuwe Wolpherensedijk and the Newtonweg one person had been situated as indicated by the red dots in Figure 52.

![Figure 52, overview of the five registration places during the license plate registration session. The red dots represent the suburb locations and the blue dots the city centre places](image)

In order to determine the percentage of freight vehicles, that entered the historical centre, a second line of persons, was situated on two entry points of the historical centre. These entry points are: Korte Brug and Paardenwater. In Figure 52 these locations are indicated by the blue dots.
One other objective had been to determine the location where in the historical centre the freight vehicles loaded/unloaded their goods and also the time it took to load/unload the goods. As the observations had been performed at all entries of the centre, the total time that a freight vehicle stayed in the city centre, could be calculated.

All persons, involved in the registration session, counted the incoming and the outgoing license plate numbers. This way the time that the freight vehicles had been in Gorinchem could be calculated. By this registration, also their route through Gorinchem could be determined.

A second objective from the registration session had been to have a better estimation of the key values for freight transportation in Gorinchem. This was used at the effect calculations of the freight transportation projects. The results will be passed on towards the city council of Gorinchem to allow further investigation of the freight traffic in the city.
ANNEX C  TOTAL AMOUNT OF VISITORS CALCULATION

In the passer-by studies (Nicasie, 2011) (Nicasie, 2012) (Nicasie, 2013) the number of visitors had been counted and surveyed. However, the counting and the inquiry had been held on specified times, on two Saturdays, one Wednesday and one Thursday. To adjust the number of visitors inquired, numerous correction factors had been applied to the results of these passer-by studies in order to calculate the total number of visitors per year. This annex gives an overview of the correction factors and calculation.

The first step had been the adjustment of the passer-by-studies, which had been done on specified times during the day. From (Centraal Bureau voor de Statistiek, 2015) characteristics about trips per person over a twenty-four hours’ period have been derived. Table 40 shows the values of the movements over a day and the specified time frames of the inquiries.

Table 40, characteristics of movement over the day

<table>
<thead>
<tr>
<th>Time of the day</th>
<th>Movement values per person per day</th>
<th>Time frames of the passer-by studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 4 hour</td>
<td>0,01</td>
<td></td>
</tr>
<tr>
<td>4 – 7 hour</td>
<td>0,06</td>
<td></td>
</tr>
<tr>
<td>7 – 8 hour</td>
<td>0,11</td>
<td></td>
</tr>
<tr>
<td>8 – 9 hour</td>
<td>0,22</td>
<td></td>
</tr>
<tr>
<td>9 – 12 hour</td>
<td>0,45</td>
<td></td>
</tr>
<tr>
<td>12 – 13 hour</td>
<td>0,2</td>
<td>Time frame 1</td>
</tr>
<tr>
<td>13 – 14 hour</td>
<td>0,2</td>
<td>Time frame 2</td>
</tr>
<tr>
<td>14 – 16 hour</td>
<td>0,45</td>
<td>Time frame 3</td>
</tr>
<tr>
<td>16 – 17 hour</td>
<td>0,23</td>
<td>Time frame 4</td>
</tr>
<tr>
<td>17 – 18 hour</td>
<td>0,23</td>
<td>Time frame 5</td>
</tr>
<tr>
<td>18 – 19 hour</td>
<td>0,15</td>
<td>Time frame 6</td>
</tr>
<tr>
<td>19 – 20 hour</td>
<td>0,13</td>
<td>Time frame 7</td>
</tr>
<tr>
<td>20 – 24 hour</td>
<td>0,26</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2,70</td>
<td></td>
</tr>
</tbody>
</table>

By the summation of the movement values per the time frame, the number of movements per person for the specified times can be calculated. By dividing the total movement per day number by the number of movements per person for the specified time frames, a correction factor for a day can be calculated. This correction factor is applied to the counted number of visitors during a day in the passer-by studies. Table 41 shows the number of visitors per day for the three passer-by studies.

Table 41, overview of the visitors per day per year

<table>
<thead>
<tr>
<th>Year</th>
<th>First Saturday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Second Saturday</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>7,262</td>
<td>3,801</td>
<td>3,611</td>
<td>6,129</td>
<td>5,201</td>
</tr>
<tr>
<td>2012</td>
<td>3,937</td>
<td>2,347</td>
<td>2,811</td>
<td>3,472</td>
<td>2,141</td>
</tr>
<tr>
<td>2013</td>
<td>5,405</td>
<td>2,232</td>
<td>2,988</td>
<td>8,040</td>
<td>4,666</td>
</tr>
</tbody>
</table>

Table 41 shows the number of visitors per day, who travel to Gorinchem. With this number, the number of visitors per week can be calculated. From (Centraal Bureau voor de Statistiek, 2015) the
statistics of movement per person per day of the Netherlands can be found. In Table 42 an overview
of average movement figures per person is given per weekday. Furthermore the correction factor per
day is given.

Table 42, movement figures and correction factor per day of the week

<table>
<thead>
<tr>
<th>Weekday</th>
<th>Movement figures</th>
<th>Correction factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunday</td>
<td>1.98</td>
<td>1.36</td>
</tr>
<tr>
<td>Monday</td>
<td>2.73</td>
<td>0.99</td>
</tr>
<tr>
<td>Tuesday</td>
<td>2.86</td>
<td>0.94</td>
</tr>
<tr>
<td>Wednesday</td>
<td>2.88</td>
<td>0.93</td>
</tr>
<tr>
<td>Thursday</td>
<td>2.79</td>
<td>0.96</td>
</tr>
<tr>
<td>Friday</td>
<td>2.87</td>
<td>0.94</td>
</tr>
<tr>
<td>Saturday</td>
<td>2.72</td>
<td>0.99</td>
</tr>
<tr>
<td>Average</td>
<td>2.69</td>
<td></td>
</tr>
</tbody>
</table>

The correction factor can be calculated by dividing the average number of movement per day by the
movement figure for a specific day in the week. The correction factor adjusts the number of visitors
per day, which is derived from Table 41 counted during the passer-by studies in a day to the number
of visitors in a week.

Table 43, number of visitors per week for Gorinchem

<table>
<thead>
<tr>
<th>Year</th>
<th>First Saturday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Second Saturday</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>7,182</td>
<td>3,550</td>
<td>3,482</td>
<td>6,061</td>
<td>5,069</td>
</tr>
<tr>
<td>2012</td>
<td>3,894</td>
<td>2,192</td>
<td>2,710</td>
<td>3,434</td>
<td>3,142</td>
</tr>
<tr>
<td>2013</td>
<td>5,405</td>
<td>2,232</td>
<td>2,988</td>
<td>8,040</td>
<td>4,565</td>
</tr>
</tbody>
</table>

To calculate the number of visitors per week, the values in Table 41 are adjusted with the correction
factor for per day to per week and the average of all days per year of the Gorinchem is taken. During
the second Saturday in the passer-by studies an event was held in Gorinchem. Therefore the number
of visitors on this day is higher compared to a normal Saturday. To calculate the total amount of
visitors, the average numbers of the four days is multiplied by the number of weeks in a year. The
following table shows the numbers of visitors per year.

Table 44, total amount of visitors for Gorinchem

<table>
<thead>
<tr>
<th>Year</th>
<th>Average visitors per week</th>
<th>Average visitors per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>5,069</td>
<td>263,575</td>
</tr>
<tr>
<td>2012</td>
<td>3,142</td>
<td>158,989</td>
</tr>
<tr>
<td>2013</td>
<td>4,565</td>
<td>237,404</td>
</tr>
</tbody>
</table>

From the three averages visitors per year in Table 44, the average number of visitors per year of the
past years can be calculated. The average number of visitors is rounded to 220,000. With this
number the amount of potential users of the P&R/P&W facilities have be calculated, which is shown
in section 6.2.1.
ANNEX D  DETAILED EVALUATION OF VEHICLE KILOMETERS

In this annex a detailed version of the evaluation is given for the UCC. The formulas of the calculations and the parameters, which are used, are presented. In addition, the results are given and discussed.

D.1 FREIGHT TRAFFIC VEHICLE KILOMETERS

To calculate the effect on the amount of freight traffic kilometres, numerous parameters have to be known. Table 45. Shows an overview of all parameters concerning the service area, trucks and deliveries.

Table 45, overview of the parameters needed for calculations

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface of the service area</td>
<td>0.25</td>
<td>km²</td>
</tr>
<tr>
<td>Load factor</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>Capacity fossil fuel powered truck</td>
<td>18</td>
<td>m³</td>
</tr>
<tr>
<td>Capacity electric powered truck</td>
<td>15</td>
<td>m³</td>
</tr>
<tr>
<td>Average load size</td>
<td>1.8</td>
<td>m³</td>
</tr>
<tr>
<td>Operating hours per day</td>
<td>9</td>
<td>Hours</td>
</tr>
<tr>
<td>Access and egress time between UCC and service area</td>
<td>10</td>
<td>Minutes</td>
</tr>
<tr>
<td>Stop time per stop in the city centre</td>
<td>15</td>
<td>Minutes</td>
</tr>
<tr>
<td>Load time at the UCC</td>
<td>20</td>
<td>Minutes</td>
</tr>
</tbody>
</table>

Another important factor, which has to be calculated, is the required number of trucks. The number of trucks depends on the total cubic metres freight serviced in a day and the capacity of the trucks. A factor, which also influences the required number of trucks, is the load factor of the trucks. The following formula can be used in order to calculate the required number of trucks, which has to be rounded to the highest near integer (Kloppers, 2008). The final factor that influences the required number of trucks is the number of round trips possibly made per day, which will be explained afterwards.

\[
NDTR = \frac{x}{(CDTR \times LS) \times NRT}
\]  

(D.1)

Where:

\( NDTR \) = Number of required distribution trucks;
\( x \) = Cubic metres of freight serviced per year;
\( CDTR \) = Capacity distribution trucks (from fossil fuel powered truck or electric powered truck);
\( LS \) = Average load size;
\( NRT \) = Maximum number of roundtrips per day.

To calculate the number of roundtrips that can be made, other aspects have to be calculated. To start the calculation, the maximum number of stops of the vehicles has to be known. This depends
on the capacity. For trucks, the following formula yield the maximal number of stops, which is rounded to greatest integer less than the outcome:

\[ NST = \frac{CDTR \cdot LF}{LS} \]  

(D.2)

Where:

\( NST \) = Maximum number of stops;
\( LF \) = Load factor.

With the maximum numbers of stops known for the trucks, their round-trip time and the number of round-trips per day can be calculated with the following formulas.

\[ RTT = LTUCC + 2 \cdot AT + NST \cdot ST \]  

(D.3)

\[ NRT = \frac{OH - 60}{RTT} \]  

(D.4)

Where:

\( RTT \) = Rountrip time;
\( LTUCC \) = Load time at the UCC;
\( AT \) = Access and egress time between the UCC and the service area;
\( ST \) = Stop time per stop in the city centre;
\( NRT \) = Number of roundtrips per day;
\( OH \) = Operating hours per day.

If one knows all these parameters, the effect on the freight traffic kilometres can be calculated. From the license plate registration session, the numbers of freight vehicles that enter the city centre is known. For calculating the length of an average roundtrip, a formula derived from (Stein, 1978) is used. This article described the length of a bus trip as a function of the surface of service area and the number of stops. This formula is used in this project to determine the length of an average roundtrip and is shown in formula (D.5).

\[ LRT = 1,5 \sqrt{SSA \cdot NST} \]  

(D.5)

Where:

\( LRT \) = Length of a roundtrip;
\( SSA \) = Surface of the service area.

All formulas, which are needed to calculate the vehicle kilometres of the freight traffic, are known. The final parameters that are needed are the freight traffic numbers in the city centre of Gorinchem. The license plate registration session (annex B) yielded these numbers. Because the 5 observers were spread over three suburb locations and two city centre locations, the percentages of the vehicles which entered Gorinchem and which entered the city centre could be calculated. As not all vehicles transport supplies to the city centre, an assumption has been made for the percentages of vehicle that did. This percentage has been used to calculate the number of vehicles, which delivered in the centre. These assumptions were based on the findings of the supply profile of Bergen op Zoom (DHV B.V., 2010). Table 46 shows the percentages of the freight traffic that entered the city and the percentage of the traffic, which made deliveries in the city centre.
As mentioned in annex B the license plate registration was held on an average day in Gorinchem. This was done in order to find the average number of freight traffic in the city, which can be used in the traffic evaluation. Using this input data and the previous described formulas, the vehicle kilometres in the city centre can be calculated. The results for the current situation are shown in the following tables.

Table 47, amount of Vehicle kilometres per week of all freight traffic in the city centre

<table>
<thead>
<tr>
<th>Type of vehicle</th>
<th>Length of a roundtrip (km)</th>
<th>Total kilometres in the city centre (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vans</td>
<td>3.2</td>
<td>2336</td>
</tr>
<tr>
<td>Light &amp; medium trucks</td>
<td>1.4</td>
<td>251</td>
</tr>
<tr>
<td>Heavy trucks</td>
<td>1.1</td>
<td>69</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>2656</td>
</tr>
</tbody>
</table>

A difference between the two tables is the length of the roundtrip. This results from the difference in the number of stops between serving the target group and the total city centre. Averaged, the target group has a lower number of stops. Therefore the average roundtrip length is smaller than the average roundtrip length of vehicles, which serve the entire city centre. From the tables can be concluded that the current percentage of the freight traffic, which serves the target group in the city centre, is 17 per cent of the total amount vehicles kilometres in the city centre.

In the scenarios, a part or all freight traffic will be replaced by the UCC’s service. Therefore the vehicle kilometres of the target group will be reduced. Because of the usage of light trucks by the UCC, the amount of vehicle kilometres by light trucks is not entirely reduced to zero in the target group. Table 49 shows the differences in vehicle kilometres for full participation scenarios and Table 50 shows the differences for the limited participation scenarios.
Table 49, reduction of vehicle kilometres in the full participation scenarios

<table>
<thead>
<tr>
<th>Type Vehicle</th>
<th>Full fuelled-powered scenario</th>
<th>Difference</th>
<th>Full powered scenario</th>
<th>electric powered scenario</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vans</td>
<td>1967</td>
<td>-15.8 %</td>
<td>1967</td>
<td>- 15.8 %</td>
<td></td>
</tr>
<tr>
<td>Light &amp; medium truck</td>
<td>205</td>
<td>-18.3 %</td>
<td>210</td>
<td>- 16.4 %</td>
<td></td>
</tr>
<tr>
<td>Heavy truck</td>
<td>45</td>
<td>-35.4 %</td>
<td>45</td>
<td>- 35.4 %</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2217</td>
<td>- 16.5 %</td>
<td>2222</td>
<td>- 16.4 %</td>
<td></td>
</tr>
</tbody>
</table>

Table 50, reduction of vehicle kilometres in the limited participation scenarios

<table>
<thead>
<tr>
<th>Type Vehicle</th>
<th>Limited fuelled-powered scenario</th>
<th>Difference</th>
<th>Limited powered scenario</th>
<th>electric powered scenario</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vans</td>
<td>2281</td>
<td>- 2.4 %</td>
<td>2281</td>
<td>- 2.4 %</td>
<td></td>
</tr>
<tr>
<td>Light &amp; medium truck</td>
<td>248</td>
<td>- 2.7 %</td>
<td>248</td>
<td>- 1.1 %</td>
<td></td>
</tr>
<tr>
<td>Heavy truck</td>
<td>66</td>
<td>- 5.3 %</td>
<td>66</td>
<td>- 5.3 %</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2595</td>
<td>- 2.5 %</td>
<td>2595</td>
<td>- 2.3 %</td>
<td></td>
</tr>
</tbody>
</table>

The difference between the reductions of the amount of vehicle kilometres is in the light and medium trucks category. Due to the difference of capacity size between the fossil-fuelled and electric powered trucks, there is one more truck needed in the full electric powered scenario compared to the full fossil fuel powered scenario. Therefore the number of vehicle kilometres is higher in the electric powered scenario and the total reduction is smaller.

The same applies to the limited participation scenarios, although both scenarios only require one truck in order to make all deliveries per day. The electric powered truck has to drive more often between the UCC and the city centre, due to its smaller capacity. Therefore the reduction in the category of the light and medium trucks is smaller compared to the reduction in the limited fossil fuel powered scenario.

D.2 FREIGHT TRAFFIC EMISSIONS

With the differences known in the amount of vehicle kilometres in the city centre, the effects on the air emissions can be calculated. However, one type of parameters is needed in order to calculate the reductions, namely the amount of grams per kilometre of the emissions. Table 51 shows these parameters for the carbon dioxide and fine particulars.
Table 51, emissions values per type

<table>
<thead>
<tr>
<th>Type of emission</th>
<th>Vans (g/km)</th>
<th>Light and medium trucks (g/km)</th>
<th>Heavy trucks (g/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂</td>
<td>127</td>
<td>500</td>
<td>900</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>0.051</td>
<td>0.260</td>
<td>0.302</td>
</tr>
</tbody>
</table>

To calculate the amount of emissions in the city centre, the amount of vehicle kilometres shown calculated in the previous section are multiplied by the values shown in Table 51. This results in the amount grams expelled per week. The current amount of emissions of the freight traffic in the city centre is presented in table

Table 52, emissions in the current situation

<table>
<thead>
<tr>
<th>Type of vehicle</th>
<th>Current situation</th>
<th>CO₂ emissions (kg/week)</th>
<th>PM₁₀ emissions (kg/week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vans</td>
<td></td>
<td>294.4</td>
<td>0.119</td>
</tr>
<tr>
<td>Light and medium truck</td>
<td></td>
<td>125.3</td>
<td>0.065</td>
</tr>
<tr>
<td>Heavy truck</td>
<td></td>
<td>62.5</td>
<td>0.021</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>482.2</td>
<td>0.205</td>
</tr>
</tbody>
</table>

Due to replacement of freight traffic by the service of the UCC, not only the amount of vehicle kilometres is reduced but the amount of emissions too. Table 53 shows the differences in the amount of emissions for the full participations scenarios and Table 51 gives the differences for the limited participation scenarios.

Table 53, emissions reduction for the full participation scenarios

<table>
<thead>
<tr>
<th>Type of vehicle</th>
<th>Full fossil-fuelled powered scenario</th>
<th>Full electric powered scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO₂ (kg/w)</td>
<td>Difference</td>
</tr>
<tr>
<td>Vans</td>
<td>247.9</td>
<td>- 15.8 %</td>
</tr>
<tr>
<td>Light &amp; medium truck</td>
<td>102.4</td>
<td>- 18.3 %</td>
</tr>
<tr>
<td>Heavy truck</td>
<td>40.4</td>
<td>- 35.4 %</td>
</tr>
<tr>
<td>Total</td>
<td>390.7</td>
<td>- 19.0 %</td>
</tr>
</tbody>
</table>
In contrast to the amount of vehicle kilometres, where the fossil fuel powered trucks of the UCC score better on the reduction, the electric powered trucks reduces the amount of emissions more. However, as mentioned before, the electric powered trucks do not expel emissions during their operations, but the production and demolition/recycling do produce emissions.

### Table 54, emissions reduction for the limited participation scenarios

<table>
<thead>
<tr>
<th>Type of vehicle</th>
<th>Limited fossil-fuelled powered scenario</th>
<th>Limited electric powered scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO₂ (kg/w)</td>
<td>Difference</td>
</tr>
<tr>
<td>Vans</td>
<td>287.4</td>
<td>- 2.4 %</td>
</tr>
<tr>
<td>Light &amp; medium truck</td>
<td>121.9</td>
<td>- 2.7 %</td>
</tr>
<tr>
<td>Heavy truck</td>
<td>59.2</td>
<td>- 5.3 %</td>
</tr>
<tr>
<td>Total</td>
<td>468.5</td>
<td>- 2.8 %</td>
</tr>
</tbody>
</table>
ANNEX E DETAILED FINANCIAL FEASIBILITY CALCULATIONS

In the previous annex, the calculations of the evaluation on two of the criteria mentioned in section 5.2 were discussed. In this annex the financial calculations of the Urban Consolidation Centre are explained. To calculate the financial feasibility of the UCC, different parameters are used. The financial costs are shown in Table 23 in section 6.3.2. Table 55 shows an overview of the other parameters, which are used during the calculations.

Table 55, the parameters during the calculations for the financial feasibility

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCC operating time</td>
<td>540</td>
<td>Minutes</td>
</tr>
<tr>
<td>UCC operating weeks</td>
<td>52</td>
<td>Per annum</td>
</tr>
<tr>
<td>UCC days</td>
<td>6</td>
<td>Per week</td>
</tr>
<tr>
<td>Load factor UCC trucks</td>
<td>85</td>
<td>%</td>
</tr>
<tr>
<td>Capacity fossil-fuelled truck</td>
<td>18</td>
<td>m³</td>
</tr>
<tr>
<td>Capacity electric truck</td>
<td>15</td>
<td>m³</td>
</tr>
<tr>
<td>Average volume per load</td>
<td>1.8</td>
<td>m³</td>
</tr>
<tr>
<td>Maximum storage height</td>
<td>1.2</td>
<td>m</td>
</tr>
<tr>
<td>Number of personnel</td>
<td>5 + number of distribution trucks and forklift trucks</td>
<td>Persons</td>
</tr>
<tr>
<td>Depreciation period real estate</td>
<td>20</td>
<td>Years</td>
</tr>
<tr>
<td>Depreciation period for IT service and furniture</td>
<td>5</td>
<td>Years</td>
</tr>
<tr>
<td>Costs for marketing materials</td>
<td>2,800</td>
<td>€</td>
</tr>
<tr>
<td>Costs for IT Systems;</td>
<td>15,400</td>
<td>€</td>
</tr>
<tr>
<td>Costs for office furniture</td>
<td>1,400</td>
<td>€</td>
</tr>
</tbody>
</table>

The financial situation can be divided into two aspects: the yearly revenues and the yearly costs of the UCC. To be financial viable without help from subsidies, the revenues have to be larger than the costs per year. To assess the financial viability of the UCC, the revenues and the costs are formed as a function of the cubic metres freight serviced per year.

E.1 REVENUES PER ANNUM OF THE UCC

The revenues from the UCC result from the savings made by the consignees of the target group and the savings made by the transport companies. The consignees save money, due to the better connection of the deliveries to the there opening times. Therefore the consignees do not have to hire employees before their shop opens. This saves the consignees € 3.32 per cubic metre of freight (Kuiper, 2006).

The second revenues for the UCC results from the savings made by the transport companies. The transport companies, which serve the city centre in Gorinchem, do not have to travel towards the city centre once an UCC is introduced. This saves the transport companies time as they can travel more quickly to their next destination. The total savings for the companies is € 7.02 per cubic metre of freight (Kuiper, 2006).

The total revenues for the UCC are the sum of the revenues of the consignees and the transport companies. The following formula shows the total income for the UCC.
\[ TR = (TCS + CS) \cdot x = (7.02 + 3.32) \cdot x \]  
\hspace{1cm} (E.1)

where:

\( TR \) = Total yearly revenues  
\( TCS \) = Transport company savings;  
\( CS \) = Consignees savings;  
\( x \) = Cubic metres freight serviced per year.

### E.2 COSTS PER ANNUM OF THE UCC

The costs of an UCC results from the ground and real estate expenses, the mobile material and the overall expenses. The first expenses are made for the ground and real estate. These concern the ground that has to be bought to build the new facility. The real estate expenses are the costs concerning the actual building of the new facility. Final expenses have to be made for the costs of the infrastructure, which is needed to connect the UCC to the existing infrastructure and within the UCC to ensure the storage and distribution.

To calculate the total surface of the UCC, the surface for the storage area is calculated first. The maximum surface for storage can be calculated by dividing the cubic metres of freight serviced per day by the maximum storage height, as shown in formula (E.2) (Lewis et al., 2010).

\[ SSF = \frac{x}{SH} \]  
\hspace{1cm} (E.2)

\[ RES = SSF \cdot 2 \]  
\hspace{1cm} (E.3)

Where:

\( SSF \) = Storage surface;  
\( x \) = Cubic metres freight serviced per annum;  
\( SH \) = Maximum storage height;  
\( RES \) = Real estate size.

An UCC does not consist only from storage area. It also contains offices and space for movement of the forklift truck for example. Therefore the total real estate size of the UCC is the double amount of storage surface. An UCC does not start with one square metre. Therefore a minimum size has been taken as assumption, which is 100 m\(^2\) and therefore the following rule holds formula (E.3): \( RES \geq 100 \).

With the surface of the real estate designed, the total surface of the infrastructure can be calculated. The infrastructure is needed within the building and outside the building to connect it to the existing infrastructure. The connecting infrastructure (aprons space) can be calculated by multiplying the required number of trucks (calculated in annex D) times 3.7 metres and 36.5 metres (Nova Technology International, 2013). The following formula yields the total surface of the infrastructure.

\[ INFC = RES + NDTR \cdot (3.7 \cdot 36.5) \]  
\hspace{1cm} (E.3)

where:

\( INFC \) = Total square meters infrastructure;
Number of required distribution trucks.

The total surface of infrastructure represents two aspects, namely the total surface where infrastructure has to be applied and the total amount of ground, which have to be purchased to construct the UCC. Therefore the total yearly costs of ground, real estate and infrastructure are calculated by formula (E.4).

\[
TGRC = \frac{INF_GRC + INF_{IC} + RES_{BC}}{DTR}
\]  
\[\text{(E.4)}\]

Where:

\[
TGRC = \text{Total costs for ground surface, infrastructure surface and real estate per annum;}
\]
\[
GRC = \text{Ground costs;}
\]
\[
IC = \text{Infrastructure costs;}
\]
\[
BC = \text{Building costs;}
\]
\[
DPR = \text{Depreciation period real estate.}
\]

**Mobile material**

An UCC uses two types of mobile material, namely trucks for distribution and forklift trucks to transfer the freight from trucks to the storage area and vice versa. The formulas to calculate the required number of distribution trucks were discussed in the previous annex.

The number of forklift trucks depends on the surface of the UCC. A forklift trucks can service 370 m\(^2\) (Lewis et al., 2010). This concludes the formula for the number of forklift trucks as:

\[
NFLT = \frac{RES}{370}
\]  
\[\text{(E.5)}\]

Where:

\[
NFLT = \text{Number of forklift trucks.}
\]

The number of forklift trucks is always rounded to the first highest integer. This means that minimal 1 forklift is present at the UCC. As soon as the UCC reaches a total surface of 371 m\(^2\), 1 m\(^2\) more than one forklift trucks can service, the UCC has to lease another forklift truck, therefore two forklift trucks are operating in the UCC.

A parameter, which is related with the number of distribution and forklift trucks, is the number of personnel that works at the UCC. (Lewis et al., 2010) shows the type of personnel, which works at an UCC. The average wages of UCC personnel is € 41,000 per person. The total number of personnel is the number of drivers of the distribution and forklift trucks added by a general manager, operations manager, supervisor, marketing/recruitment staff and a cleaner.

**Overall expenses**

The last category of the yearly costs of a UCC is the overall expenses. This category can be divided in maintenance, insurance and overhead costs. For the maintenance costs a 2.5 per cent is taken over the ground and real estate costs and the mobile material. In this case, the total ground and real estate costs are taken into account and not the costs per annum. Formula (E.6) shows the total maintenance costs per annum.

\[
MC = (TGRC \cdot DTR + NFLT \cdot LFLT + NDTR \cdot LDTR) \cdot 0.025
\]  
\[\text{(E.6)}\]
Where:

\( MC \) = Total maintenance costs;
\( LFLT \) = Lease costs per annum of a forklift truck;
\( LDTR \) = Lease costs per annum of a distribution truck.

The second overall expense is the insurance costs, which can be calculated by the cubic metres of freight serviced per year times a fixed parameter of € 0.25. The formula shows the total insurance costs per annum.

\[
INS = 0.25 \cdot x \tag{E.7}
\]

Where:

\( INS \) = Total insurance costs per annum.

Except for the overhead costs, all other costs are known. Together these costs form the operation costs of the UCC. The formula below present the total operation costs.

\[
OC = TGR + NFT \cdot LFLT + NDTR \cdot LDTR + MC + INS + PC \cdot NP \tag{E.8}
\]

Where:

\( OC \) = Total operation costs;
\( PC \) = Personnel costs;
\( NP \) = Number of personnel.

The final overall expenses are the overhead costs. Overhead costs concern unexpected charges, IT-services and furniture. The costs of IT systems and furniture have to be divided by the depreciation period of 5 years (Gemeente Rotterdam, 2013). To take unexpected charges into account, 10 per cent of the overall costs are taken. The total overhead costs are presented in the following formula.

\[
OHC = MM + \frac{ITS + OF}{DPO} + OC \cdot 0.1 \tag{E.9}
\]

Where:

\( OHC \) = Total overhead costs for a UCC;
\( MM \) = Costs for marketing materials
\( ITS \) = Costs for IT systems;
\( OF \) = Costs for office furniture;
\( DPO \) = Depreciation period for furniture and IT systems.

The final step in the calculation of the total yearly costs of an UCC is the summation of the operational costs and the total overhead costs. The final step is shown in formula (E.10).

\[
TYC = OC + OHC \tag{E.10}
\]

Where:

\( TYC \) = Total yearly costs of the UCC.
As mentioned before, the total yearly costs have to be lower than the total yearly revenues made by the UCC in order to be financial viable, without the help of subsidies by national and/or international governments.