CME – MASTER THESIS

Car drivers' preferences regarding parking information

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Content

Preface

In this document I present my graduation thesis for the completion of the master Construction Management and Urban Development at the Eindhoven University of Technology (TU/e). This study focussed on car drivers' preferences regarding parking information.

First of all, research is not just collecting data and making wise conclusions, it is more. A good researcher should also be a good project manager. The main pillars are: time management (get the right data at the right time), and decision making. During the production of this research both were extreme important. I started the project with a literature study towards sustainability, search behavior, parking and travel information. With help of my supervisors I quickly started with selecting the attributes for the questionnaire. Thereby it was important to select the right research methods. The next step was the data collection and analysis. Due to the Kenwib program I was able to collect data from 525 respondents!

Second, I would like to thank my graduation committee, prof.dr.ir. Wim Schaefer, dr.ing. Peter van der Waerden and dr. Paul van Loon for their guidance and support during this graduation project. Paul, I enjoyed our sessions with your enthusiasm about parking and thereby all your advice regarding the world of parking. Peter, I learned a lott from you, I am very thankful for all the effort you give to this project. Thereby I experienced the way which we worked together as very comfortable. Wim, I would like to thank you for guidance in the beginning of this project, for me it was hard to find the right subject, now I am more than happy with the result of this project. Thereby I would like to thank you for the possibilities from the KENWIN program.

At the end I want to thank my parents, sister and brother, by their support, they gave me the opportunity to study. Beside this I want to thank my friends, for the chats which have nothing to deal with doing research. Furthermore I would like to thank the members from the study trip to China, I had a great time and it was a very good distraction for my graduation time. Also I want to thank my fellow graduation students, I had a good time at our table on floor five, we helped each other as much as possible and I enjoyed the diners.

By the completion of my master and providing this research I hope I constructed a good instrument to measure car drivers' preferences regarding parking information.

Enjoy Reading,

Tim Jansen
Geldrop, July 2013

Management summary

In recent years governments are facing with more and more problems concerning global heating and the emission of harmful gasses. To counter these problems and improve the livability of their citizens several initiatives are necessary. One of those problems concerning global heating and the emission of harmful gasses is related to the emission of CO_2 and particulate matter by local traffic in urban areas. Due to this cause, several studies have proved that it has a direct effect on the health of the people living nearby. It proves that long-term exposure to combustion-related fine particulate air pollution is an import environmental risk factor for cardiopulmonary and lung cancer mortality. Besides, research shows that a reduction in exposure to ambient fine-particulate air pollution contributed to significant and measurable improvements in life expectancy (Pope et al, 2002).

According to calculations by the Planbureau voor de leefbaarheid (Office for Liveability), Centraal bureau voor de Statistiek (Central Office for Statistics) and the University of Wageningen traffic is responsible for about 15% of total energy consumption in the Netherlands. In addition, nearly 47% of the total (fossil)fuel consumption accounts of passenger cars. These days, a non-negligible part of the total travel time can be spent for searching for a free parking lot. The search for parking spaces increases road congestion significantly (Gallo et al, 2011). Some researcher attempted to estimate the volume of cruising and the time to find a parking facility/space (Shoup, 1997). There was estimated that between the 8% and 74% of traffic can be generated by cruising for parking (Arnott et al, 2005; Shoup, 1997; Spittje, 2007; van Ommeren, 2011; Gallo et al,2011; Geng et al, 2012). There is even estimated that the average time to find a parking space is ranged between 3.5 and 14 minutes (Shoup, 1997; Gallo et al, 2011).

Governments implemented several measures to reduce air pollution and emission of CO_2 as much as possible. Examples of these measures are mobility management with parking guidance systems as a good example, Cycling policy, cleaner and more efficient vehicles, carpooling, cleaner and more efficient supply-chain, sustainability in public transport, alternative fuels and parking regulation. Due to the diversification of functions of city's and broadening of shop opening hours, urban areas have an increasing amount of traffic. With this increasing amount of mobility, there is a still growing demand of parking space on-street and off-street (Jogems & Spittje 2005). In absence of enough free space and costs, it is hard to expand parking capacities. Therefore a parking guidance system offers a solution. Only these days, disagreements exist about the efficiency of these systems.

When people or in other words, car drivers, know where to park the amount of search traffic will decrease. Which indirectly is related to the emission of harmful gasses and results in a better livability of the urban area. Therefore car drivers needs real-time and specific information about parking facilities close to their final destination. So they do not have to search for a parking spot.

1. Introduction

This part of the report describes about the framework of the research project. First, the context of the research is described in the section problem statement. The central research question and some sub-questions are stated, as well as a framework for the research methodology is given. The relevance of the study and the involved organizational partners are described. Finally the outline of the research is given in the reading guide.

1.1 Problem statement

These days, sustainability is a hot item amongst (local) governments and other interested parties. Sustainability is hot because of the environmental issues (the global heating effect, emission of harmful gasses, etc. etc.) which become increasingly important these days. Therefore governments and other interested parties are searching for solutions which can encounter the environmental problems.

One of the major problems within urban areas is the emission of harmful gasses, which consequently contributes to environmental problems. The emission of harmful gasses do not only have effect on the environment. It also affects the livability of urban areas and will have effect on the health of its inhabitants living in these urban areas. According to calculations by the Planbureau voor de leefbaarheid (Office for Liveability), Centraal bureau voor de Statistiek (Central Office for Statistics) and the University of Wageningen traffic is responsible for about 15% of total energy consumption in the Netherlands (Cramer, 2012). In addition, nearly 47% of the total (fossil)fuel consumption accounts of passenger cars. From these facts, it is obvious to say that local traffic contributes to the environmental problems.

By decreasing the amount of local traffic, the pollution of harmful gasses can decrease enormously. Recent studies shows that a certain amount of local traffic exists of search traffic (see paragraph 2.3.2). Those studies show also that a certain amount of this search traffic is searching for a parking spot close to their final destination (e.g. Arnott et al, 2005; Shoup, 1997; Spittje, 2007; van Ommeren, 2011; Gallo et al,2011; Geng et al, 2012).

Concluding that if people or in other words, car drivers, know where to park the amount of search traffic will decrease. This is indirectly related to the emission of harmful gasses and results in a better livability of the urban area. Therefore, car drivers need real-time and specific information about parking facilities close to their final destination. So they do not have to search for a parking spot (Felici and Schurink, 2011).

1.2 Research aim

At this point (local) governments have great difficulty to reduce the amount of 'search traffic' in city centers. In addition, the parking world is desperately searching for a way to better inform users of parking facilities (Felici and Schurink, 2011).

At this moment there are several initiatives (parkeerlijn.nl, prettigparkeren.nl and parkerenindestad.nl) providing some amount of the available parking data. It seems that those projects are not successful. In addition, parking guidance systems appear not to have the desired effect as was expected. Such systems only prove to be successful when complete information as service providers (may) offer, is the integration of:

- Latest parking information;
- Current traffic information (i.e. road works);
- Navigation services;
- Other (personalized) information, such as multi-modal travel information and weather info.

This study only takes into account the information flow which is useful for the user and not the information flows between the various parties associated with the parking world. For example information concerning occupancy is important for a user while information about the use of energy is not. There will be a focus on what kind of information the user needs to create a suitable/preferable choice.

Consequently, the following research questions are formulated:

Main question 1:

'What parking information supports a drivers' parking search behavior?'

Sub-question 1.1;

'What information do travelers want to make an optimal parking choice?'

Sub-question 1.2;

'Do travelers adapt their behavior based on distributed information?'

Most important in this project, is the collection of the car drivers' preferences regarding parking information, therefore an instrument has to be developed which is able to measure those preferences.

1.2.1 Research Relevance

The relevance of this study can be considered from the viewpoints of the Eindhoven university of technology (TU/e) and the stakeholders (National database parking facilities, local, regional and national government and owners parking facilities). The first paragraph of this describes the relevance of the TU/e. For the coming years, the university set up a master plan which is related to this research topic. In the second paragraph, the relevance of the project for the stakeholders is elaborated. Eventually in the final paragraph the expected results are presented.

1.2.1.1 TU/e relevance

In the context of the master plan 2020 of the Eindhoven University of Technology, the university has set up three strategic areas (Peels et al, 2011). These areas are; 'Energy', 'Health' and 'Smart Mobility'. Most of the research done by the university will focus on these topics. Both Smart Mobility as well as Energy are used as keywords that correspond with this graduation project. So in the interest of the university's focus, this research fits exactly within their ambition.

The university's strategy regarding Smart Mobility is as follows: for the university, technology is an important solution to minimalize the negative side effects of mobility. Traditionally, the university has knowledge in the field of Intelligent Transport Systems, Automotive Technology, Logistics and Planning Systems, and ICT/ Embedded Systems. All fields are needed to play an important role in helping the world transition towards smarter and more sustainable mobility. Research on car drivers' preferences towards parking information reduces the amount of traffic within urban areas and gives a boost to the accessibility and safety within urban areas. The faculty of The Built Environment contributes to this with research in human behavior as guide to smart mobility.

Within the Energy area, the university gives their view as follows: 'The energy strategic area envisions a sustainable world that can produce enough energy for its consumption, unimpeded by scarce resources and without any impact on the climate'(Peels et al, 2011). In this, the university focuses on the built environment and fuel technologies. By reducing search traffic, the amount of unnecessary fuel consumption will decrease. This contributes to a more sustainable environment and has less impact on the climate. Within the faculty of The Built Environment, research is done in everything that has to do with energy consumption in urban areas, including the mobility aspects as defined in this graduation project.

For the stakeholders in this project the way in which the consumption of energy, and directly to that, the decrease of CO_2 emissions and particulate matter is interesting. Especially for the KENWIB, Kenniscluster Energieneutraal Wonen In Brainport (Cluster of knowledge energy neutral housing in Brainport) program of chair holder prof.dr.ir. W.F. Schaefer. Besides that the unit urban Systems Science of the faculty of The Built Environment is involved. This unit focuses on the relationship between built environment and mobility including parking. Most of the parking based is done by dr.ing. P.J.H.J. van der Waerden. For this research the focus is on car drivers' behavior.

1.2.1.2 Relevance stakeholders case database parking facilities

The database parking facilities (Nationaal Dataloket Parkeervoorzieningen) has many stakeholders. These stakeholders can be divided into several groups, who all have their own benefits. The most important groups of stakeholders are the users of this information, the government, and the parking companies.

Governments, at different spatial levels (local, regional or national), benefit from this research. In the near future, the governments will be obliged to publish all the data they generate, even in terms of parking (Rijksoverheid, 2011). For them it is relevant to have insights into which parking information towards users is useful and what users will do with provided parking information. A direct effect of publishing this kind of data is that visitors of cities will be informed better. This results in less search traffic and a better accessibility of cities and regions. Thereby the pollution of harmful gasses decreases, so the livability of the area increases. It is even possible to say that it has positive effects on the regional economics because when accessibility increases it is more attractive to visit this region instead of a less accessible region.

Like the government, car drivers also benefits from these developments. When more information is provided, the driver can make better choices where to park and how to drive towards the chosen parking facility. By providing information about parking, the driver does not have to search unnecessarily for a parking space. This will result into shorter travel time and maybe shorter walking distances between the parking facility and destination. Eventually we can say that comfort of travelling improves with this kind of information.

There are also several commercial companies involved in the initiative of the national database parking facilties. Those companies have different interests. For a service-provider, like TomTom, the availability of information towards drivers is relevant, because they are providing the information to the users and for them it is therefore relevant to know what kind of information a driver need. Operators of parking facilities, both commercial and public, are providing their information to the (open) database. In this case it is important what users do with their information and what information affects their choice for a parking facility. Consultancy firms, like Empaction b.v., can use the results of this research project to convince governments and commercial operators of parking facilities, to publish their data to the Nationaal Dataloket Parkeer Voorzieningen (national database parking facilities) project.

1.2.1.3 Expected results

This study consists of a literature study of car drivers' preferences towards parking information. After the literature study is done, a questionnaire is made to gain detailled information concerning car drivers' preferences for parking information. Eventually a list of preferences of car drivers may be formed that is based on what information car drivers prefer the most.

The relevance of this kind of information will be questioned. As described in paragraph 1.2.1.1 and 1.2.1.2, for several parties this kind of research is relevant. Based on the provided outcome of the graduation project the stakeholders can elaborate their (business) cases concerning the database parking facilities.

Eventually the list of information requirements can be implemented into the Nationaal Dataloket Parker Voorzieningen project (National database parking facilities). Firms like TomTom have the opportunity to extract the necessary information from the database and present them to the car drivers. Governments can estimate the effects of this information provision to the accessibility, safety and environmental concerns to their municipalities.

1.3 Structure report

This research is divided into three parts. Part one, chapter 2, shows the literature study which is done regarding the principles of parking and the relationship between parking and the environment. It shows results concerning sustainability, accessibility, parking and search behavior, parking guidance systems and travelling and travel information. The second part, chapter 3 is about the research approach. In this chapter the methods and techniques concerning the data collection necessary for the research project will be elaborated. Finally, the data collection will be described including the selection of attributes and the actual construction of the questionnaire. The third and final part of this report, chapter 4, is about the analysis of the obtained data concerning parking information. Hereby an preliminary conclusion will be given about the most valuable parking information for car drivers. Finally in chapter 5, the final conclusion of this research project will be given. The total process of the project is visualized in Figure 1.

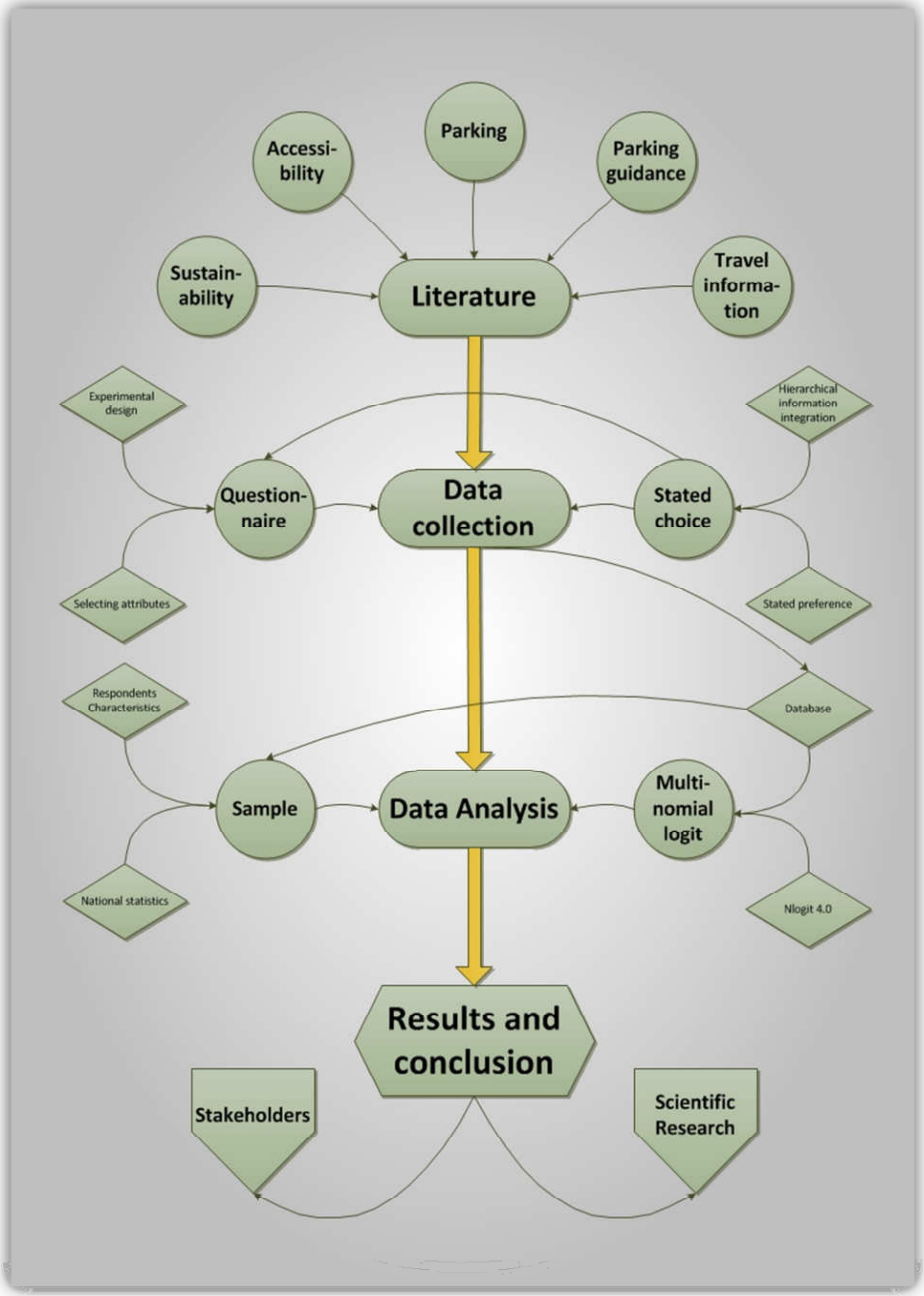

Figure 1: Process research project

2. Theoretical framework

This chapter describes the various aspects concerning the problem statement for this research project. As stated earlier, these days, governments and other parties are dealing with various problems concerning the environment. The emission of harmful gasses who causes problems like the global heating effect and health problems of citizens living nearby. In paragraph 1.1 it was concluded that reduction of the amount of search traffic would help to decrease the before mentioned problems regarding health and environment.

The reduction of search traffic due to the provision of parking information will have other advantages. Within this chapter those parts that influences all those aspects of parking information will be elaborated.

First, the sustainable environment will be elaborated using the questions, what are the current problems and who causes these problems? The second paragraph will deal with accessibility, for governments and local retail this issue covers an important benefit by providing real time parking information. Thirdly, an important result related to parking spots will be elaborated, the parking search behavior. Therefore it is important to know how the problems concerning parking have been developed, and what is search traffic exactly. In the fourth paragraph, the working of parking guidance systems will be described. Currently many municipalities have installed parking guidance systems in their inner cities. These days, there are some disagreements about the working of them. Finally, a paragraph will be assigned to travelling and travel information based on the questions how do people deal with travel information and are there differences towards travel information towards difference travel purposes? This chapter will be enclosed with a conclusion, within this paragraph all the findings will be summarized and discussed.

2.1 Sustainability

For many years (local) governments are confronted with problems toward air quality (Nationaal Samenwerkingsverband Luchtkwaliteit, National partnership air quality) (Cramer, 2012). Besides administrative awareness, the public media gives much attention to these problems. In an article of the Parool, a Dutch national newspaper, the writers describes the problems and consequences of the Dutch quality of air.

"Fijnstof van stadsverkeer is sluipmoordenaar" (Particulate matter from urban traffic is an assassin) The tiny suspended particles would include ensuring that it accelerates the declining of the mental state of elderly, especially of women. Where exactly does this particulate matter come from these days? It is assumed that particles are produced by both human and non-human activities, engine emissions, combustion of oil and gas, rubber tires, road damage, pollution of heavy industries and combustion engines. But also Sahara-sand, dust worn from buildings by weather and sea salt contributes to this problem. These are some important sources. Particulate emissions from traffic still have the most direct impact. The smaller particles are the more harmful they are because they penetrate deeply into the

lungs. But the coarser PM-10 dust can cause mechanical and toxic effects of the airway mucus drain, respiratory symptoms and respiratory irritation. According to research by TNO, ECN, RIVM researchers conclude that 75 % of PM10 dust and 80% of PM2, 5 is caused by humans. [Het Parool, Saturday, June 16, 2012]

The article suggests, because it does not prove anything at all, that mainly local traffic is largely responsible for direct effects of particulate matter. Besides it proves the public awareness to the problems with air quality. Thereby, several researchers investigated the effects of air quality on health (Pope et al, 2002; Janssen et al, 2003; Oberdörster et al, 2003; Schlesinger et al, 2003; Gouderman et al, 2007; Knol, 2009; Pope et al, 2009). Gouderman et al (2007) show in his case that children, who live within 500 meter of a highway have a reduced growth of long function. Research from Pope et al. (2009) specifies that long-term exposure to combustion-related fine particulate air pollution is an import environmental risk factor for cardiopulmonary and lung cancer mortality. Beside, research shows that a reduction in exposure to ambient fine-particulate air pollution contributed to significant and measurable improvements in life expectancy (Pope et al, 2002). Thereby the number of deaths caused by air pollution is not identifiable. This allows the reporting numbers of additional deaths from air pollution lead to erroneous interpretations. Moreover, once everyone will die. Therefore, there can be no question of the fact "excess mortality". It is therefore meaningful to use the health measure 'won or lost (healthy) years' (Knol et al, 2009).

Noteworthy, the Dutch national government stated, in their report Nationaal Samenwerkings- verband Luchtkwaliteit (National partnership air quality) that not everyone is equally susceptible to the adverse effects of air pollution. For large groups, such as the entire population of the Netherlands, it seems that there are no safe concentrations. At the individual level variation in sensitivity exist. They are often elderly with cardiac, vascular and respiratory diseases and children who are sensitive to air pollution. Furthermore, asthmatics suffer more from air pollution.

Nowadays, the air quality in the Netherlands is getting better. Yet there are still places where the requirements are not met in terms of particulate matter (fijn-stof) and NOx concentrations. In the Netherlands, the requirements to reduce particulate matter and NO_x concentrations are laid down in the Wet Luchtkwaliteit (Air Quality Act). At these bottlenecks, places where the requirements from the Wet Luchtkwaliteit are not met, road traffic delivers an important contribution to the (too) high concentrations of pollutants in the air. A reduction in the amount of traffic or a shift to cleaner road transport can make a significant contribution in reducing the number of local bottlenecks.

Parallel to these developments local, regional, national and international governments make increasingly stringent requirements in terms of energy consumption with the aim to counteract the greenhouse effect. In various covenants (Kyoto and later Bonn) there are international agreements to reduce CO2 emissions and energy consumption drastically.

Thus, all the member states within the European Union agreed that in 2020 the so-called 20-20-20 standard has be achieved, 20% less greenhouse gas, 20% more sustainable energy and 20% energy saving. This is enshrined in the European Climate and Energy Package. To further answer this question, some local authorities, such as the government in the Eindhoven region, agreed to be energy neutral in 2040.

Numerous measures are necessary to meet these requirements. Consider reducing the emission of polluting gases in heavy industry, the promotion of renewable energy, apply / commit energy saving systems, technical requirements relating to energy consumption of houses and finally tighten the rules for combustion engines. These measures are just a few examples of ways to meet the stringent requirements.

At this time the government succeeds well to the demands concerning reducing energy usage. There remain some problems which are difficult to tackle. These are located mainly in urban areas where the demand for CO2 and particulates can barely be tackled. According to calculations by the Planbureau voor de leefbaarheid (Office for Liveability), Centraal bureau voor de Statistiek (Central Office for Statistics) and the University of Wageningen traffic is responsible for about 15% of total energy consumption in the Netherlands. In addition, nearly 47% of the total (fossil)fuel consumption accounts of passenger cars.

It is important to reduce the amount and/or duration of car trips. This will lead to a reduction of the emission of harmful gasses. Which will eventually results into a better livability of urban areas. Ensured by a better air quality it will lead to a decrease of health problems. In the following paragraphs of this chapter an inside will be given into the possibilities to counter these problems.

2.2 Accessibility of urban areas

Providing a good accessibility is these days an important task for municipalities/ governments But what is accessibility actually and why is it so important for governments? This part of the study treats all the elements concerning accessibility.

Accessibility is defined in several ways, and thus has taken a variety of meanings(Geurs & van Wee, 2004). There are some well-known definition of accessibility, such as 'the potential of opportunities for interaction' (Hansen, 1959), 'the ease with which any land-use activity can be reached from a location using particular transport system' (Dalvi & Martin, 1976), 'the freedom of individuals to decide whether or not to participate in different activities' (Burns & Lerman, 1979) and 'the benefit provided by a transportation/land-use system' (Ben-Akiva & Lerman, 1979). Others defined accessibility as 'the freedom or ability of people to achieve their basic needs in order to sustain their quality of life' (e.g. Pasaogullari & Doratli, 2004). Another important definition is 'Accessibility typically refers to the "ease" with which desired destinations may be reached' (Niemeier, 1997). The Dutch government defined accessibility in their Nota Mobiliteit (Memo Mobility) as 'the travel time it takes from door to door' (Perdonk et al, 2008). Thereby they stated that national, as well as international connections are crucial to keep operating the main ports (Schiphol Airport and Harbor of Rotterdam), urban networks and economical hotspots (Perdonk et al, 2008).

Notable, in the late forties researchers started to study the way individuals and aggregates of individuals respond to the constraints of cost, time, and effort to access places, individuals, and other spatially-distributed opportunities (Tranos et al, 2013).

For the definition of accessibility, there are three different perspectives (e.g. Geurs et al, 2001; Levine et al, 2002; Tillema et al, 2003):

1. An infrastructure oriented approach, this approach is used by planners and policy makers in terms of transportation and traffic. Focus in these is the network of transportation. In general, little delay due to traffic results in a good accessibility.
2. An activity oriented approach. In these, the focus is on the amount of effort it takes to reach a certain location/activity. In geographical and planning terms, this approach is usually divided into;
    - Geographical accessibility: With focus on the potential accessibility of an activity from a certain location;
    - Spatial accessibility: With the focus on time elements were individuals can participate in specific activities.
3. Utility based approach, this approach is based on the utility people granted to reach a certain location/activity.

In general, accessibility depends on travel-time: accessibility is so far not associated to certain types of transportation but is network transcending. For governments it is important to cooperate with these types to ensure the accessibility. But what is meant with a good travel time? Based on the Nota Mobiliteit of the Dutch government, a good travel-time is a travel-time in which the traveler is on time at his destination (Perdonk et al, 2008). According to the Dutch government, ‘on time’ means at longer distances (over 50 km) up to 20% earlier or later than the expected/desired travel time and at shorter distances up to 10 minutes shorter or longer than the expected/desired travel time at a specific time at the day (Ministry of Infrastructure and environment, 2004). The understanding of expect travel-time is quite complex (Perdonk et al, 2008). We can divide travel-time into two components. The first component is travel-time without any delay: the second component is delay-time.

How do travelers experience accessibility? Research shows that the ‘effort’ to reach a particular destination, consists of three components(Hoogendoorn-Lanser et al, 2011):

- 'Out-of-pocket’ costs, such as fuel costs for the car, the cost of a ticket or parking fees;
- Time and specificities of the journey, such as the unreliability of travel time;

- Comfort and quality during the trip, as, for example standing in the train, the number of transfers during a journey by public transport or a feeling of insecurity on the station.

The elements, which determine accessibility, can be grouped into three categories, that are mentioned above, travel-costs, travel-time and travel-effort. Figure 2 gives an overview of these elements. In this figure the elements are divided into the most common types of transportation.

elements \ mode	Car	public transport	bicycle/walking
time	walking to parking place in vehicle travel time congestion time finding a parking place walking to destination	hidden waiting time travel time of access/egress mode waiting time at station in vehicle travel time transfer time	travel time bicycle parking
costs	fixed costs fuel costs maintenance costs parking costs road-pricing costs	costs of tickets/fares	fixed costs maintenance costs
effort	level of (dis)comfort physical effort reliability stress accident risk information status	level of (dis)comfort physical effort reliability stress accident risk social safety information status	level of (dis)comfort physical effort social safety

Figure 2: Elements within the transport component of accessibility (Geurs, 2001)

It may even be that the one person qualifies the accessibility of an area as good, while another qualifies the accessibility of the same area as bad. A good example of this is the accessibility of the city center in Amsterdam. If someone travels by car from The Hague to Amsterdam's city center, the accessibility of it, especially in the rush hour, is generally not perceived good. It is likely that these motorists between The Hague and Amsterdam get jammed and also on the Amsterdam road motorists will encounter delays. At the same time the inner city is known for its wide range and variety of shops. For these retailers it is lucrative to settle in the center of Amsterdam because they attract sufficient customers. The number of customers that the retailers attracts, can be seen as a sign that the inner city is good accessible for customers (Perdonk et al, 2008).

What is the reason that accessibility is so important for (national) governments? The Dutch national government stated, in their structural view concerning infrastructure and environment (structuurvisie infrastructuur en ruimte), that to be competitive towards other countries, a good accessibility is essential to achieve this goal. Thereby, accessibility improves the livability of citizens (van Wee et al, 2001).

Furthermore, it is important to know how travelers experience accessibility, with in particular accessibility concerning parking. Accessibility can be divided into several components (Geurts et al, 2001). For car drivers, searching for a parking spot, their opinion about accessibility depends mostly on the search time for a parking spot. Discarding elements like traffic jams and reachability of the final destination. The main purpose of the national database parking facilities is to reduce the search time for car drivers. By doing this, the accessibility increases in a positive way. Research shows that there is a linkage between accessibility and trip generation (Geurts et al, 2001). These findings are rarely miscellaneous instead that accessibility always increases the amount of trips. In general, the accessibility of a destination improves when search-time reduces.

By providing parking information to car drivers, accessibility of the destination will increase because the travel time will be shortened. So in term of accessibility, for governments it is important to have a good provision of parking information to improve the accessibility of their municipality. Thereby the comfort of traveling for the car drivers will be ensured.

2.3 Parking and search behavior

This paragraph will explain in detail the development of parking policies in the Netherlands and thereby, describes the problems concerning of parking searching behavior.

2.3.1 Parking in general

These days it is impossible to imagine a Dutch street without cars parked in it. In 2002 the Netherlands has to deal with about 6.7 million passenger cars and another million trucks. The biggest part of the day these vehicles are parked. Estimation in the Netherlands is that there are around 8.9 million public parking and also many private parking spaces for residents and businesses (Parkeren in Nederland, 2002).

Parking plays a prominent role in Dutch society. It forms one of the cornerstones of the municipal traffic and transport policy. Municipalities aspire to enlarge the accessibility, liability and vitality of their town. Ever since the introduction of car ownership in the Netherlands, it proved to be a difficult task, especially because the interests of residents, visitors, businesses and retailers are often diametrically opposed at this point (CROW, 2004). Thereby, other spatial problems have an impact on the policies concerning parking. The increase of car traffic and the decrease of available land for parking spaces needed to park cars forces municipalities to regulate both car traffic and parking in urban areas. In recent years, parking has become an important part of governments' mobility management programs (Van Der Waerden, 2012; CROW, 2007).

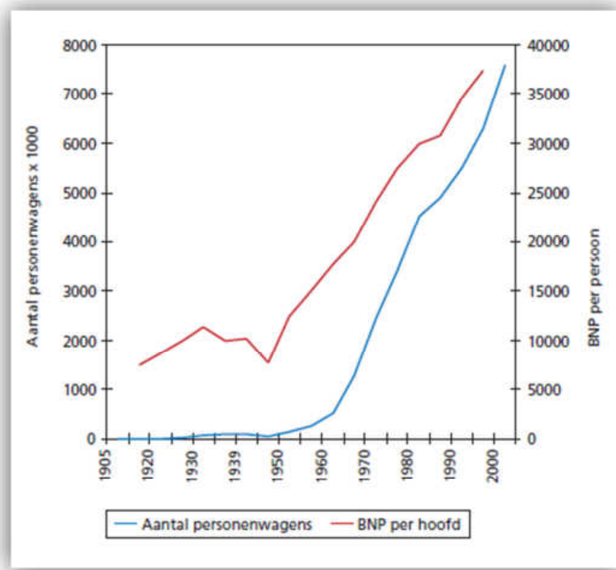

Figure 3: Rise of car-ownership in the Netherlands (CROW, 2007)

Before the Second World War, the use of a car was a rarity. The bicycle was the national mean of transportation. In the sixties, car use becomes to play a significant role. The number of cars increased explosively, in 1960 there were only 522,000 cars in the Netherlands, in 1970 there were nearly five times as much cars: nearly 2.5 million (CROW, 2004) This is also displayed in Figure 3. This figure shows the growth of cars over the years. In the seventies and eighties, the number of cars increases rapidly. Initially the car was a luxury, but soon it was a natural possession of all classes in the Dutch society. Gradually, a second or even third car per household became common. Through this, car ownership still continued growing in the nineties. Around the Millennium, the Netherlands had almost as many cars as households (CROW, 2004).

Due to increasing use of the car, parking became a growing social problem. Inner cities did not have enough facilities to satisfy the need of parking and became more and more inaccessible for cars. In order to tackle this problem the government, provinces and municipalities came with various types of parking policies in the last decades. CROW (2004) distinguishes three types of policies that are implemented in successive periods:

a) **Question based parking policy:** The sixties were marked by the explosive increase in the number of cars. This strong growth was then not considered as a serious problem, but rather as an expression of the long-desired economic growth. With no doubt parking may hinder the accessibility of the city. The slogan was therefore to continue to the meet of the growing demand for parking spaces.
b) **Guiding parking policy:** In the early seventies the negative aspects of the increasing use of the car becomes more a national problem, results in a different approach of the national government. The spectacular growth of car use was gradually seen as a threat that had to be curbed. There was more focus on the threats of traffic on the urban environment, such as air pollution and noise. With a guiding parking policy the

government wanted to stimulate people's awareness in their choice of mean of transportation.

c) **Integrated parking policy:** In the nineties the controlling/guiding measures proved not to be appropriate against the continued growth of car use. A new period of parking policy was inaugurated. With integrated parking, parking solutions are not only found in the instruments themselves. The individual parking arrangements and facilities are part of an integrated approach to the development of an area. So the ways in which mobility has to be facilitated in a particular is not only based on parking instruments themselves.

The question arises if the current practice of parking policy also offers sufficient perspective for the future, taking account with the further increase of car ownership. Research of CROW (2007) indicates several future problems:

- Poor utilization of inner city parking facilities;
- Shortage of parking in residential areas;
- More regulation of on-street parking, especially within smaller municipalities;
- Decrease of the Dutch population enhanced parking problems
- Governmental agencies gain problems between mobility policies and profitable operation of parking facilities;
- Investments for creating parking facilities getting to high
- Parking fees becomes too high
- Commercial parties are only interested in high profitable locations and facilities, governments can’t compete with them.

2.3.2 Parking search behavior

This paragraph will give more insight into the problem of search traffic: what causes this and what are the effects of these? Thereby a limited study will be done on why do car owners cruising around looking for a free parking space.

Most of the pollution that causes problems to the local environment is caused by local traffic. According to calculations by the Planbureau voor de leefbaarheid, Centraal bureau voor de Statistiek and the University of Wageningen traffic is responsible for about 15% of total energy consumption in the Netherlands. In addition, nearly 47% of the total (fossil)fuel consumption accounts of passenger cars. These days, a non-negligible part of the total travel time can be spent for searching for a free parking lot. The search for parking spaces increases road congestion significantly (e.g. Gallo et al, 2011). We can call this kind of traffic search traffic, traffic that is arrived at their final destination and is searching for a free parking spot close to their final destination.

It is hard to define the amount of search traffic. Actually cruising for a parking space creates a mobile queue of cars that are waiting for parking space vacancies (Shoup, 1997). The problem is that these cars are mixed with other traffic that actually goes somewhere. Before most transport economist and city planners neglected it as a source of congestion because this kind of cruising is invisible. Nowadays, due to the still becoming stringent requirements concerning air pollution and CO_2 emissions this kind of congestion is investigated.

Governments took in the past several measures to reduce the amount of (polluting) cars in the municipality. Think of environmental zones, speed limits and so forth. Some researcher attempted to estimate the volume of cruising and the time to find a free parking facility/space (Shoup, 1997). It was estimated that between the 8% and 74% of traffic is generated by cruising for parking (e.g. Arnott et al, 2005; Shoup, 1997; Spittje, 2007; van Ommeren, 2011; Gallo et al,2011; Geng et al, 2012). It was also estimated that the average time to find a parking space is ranges between 3.5 and 14 minutes (e.g. Shoup, 1997; Gallo et al, 2011). Figure 4 shows the results of studies that have been carried out (Shoup, 1997). In this figure a distinction is made between the share of traffic cruising and the average search time. Notable in this figure is that the first studies already carried out in early 1900.

All this cruising for free parking spaces results into unnecessary consumption of fuels, with direct influence on the quality of air pollution. For example, it has been reported that over one year in a small Los Angeles business district, cars cruising for parking created the equivalent of 38 trips around the world, burning 47.000 gallons of gasoline and producing 730 tons of carbon dioxide (Shoup, 1997). Even if a car is looking for a short time for a parking space, this can create a surprising amount of traffic. If we look at a congested downtown were it takes three minutes to find a parking spot and the parking turnover is 10 cars a day for that space. Each parking space generates 30 minutes of cruising time per day. If we look further and determine the average cruising speed on 10 miles per hour, each parking space generates five vehicle miles travelled per day. On a year total this will be 1825 miles. Thereby this cruising adds to traffic that is already congested, it makes a bad situation even worse (Shoup, 1997).

Twentieth century cruising

Year	City	Share of traffic cruising (percent)	Average search time (min)
1927	Detroit (1)	19%	
1927	Detroit (2)	34%	
1933	Washington		8.0
1960	New Haven	17%	
1965	London (1)		6.1
1965	London (2)		3.5
1965	London (3)		3.6
1977	Freiburg	74%	6.0
1984	Jerusalem		9.0
1985	Cambridge	30%	11.5
1993	Cape Town		12.2
1993	New York (1)	8%	7.9
1993	New York (2)		10.2
1993	New York (3)		13.9
1997	San Francisco		6.5
2001	Sydney		6.5
Average		30	8.1

Note: The numbers after Detroit, London, and New York refer to different locations within the same city.
Sources: Simpson (1927), Hogentogler et al. (1934), Huber (1962), Inwood (1966), Bus+Bahn (1977), Salomon (1984), O'Malley (1985), Clark (1993a, b), Falcocchio et al. (1995), Saltzman (1994), and Hensher (2001).

Figure 4: Twentieth century cruising for parking (Shoup, 2006)

To understand the elements of cruising for parking it is important to know all the elements of a car trip. According to Gallo et al (2011), a car trip can be partitioned into the following parts:

- Walking trip between home and personal car (walking access time);
- On-board trip until destination zone (on-board time);
- Cruising for parking at destination (search time);
- Walking trip between parked car and destination (walking egress time).

For this case, it is interesting to understand all the elements which are related with the key-words search time. To understand this, it is important to know why people are cruising for parking and do not directly drive to a certain parking space/facility. In most cases, people are cruising for a parking space when their current place is occupied or too expensive and will search for a cheaper place. Drivers do not explicitly calculate whether to cruise or to pay, but several factors influence the decision. To help understand the car drivers' parking choice, consider the following variables (Shoup, 1997);

- Price of on-street parking;
- Price of off-street parking;
- Parking duration;
- Time spent searching for on-street parking space;
- Fuel costs of cruising;
- Number of people in the car;
- Value of time spent cruising;
- Walking distance between parking and final destination(s).

With these variables, it is possible to compare drivers' parking choices and give a good insight into the factors of choosing whether to cruise or to park.

Eventually we can conclude that search traffic is responsible for a certain amount of traffic congestion within urban areas. This results in effects on the environment. Besides it has effects on environment and health, all this 'search traffic' has a (indirectly) negative impact on the accessibility of citycenters. What causes economic implications for the region. This combination makes the problem of search traffic in recent years a very trendy/hot topic among Dutch municipalities. These days (local) governments should meet the still increasing stringent standards on the environment and health. On the other hand, the municipalities seek to be very happy when the accessibility of their municipality is ensured.

2.4 Parking guidance systems

In this paragraph, the working of parking guidance systems will be elaborated. Thereby, the effectiveness of these systems will be discussed.

Air pollution and emission of CO_2 causes several problems to health, livability and environment within municipalities. Research shows that local traffic is responsible for a large amount of these problems. Thereby a certain amount of all (local) traffic is search traffic, traffic that arrives at their final destination and starts searching/cruising for a free parking spot close to their final destination. Some research shows that between 8% and 74% of traffic is generated by cruising for parking (e.g. Arnott, 2005 et al; Shoup, 1997; Spittje, 2007; van Ommeren et al, 2011; Gallo et al,2011; Geng et al, 2012).

Governments implemented several measures to reduce air pollution and emission of CO_2 as much as possible. Examples of these measures are mobility management with parking guidance systems as a good example: cycling policy; cleaner and more efficient vehicles, carpooling; cleaner and more efficient supply-chain; sustainability in public transport; alternative fuels and parking regulation.

Due to the diversification of functions of cities and broadening of shop opening hours, urban areas suffer from an increasing amount of traffic. With this increasing amount of mobility, there is a still growing demand of parking space on-street and off-street (Jogems and Spittje 2005). In absence of enough free space and due to high costs, it is hard to expand parking capacities. Therefore a parking guidance system offers a solution. Municipalities start in the seventies with the implementation of dynamic route information systems, before static guidance systems were common. Advantage of these systems is the reduction are the amount of search traffic, with the indirect result reduction of air pollution, emission CO_2 and enlarge the accessibility of their municipality (Jogems and Spittje 2005).

In the beginning (early seventies) of dynamic parking guidance systems, it was only possible, to show a free/occupied status, due to the limited computing capacity of computers. Later on, in the nineties, a second generation dynamic parking information systems was developed. These new systems made it possible to present more accurate information concerning the amount of free parking spaces could be presented. In those days parking guidance systems are connected with several other systems, like systems for public transport (Jogems & Spittje 2005). It depends on the situation which system will be implanted, dynamic, static, or a combination of them. Nowadays, the systems display different types of information to drivers: information on the location of car parks, information on the direction or route to take to the car park, and information on the availability of spaces at the car park. The contents of space availability can be global (free or occupied) or detailed (the specific number of free spaces) (e.g. Van der Waerden et al, 2011).

Do these parking guidance systems actually influence drivers' behavior? Recently some is research is carried out about this effectiveness. The research showed a split view about parking guiding systems (e.g. Axhausen et al, 1994; Thompson et al, 1997; Spencer & West, 2004; Barzeele, 2010; Waerden et al, 2011). Spencer & West (2004) determined in their research the benefits that the government of San Jose was expecting of the deployment of a parking guidance system;

- More efficient use of existing parking spaces which reduces the need to construct new parking facilities;
- Assistance to the driver in finding the nearest available short-term parking garage;
- Provides an aid to orient persons unfamiliar to the area;
- Informs the traveler of the amount and location of available short term parking spaces;
- Reduces the amount of time motorists spend searching for available parking facilities;
- Reduces congestion and air pollution by lowering the number of drivers searching for a parking space;
- Increases garage occupancy, thus permitting an amortization of costs in a relatively short period of time.

It depends on the user if these benefits will be achieved, if the user does not use the parking guidance, the expectations will not be met. Full compliance with a system of static parking direction signing could lead to a reduction in average journey time of up to 25%. The potential benefits of a dynamic parking guidance system should be even greater (Bonsall & Palmer, 2004). Research showed that even 25% of the average total travel time of journeys to central urban areas is taken up in searching for a parking space (Bonsall & Palmer, 2004). This this could be up to 40% during peak congestion (Axhausen et al, 1994).

Recent surveys of parking guidance systems have indicated a broader range of studies and presented a range of percentages from 20% to 82% referring to awareness, appreciation, and use of parking guidance systems (e.g. Spencer & West, 2004; Waerden et al, 2011). Other research showed that parking guidance systems are recognized by a majority of the drivers but used only by a minority (e.g. Polak et al, 1989; Axhausen et al, 1994;Waerden et al, 2011). Notable is that this problem is well-known for more than twenty years. According to them, the low usage is because drivers' unwillingness to rely on the system completely. The influence of a parking guidance system decreases when car drivers became more familiar with the local situation (Bonsall & Palmer, 2004).

For the case of the national database parking facilities in the Netherlands, the success of parking guidance systems is an interesting part of the implementation of this database. The purpose of this national database parking facilities is to provide parking information in-car and pre-trip. This will be done by using the navigation system of the car or smartphone. The effects of the pre-trip provision of parking information do have the same results/effects as with parking guidance systems. The aim of both systems is to reduce search traffic. Interesting part for this new system is the drivers usage just like with a parking guidance system. Notable with this initiative is the full support of service-providers for this new way of parking guidance (Felici & Schurink, 2011).

2.5 Travelling and travel information

This paragraph will elaborate on the receptivity of travel information by car drivers. Travel information covers all information about transport facilities and services that a traveler can use to make her or his trip as convenience as possible (e.g. Van der Waerden et al., 2005). It is important to know that adequate information can optimize both search and travel time of the traveler (Grotenhuis et al., 2007). This holds especially when this information is provided pre-trip. Therefore the choice behavior regarding parking and travel information is important. Thereby, the purposes of each trip are further explained.

First of all, the need to travel can be defined to the need or desire to travel. In this context a distinction is made between desired trips and necessary trips. For example, work, school or healthcare are not always available at home, so people have to make a trip towards a certain location. Trips to friends and leisure are 'not necessary' trips and are called 'desired trips'. This is an important distinction within the need to travel.

Travel information can be divided in static information, dynamic information and real-time information (Grotenhuis et al., 2007). Travel information is not only about the content of the information: it also includes the conditions of the information and the composition of the information. When planning and undertaking a trip, travelers have different purposes to fulfill. These purposes are presumed to affect the tasks and decisions, and hence the information needs of a traveler, and can be assigned to three different stages of a journey, roughly in conformity with three location types (Grotenhuis et al., 2007):

- Pre-trip: The pre-trip stage is essentially the travel planning step, when the user prepares his/her future travel.
- Way-side: Wayside locations can be bus stops, stations, ferry docks, public transport centers, and park and rides. Among wayside locations, first stop locations and interchanges can be distinguished.
- On-board: On-board information consists of information provided inside a vehicle, and is always preceded by pre-trip information and wayside information.

When people make a trip a distinction can be made between familiar travelers, who frequently use public transport. On the other hand, there are unfamiliar travelers, who occasionally or never use public transport. It is important to know that familiar travelers usually know their itinerary so they do not need much information in the pre-trip stage; in contrast, unfamiliar travelers will have a high need for pre-trip planning. There are also other factors that determine customers' information needs, such as time of day or day of week, journey purpose, travel time and distance, and area type, and personal factors, such as person type (gender, age, education, job, disabled, etc.) and changes in individuals' travel over time (e.g. Balcombe et al., 2004).

Actually, looking back at the previous part, the most interesting and influenceable group, for the research project, are the unfamiliar travelers, who want their information real-time and pre-trip. It is an good starting point for elaborating the provision of parking information.

It is important to assume that travelers use information in a certain situation when the benefits of information compensate the cost of them. Basically, this is a form of uncertainty by the travelers. To be successful as a travel information service, reliability, availability, confidence and relevance are important aspects (Chorus, 2004).

As mentioned before, every trip has a different purpose. Hereby it is actually quite different to say which elements in information provision are important for travelers, because of the fact that each form of traveling, necessary versus desired, requires other information. In a study of Trendbox, commissioned by the Vexpan, eight different purposes of parking were distinguished: at home, at work, witch grocery shopping, with other kinds of shopping (clothing, shoes, etc.), when going out with family/friends/colleges, when visiting family or friends, when making a day trip and when one has to be somewhere for work (Goudkade and Snel, 2010)

It is important to specify the trip-purpose. Research carried out by Trendbox also investigated for each of the eight above mentioned travel specifications which factors are the most important for car drivers. It is notable that each of the different categories has another ranking in terms of importance. For example, Figure 5 and Figure 6 show this ranking. Figure 5 shows parking requirements with working and Figure 6 shows parking requirement when going out.

Actually, this is quite logical because every trip asks a different approach. When you park at home, it is important that it is cheap/free, safe and that you always have a free parking space. If you decide to go out to the nightclub, you are intended to park your car on a safe place but it do not care if there is asked for a parking fee. So, there are a lot off factors which influence parking decisions based on the type of trip the traveler is making.

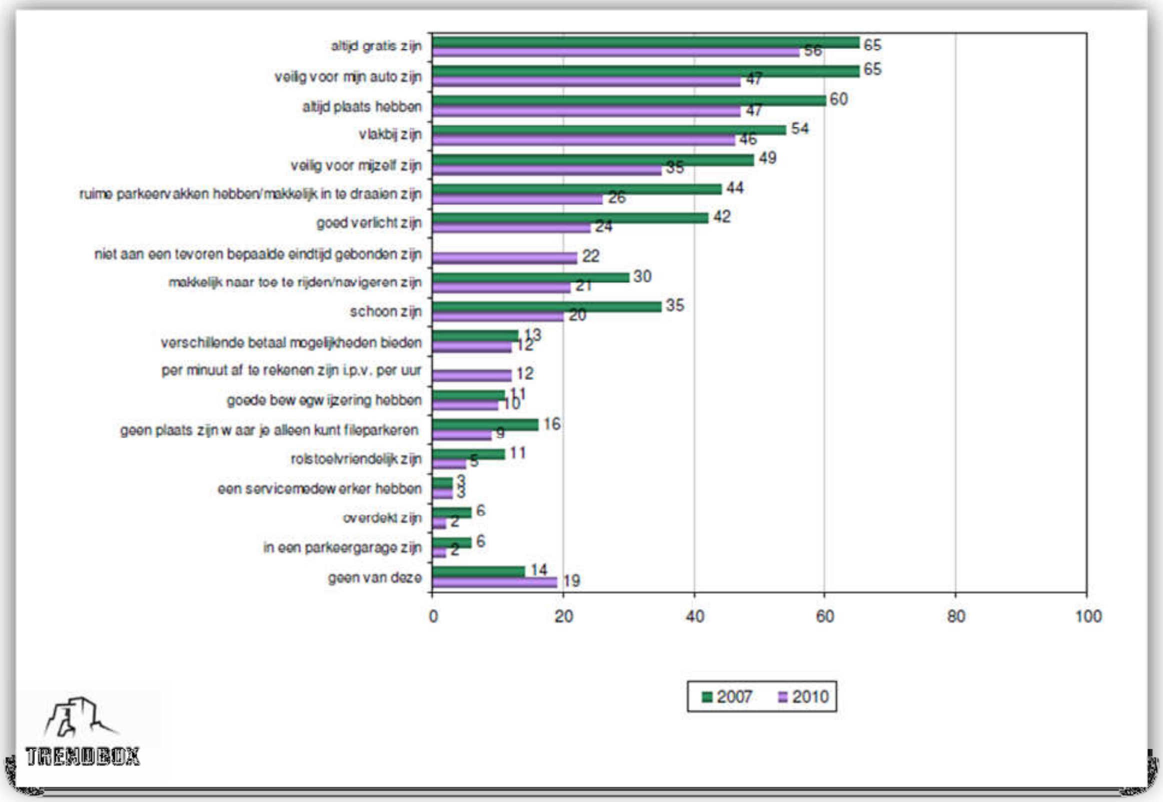

Figure 5: Ranking parking requirements at work (Goudkade and Snel, 2010)

In Figure 5 a ranking is given about parking requirements related to work, this is also done in Figure 6, in this case a ranking is given when people park their car when going out. The importance concerning the elements are visualized by ranking them and present the actual outcome from the questionnaire made by trendbox. For Figure 5. 'altijd gratis zijn' (always free), 'veilig voor mijn auto zijn' (safe place for my car) and 'altijd plaats hebben' (always a space available) are the most important factors. For the case in Figure 6 this is 'veilig voor mijn auto zijn' (safe place for my car), 'goed verlicht zijn' (sufficient lightning) and 'veilig voor mezelf zijn' (personal safety).

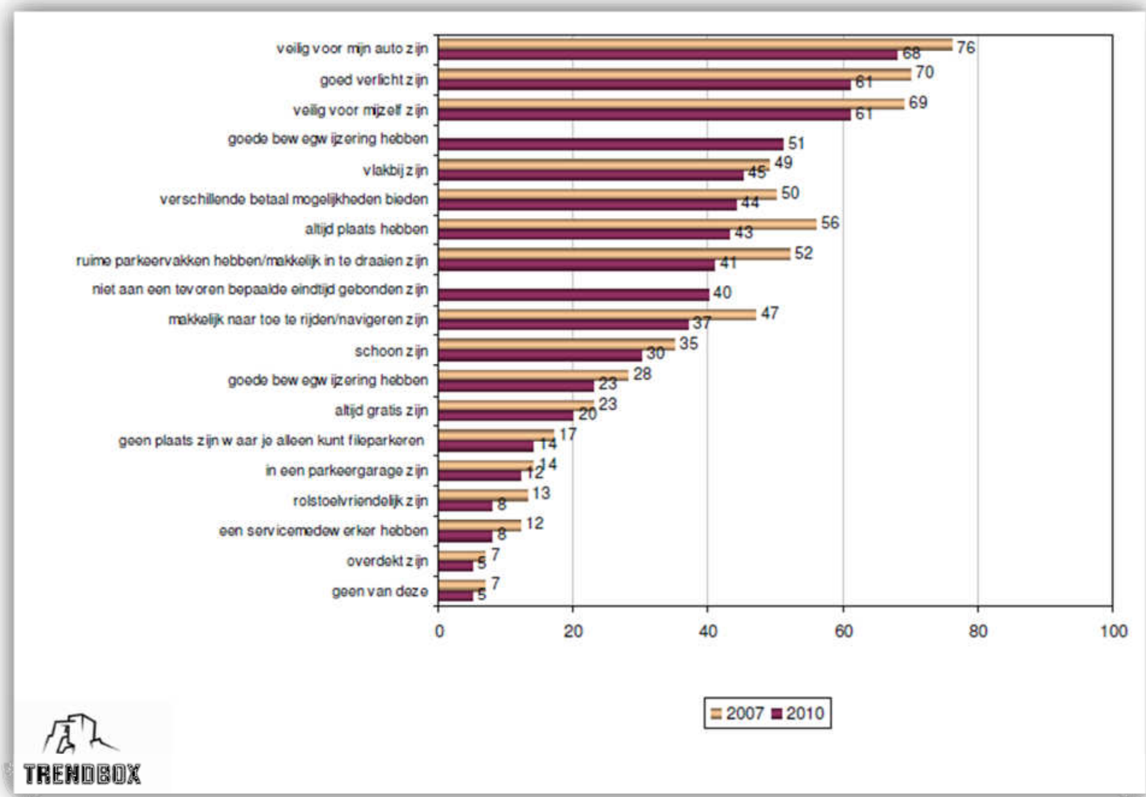

Figure 6: Ranking parking requirements when going out (Goudkade and Snel, 2010)

2.5.1 National database parking facilities

To guide travel information regarding parking, an initiative like the national database parking facilities is necessary. This initiative was established in the beginning of 2010 by the Dutch ministry of environment and infrastructure and supported by the Vexpan, a platform for parking in the Netherlands.

At this moment, a car driver needs to consult several websites or databases to obtain parking information. It is quite accidental when parking information is available in a navigation system. Service providers regarding navigation services are willing to add parking information to their current systems as an extra service. But they are withholded of it because the many parties involved. Cause they have to collect the data by each government or owner of parking facilities individual. When this data will be bundled, the providers are more interested towards it. So therefore stakeholders like governments and operators of parking facilities are willing to provide the necessary information.

Therefore the national database parking facilities is created. This initiative will collect all the data and distribute it to the service providers. Main advantage is that the service providers have one main database were they collect the data and the governments have outsourced this work.

2.6 Conclusion

The most important elements of parking information are now discussed. An initiative like the National Dutch Database Parking Facilities cannot be successful without a good identification of the (social) benefits of it. From the paragraph about sustainability it is obvious to conclude that a database will have many advantages towards sustainable goods. First of all the reduction of the emission of harmful gasses will lead to fewer problems to the environment. Indirectly this also affects local health problems as stated by studies named in paragraph 2.1. The implementation of the national database parking facilities will not only have influence on the environment. Also social benefits are obtained from this initiative. With less search traffic in urban areas, the accessibility and reachability of a certain destination increases, this results in a better economic position for that area.

Parking is a phenomenon which has developed itself during the years. In paragraph 2.3 this was discussed in relation to the problem of search traffic. For governments parking is a difficult aspect to deal with. Thereby, the parking behavior results into more search traffic within their municipalities. Research has showed that on average, about 30 % of the local traffic within inner cities is search traffic, most of them searching for a parking spot. In combination with other advantages this is the most important task to deal with for the national database parking facilities. Actually, the amount of search traffic could have a negative impact towards the accessibility of the destination which could result in a negative economic position of the destination.

The fourth part of this chapter is important because of the discussion about parking guidance systems. From these, lessons can be learnt for the implementation of the national database parking facilities. The awareness by car drivers is very important hereby, when elaborate a new initiative this would be one of the most important aspects. Thereby the fifth part of this chapter complements the study to the aspects concerning the development of the Database Parking Facilities. It is important to know what kind of person will be the target of the underlying study. For a car driver familiar with the destination, it is harder to convince them with the parking information than for unfamiliar people. Furthermore, most of the trips made by car are related to leisure activities. These trips require other information than work related trips.

Finally, providing real time parking information about parking facilities nearby the final destination of a car driver could have many advantages. These are related to sustainability, health, accessibility, and livability of urban areas. So, this initiative would be interesting for every stakeholder. The governments counter their problems towards the environment and development of their urban environment. Local businesses could attract more visitors and the owners of parking facilities could attract more visitors to their facility by accessing them more and better information.

3. Research approach

To gain data for this research project, a certain approach has to be adopted. First of all, it is important to select the required methods and techniques. This selection will be described in the second part of this chapter. Eventually, the technique stated choice with hierarchical information integration is chosen for the data collection. Multinomial logit modeling is used to analyze the outcomes of the data collection.

In the third part of this chapter, the way in which the data are collected will be explained in more detail. Firstly, the necessary attributes will be constructed on the basis of stated preference and hierarchical information integration methods and road maps. Later on, the actual questionnaire is constructed. In this paragraph, the idea behind the questionnaire will be explained.

To visualize all the steps necessary to complete the research project in the first paragraph the conceptual framework is presented. The conceptual framework gives a good representation of all important parts of the project.

3.1 Methods and techniques

To get insight into the appreciation of parking information elements a research approach is necessary. These days, there are several research methods and techniques available. All with the aim of collecting data and later on analyze these data sheets. Therefore, is it good to know at the starting point of the research which method will be the most suitable? In addition to the most suitable method of research, it is good to know which steps to use in collection and analyzing the research data.

In this chapter, several methods will be handled. These methods are chosen carefully to fit within the research design. Later on in this chapter, the method will be explained and also the reason why the method is suitable. For this research we will use a stated choice experiment for collecting our data. In combination this method use Hierarchical Information Integration will be used: it is a technique for structuring/clustering a large set of attributes within the data collection. Finally, discrete choice modeling will be used to analyze the derived data.

3.1.1 Stated Choice

With choice modeling, the model attempts to model the decision process of an individual or groups of individuals in a particular context. Within the world of choice modeling, stated preference or choice is a common used subset of choice modeling. The method of stated preference has several advantages seen from a practical standpoint. For example, in contrast to another widely used method, revealed preference. First of all, with stated preference experiments, the attribute levels are pre-specified by the analyst and given to the decision maker by the researcher as determined by some statistical design. Secondly, with stated preference data, respondents are usually shown multiple choice sets, each of which has different attribute levels (and possibly even different alternatives present, depending on the design). Thus for each respondent, we gain multiple observations over the number of choice sets completed (Henscher et al, 2005).

For stated preference, the foundation of each experiment is an experimental design. In scientific terms, an experiment involves the observation of the effect upon one variable, a response variable, given the manipulation of the levels of one more other variables (for more detail see Henscher et al, 2005).

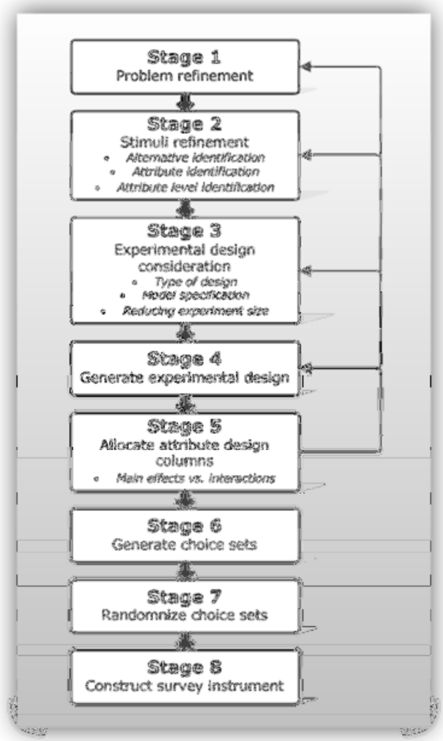

Figure 7: Road map choice experiments

Henscher et al (2005) described in their study the process of generating a stated preference experiment, see also Figure 7. First of all, this process begins with a refinement of the problem, to ensure that the analyst has an accurate understanding of what the research project hopes to achieve by the time of completion. Then, when the problem is well understood, the analyst is required to identify and refine the stimuli to be used within the experiment. It is at this stage of the research that the analyst decides upon the list of alternatives, attributes, and attribute levels to be used. This refinement may result into further scrutiny of the problem definition, and as a result a return to the problem refinement stage of the process. Moving from stimuli refinement, the analyst must now make several decisions as to the statistical properties that will be allied with the final design.

For the collection of data within this research project, this process for generating stated preference methods is very suitable. As an aside, not all steps will be necessary within our research project. Later on, in paragraph 3.3, when constructing the experiment this roadmap for choice modeling will be used with other techniques and methods.

3.1.2 Hierarchical Information Integration (HII)

Choice modeling experiments are often used to investigate preferences for several products and programs (e.g. Ryan et al, 2001). Stated preference method is a choice modeling experiments, in which respondents are requested to express preferences for sets of hypothetical choice alternatives constructed according to experimental design principles. However stated preference elements are often used, the method has a large limitation due to the inability to handle a large amount of potential influential attributes. Research shows that limitation of the amount of attributes has influence on several aspects of the experiment (e.g. Helvoort-Postulart et al, 2009).

First of all, people cannot process that many attributes at once, when the respondents have to handle large amounts of attributes they become tired and consequently they ignore or address attributes in random and uncontrolled ways. Secondly, excluding potentially significant attributes may bias estimates of utilities, reduce predictive validity and/or lower the value of the results.

Hierarchical information integration is an alternative method, to use more attributes than is possible with stated choice experiments. In this, hierarchical information integration categorizes the relevant attributes into meaningful subsets also known as constructs. This allows preference functions to be estimated ‘as if’ one full profile design had been administered, without the information overload of such a large full profile experiment (see Helvoort-Postulart et al, 2009). It is also important to know that hierarchical information integration models require the construction of two different experimental designs. First, a sub-experiment for each construct is required to measure the trade-off between the attributes defining that construct. Next, a bridging experiment is required to measure the trade-off between the decision construct evaluations to examine how the evaluations of the decision constructs are integrated into an overall evaluation of the decision alternative (Molin and Timmermans, 2009).

In studies of Molin and Timmermans (2009) and Helvoort-Postulart et al. (2009), a step-by-step plan is developed to carry out the hierarchical information integration. Molin and Timmermans (2009) use a five step plan while Helvoort-Postulart et al. (2009) use a six step plan to carry out the method. Actually, the step-by-step plan is in general similar to each other. The step-by-step plan of Molin and Timmermans (2009) will be further explained below:

1. The relevant attributes and attribute levels are selected.
2. The attributes are clustered into subsets. HII categorizes attributes into several non-overlapping subsets based on logic, empirical evidence or theory. Each subset represents a different high-order decision construct.

3. Separate experimental designs (sub-experiments) are constructed for each of the subsets, i.e. one experiment is designed for each of the decision constructs. Each sub-experiment includes a detailed description of one of the decision constructs in terms of the attributes that map into this decision construct. Each sub-experiment also includes the remaining decision constructs as additional design variables. Thus, experimental profiles describe alternatives as combinations of attribute levels and decision construct levels.
4. Individuals express an overall choice among two or more alternative profiles. Because each profile describes all aspects of an alternative that one assumes to be relevant to the respondents, the overall evaluations (choices) should provide information about respondents' utilities, regardless of which decision construct sub-experiment they take part in. One can preserve the orthogonally of the design by using a common, constant base alternative in all choice sets (Louviere and Woodworth, 1983).
5. The responses obtained in step (4) are usually analyzed with multinomial logit regression, assuming a linear additive utility function. Theoretically equivalent choice models can be estimated from responses to each sub-experiment. Furthermore, the separate sub-experiments can be concatenated to estimate all attribute parameters simultaneously.

In paragraph 3.3, were the data collection will be explained, the roadmap for Hierarchical Information Integration will be used. Hereby the roadmap from paragraph 3.1.1 can be merged with this one.

3.1.3 Discrete choice modeling

Discrete choice modeling is a research method to analyze collected choice data. The data can be collected in several ways. As mentioned before, to collect the necessary data for this research, a stated preference experiments is designed, with help of the hierarchical information integration method. In the past, several operational models have been suggested and applied in the context of individual choice behavior. These so-called discrete choice models differ in terms of operational decisions made with respects the specification of the utility function and error terms, if any (e.g. Van der Waerden, 2012). One of the most used and traditional models is the Multinomial logit model.

Compared with other choice models, the multinomial logit model is particularly attractive in many modeling scenarios due to the nature that it is linked to the decision-making behavior via maximizing (minimizing) the utility (e.g. Baibing, 2010). Furthermore, explaining the multinomial logit model, the model assumes that the random components are independently and identically double exponential (or Gumbel, see paragraph 4.2) distributed. The double exponential distribution is convenient because, in contrast to the normal distribution (e.g. Van der Waerden, 2012).

In paragraph 4.2, were the data analysis will be carried out from the data collection obtained as explained in paragraph 3.3, analysis will be done on the basis of multinomial logit modeling.

3.2 Data collection

As explained before, the data necessary for the ranking of the different information element within the world of parking were gathered using a questionnaire. In this chapter, were the collection of the data will be explained, the design of the questionnaire and the way of collecting the data will be treated.

In paragraph 3.2.1 and 3.2.2 an roadmaps for processing stated preference experiments and hierarchical information integration method are explained. In this part the choice modeling part will be elaborated. Overall, the way of constructing the questionnaire can be divided into two general parts. First, it is important to select the relevant attributes and attribute levels and the clustering of the attributes into 'constructs'. The second part is about designing the choice profiles and creating the real questionnaire.

3.2.1 Selecting the attributes

By providing car drivers information about parking facilities, close to their final destination, the drivers do not have to cruise around searching for a parking spot. This information can be provided pre-trip, during the trip or at the final destination. With the provided information, the user can choose were to park best. Of course with a for the user best selection criteria. This results in an decreasing amount of search traffic within urban areas. Indirectly, less traffic, ensures a decrease in emission of CO_2 and particulate matter and, it will improve the accessibility and livability of urban areas.

Several studies have been done on the effects of information provision in the context of parking (e.g. Khattak et al, 1993; Polak et al, 1993; Thompson et al, 1997; Paniati et al, 2007; Van der Waerden et al, 2010; Van Der Waerden et al, 2011). Information about occupation, tariffs, and, walking distance is most valued by the car drivers. Notable, the comfort of a parking facility is not treated in one of the studies. This will be an interesting part, within the provision of information, to investigate. For the developers of the national database parking facilities, it is important to know what information car drivers prefer to receive. This graduation project will treat this problem, with a focus on comfort within parking facilities.

Table 1 (Appendix A shows the same list with scientific evidence) shows elements that researchers investigated in their studies. Remarkable, parking costs, distance of parking facility to intended destination, capacity, parking time restriction, type of parking and chance of free space are mentioned very often. Mendat & Wogalter (2003) did some research into the perceptions of parking facilities. However, this study is about factors to consider when developing new parking lots or modifying existing ones. They identified five main factors, which could be useful for the current study,

1. Compliance and Visibility,
2. Layout and design
3. Safety and Crowding
4. Difficulties at Access points and environment,
5. Aesthetics.

Thereby, in the conference 'Doorbraak aan de Dommel' participants also set up a list of elements (Felici & Schurink, 2011). It is hard to implement these elements in the five above mentioned categories. Factors like walking distance, parking fee costs and level of occupation are high valued, as mentioned before. Actually, these factors are not distributable over those five main factors. Therefore, a new format has to be designed.

On the other hand, on the internet, there are several initiatives to provide parking information. Dutch websites like www.parkerenindestad.nl, www.parkeerlijn.nl and www.prettigparkeren.nl provide nationwide information about parking in major cities. The type of information provided by these websites varies enormously. For example, 'parkerenindestad' provides general information about parking. Information is given about tariffs, opening hours and locations of facilities. 'Prettigparkeren' also provides the same kind of information, but they display this in a map of the included cities, for example the city of eindhoven. Advantage of this is that it is possible to see the walking distance from a facility to the final destination. 'Parkeerlijn' is the most developed initiative. The website of 'parkeerlijn' also provides information about capacity, type of parking facility, payment options and moments, occupancy rate and special characteristics like maximum passage height. Furthermore it is possible to write a review of the visited facility and share this with future visitors. It is also possible to download the location data direct to your car navigation system.

Table 1 displays the elements of parking information derived from the literature study described in chapter 2. As stated in paragraph 3.2.2, stated preference method has a large limitation due to the inability to handle a large amount of potential influential attributes. Hence, it is meaningful to downsize the number of attributes, or search for a method that can help to create a manageable research design. Therefore we chose for the Hierarchical Information Integration method. It helps us to carry out a stated preference experiment, without the result that people have to process that many attributes at once.

Element	Element	Element	Element	Element
After transport	Electric charging point	Occupancy rate	Presence of a AED	Space to park motorcycle
Bad layout or design parking lots	GPS coordinates	Opening hours	Presence of ATM	Special days
Capacity	Handicap parking spots	Opportunity for reservation	Presence of bottle bank	Safety property (car etc)
Chance of free space	Hours when to pay	Parking guidance system in parking facility, directing you to a parking spot	Presence of Trolleys	The staff is first aid trained
Cleanliness	Lockers	Parking fee costs	Present of discounts	Toilet
Difficulty entering parking lot from street	Maneuverability limits of vehicles in parking lots.	Parking time restriction	Present of signs	Type of parking
Difficulty exiting parking lot to street	Maximum drive-through height	Personal safety	Range mobile phone/car navigation inside parking facility	Visibility
Difficulty to see pedestrians	Methods of payment	Poor aesthetics	Security	Walk ways for pedestrians
Distance of parking facility to intended destination / Walking time	Moment of payment	Poor design of lanes to drive across	Size parking spot	Security at entrance
Distance of parking spaces from entrance	Number of free spaces			

Table 1: List of parking information attributes

With hierarchical information integration it is possible to categorize the amount of attributes. This will be the second step in our process of selecting the attributes, creating the questionnaire, and collecting the data. Earlier in this chapter, several main factors concerning parking information are mentioned. Hence it is meaningful to use these. The categories in which the attributes will be designed are called 'constructs.'

As an aside, officially, structural equation modeling has to be used to classify the constructs and their attributes. Structural equation modeling is a modeling approach by which one can estimate a series of linked regression equations simultaneously (Molin & Timmersmans, 2009) . Advantage of this method is that it will classify the attributes to constructs. Therefore there an additional questionnaire is necessary. For this research project, related to the available period of time in were the project has to completed there is chosen to do not so.

The factors are redesigned into the following six constructs, based on the study of Mendat & Wogalter (2003);

1. Accessibility
2. Facilities
3. Safety
4. Location
5. Service
6. Occupation

The next step is to categorize the attributes into the above mentioned constructs. This is visualized in Table 2. Actually, to carry out a good survey, the amount of attributes per constructs is still too high. This amount of attributes per constructs still generates too many

Accessibility	Facilities	Safety	Location	Service	Occupation
Layout or design parking lots	Electric charging point	Personal safety	After transport	Hours when to pay	Capacity
Difficulty entering parking lot from street	Handicap parking spots	Presence of a AED	Distance of parking facility to intended destination / Walking time	Methods of payment	Chance of free space
Difficulty exiting parking lot to street	Lockers	Security	Location in relation to starting point	Moment of payment	Number of free spaces
Difficulty to see pedestrians	Poor aesthetics	Safety property (car etc)	Location on main road?	Opportunity for reservation	Occupancy rate
Distance of parking spaces from entrance	Cleanliness	The staff is first aid trained	(Shopping) (Leisure)Facilities nearby parking location	Parking fee costs	
Maneuverability limits of vehicles in parking lots.	Presence of bottle bank	Security at entrance	Below or above ground level	Opening hours	
Maximum drive-through height	Range mobile phone/car navigation inside parking facility		Off-street or on-street	Opportunity for reservation	
Parking guidance system in parking facility, directing you to a parking spot	Space to park motorcycle			Special days	
Poor design of lanes to drive across	Toilet				
Present of signs					
Size parking spot					
Type of parking					
Visibility					
Walk ways for pedestrians					

Table 2: Parking information attributes divided into constructs

choice tasks for a questionnaire. Even then the respondents cannot process that many attributes at once. As stated before, when the respondents have to handle large amounts of attributes they become tired and consequently they ignore or address attributes in random and uncontrolled ways. Hence downsizing the amount of attributes per construct is meaningful.

A more detailed study into those attributes shows that some attributes are almost identical/ similar to each other. Therefore merging the identical and similar attributes will deliver us the desired amount of attributes to carry out the experimental design. Table 3 shows this last step in selecting the attributes. Also in Figure 8, those attributes and constructs are visualized.

Accessibility	Facilities	Safety	Location	Service	Occupation
Layout or design parking lots	Electric charging point	Attendence security	After transport	Tariff	Capacity
Difficulty entering/ exiting parking lot from street	Handicap parking spots	CCTV in parking facility	Distance of parking facility to intended destination / Walking time	Methods of payment	Occupancy
Maximum drive-through height	Parking guidance system in parking facility, directing you to a parking spot	Walk ways for pedestrians	Type of parking/Off-street or on-street	Opening hours	Opportunity for reservation

Table 3: Final list of parking information attributes

The result of this chapter, were the hierarchical information integration approach is used to categorize the relevant attributes into meaningful constructs. The attributes are now categorized into six constructs based on a scientific background. For the respondents the number of attributes is manageable because they do not have to handle large amounts of attributes. This also affects the outcomes of the data analysis because when excluding potentially significant attributes it is possible that estimates of utilities reduce predictive validity and/or lower the value of the results.

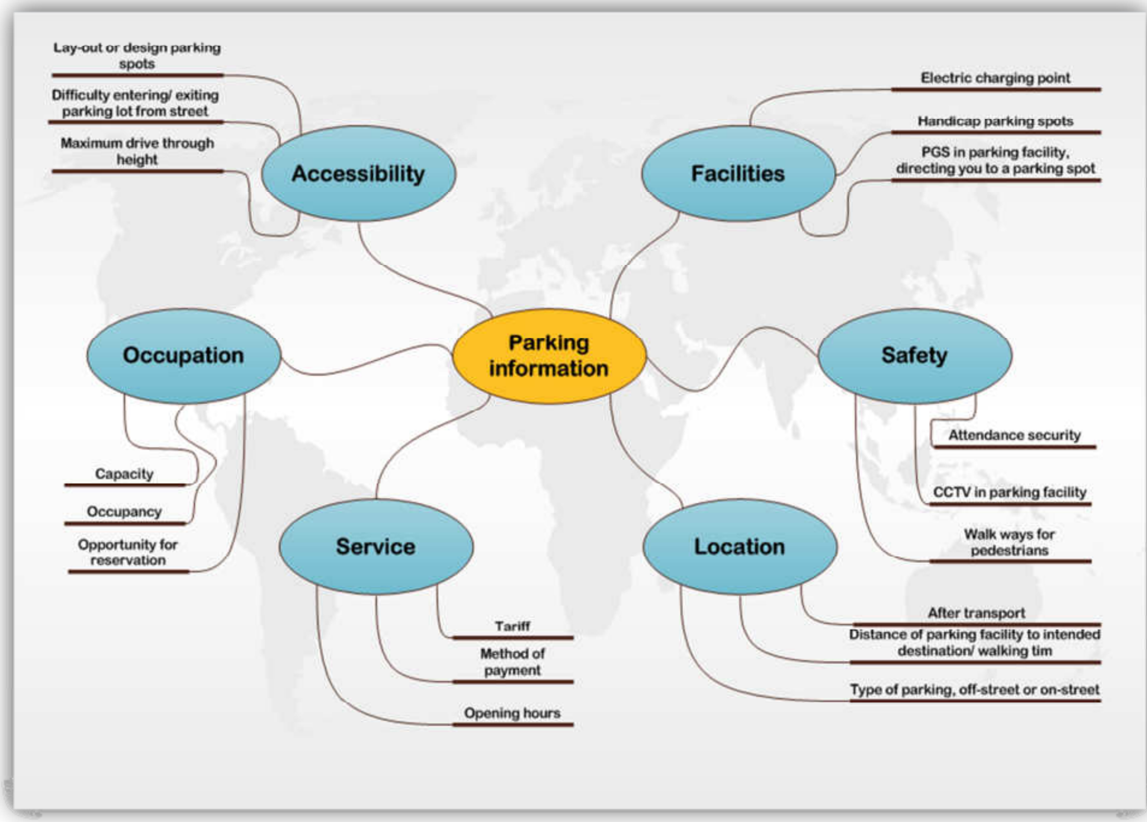

Figure 8: Relation of attributes and constructs with parking information

3.2.2 Experimental design

The construction of the questionnaire is the next step within the data collection process. Actually, before really start with constructing the questionnaire other tasks have to be carry out. The attributes, the amount of them and the way in which they are categorized are now known. Therefore, first the construction of the experimental design and the choice tasks are necessary.

Actually, now six different experimental designs were constructed to link the attributes of each decision construct to the high-order descriptions of the five other constructs. As we look to the construct 'Accessibility', see Table 3, than this construct describes different combinations of attribute levels representing the 'accessibility' construct. Thereby it is also important to describe the different combinations of levels of the remaining decision constructs (Facilities, Safety, Location, Service, and Occupation). Combining these two will leads to an enormous full fractional design. If we look to one sub-experiment, this experiment requires $2^3 \times 3^5 = 1944$ profiles. This is way too many for meaningful research. Therefore, a fractional factorial design is needed that consist of 27 profiles for each sub-experiment. By using SPSS, a statistical software program, this fractional factorial design is generated. The fractional factorial design is based on a design with only main-effects and without two stage or more interaction-effects. Otherwise, the amount of profiles would be higher. With randomization all the profiles were categorized into choice tasks with three choice sets. Randomization ensures a completely orthogonal design. For each choice task, three choice alternatives are represented. So, there are in total nine choice tasks per construct. Totally, this is still quite a lot. The respondent, now has to evaluate 54 choice tasks (6 constructs in total, 9 choice tasks per construct). Again this is still too many for meaningful research. Therefore, the decision is made to distribute those choice tasks among nine respondents. This means that each respondent will evaluate one choice task of each construct. With a total of six choice tasks, each from another construct. For respondents it is now manageable to handle the amount of attributes.

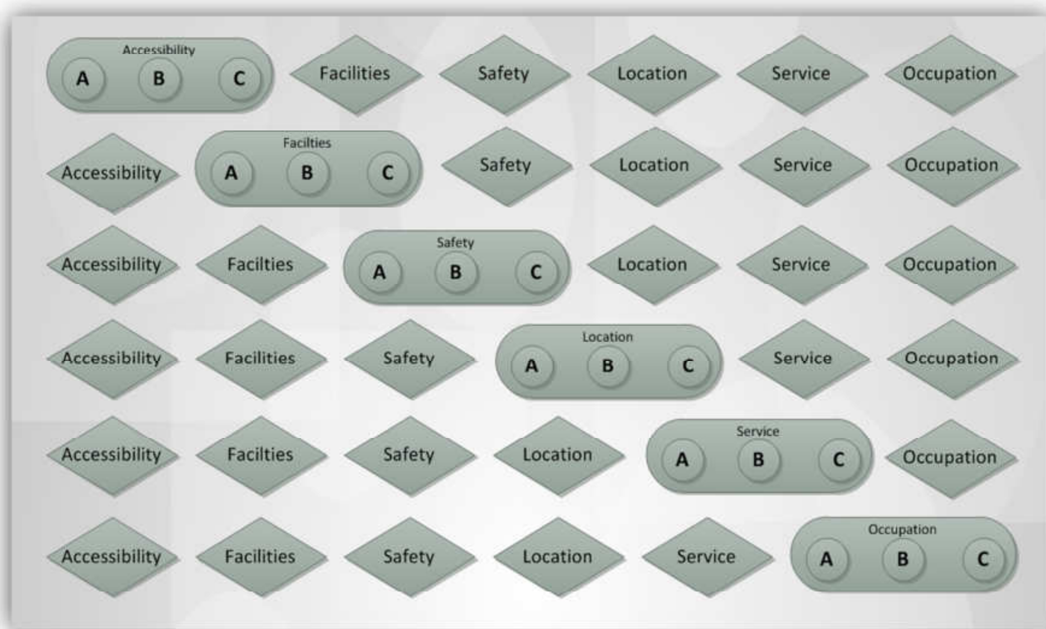

Figure 9: Design choice sets

Figure 9 visualizes in which order and how the detailed constructs are separated from the other constructs. In general all the constructs are elaborated in detail once. Respondents are asked to give three evaluations per choice task.

The main part of the questionnaire, the stated preference part, see Figure 10 and also the appendix, where the choice task is visualized, the respondents are asked to evaluate the choice alternatives. The total choice task is divided in seven different parts, visualized in Figure 10 with different numbers. In part 1 the choice task is introduced. Part 1 of the choice task is also about the specific choice task, in the case of Figure 10 task 31 about location.

First respondents are asked to evaluate, per choice set, the specific combinations of attribute levels that describe a particular decision construct, see 2 in Figure 10. The scale, of the attribute of the specific construct ranged from 1 ('information about this specific parking information attribute of this construct is available') to 2 ('information about this specific parking information attribute of this construct is not available'). Thereby, the respondents are asked to evaluate specific combinations of the remaining construct levels. For example when evaluating the attributes from the construct 'accessibility', the respondent is asked also to evaluate the other 5 remaining constructs (Facilities, Safety, Location, Service, Occupation) in more general terms, see also the third part in Figure 10. The scale of the other constructs is ranged from 1 ('information about this construct is limited available') to 5 ('information about this construct is more than highly available'). Eventually the respondents are asked to evaluate the specific choice set: they have to do this three times, because per choice task there are three choice sets, this will be done in part 2. In Figure 10, an example is given of a choice task, three choice task are presented in part 4. This part of evaluating the choice task is showed in question 1: 'Beoordeling Ligging' (review of location), see also the dark blue part. Here, the scale also ranged from 1 ('information about this construct is limited available') to 5 ('information about this construct is more than highly available').

In the second question, the respondents were asked to state whether they would choose choice alternative 1('informatiepakket 1'), choice alternative 2('informatiepakket 2') or choice alternative 3('informatiepakket 3') to support their parking decision making process, see part 5 in Figure 10. Finally, in question three the respondents are asked if they think, the chosen choice set will influence their behavior/decision making process, in Figure 10 the fifht part. The scale of the last question ranged from 1 (this package of information will barely influence my parking behavior) to 5 (this package of information will influence my parking behavior highly).

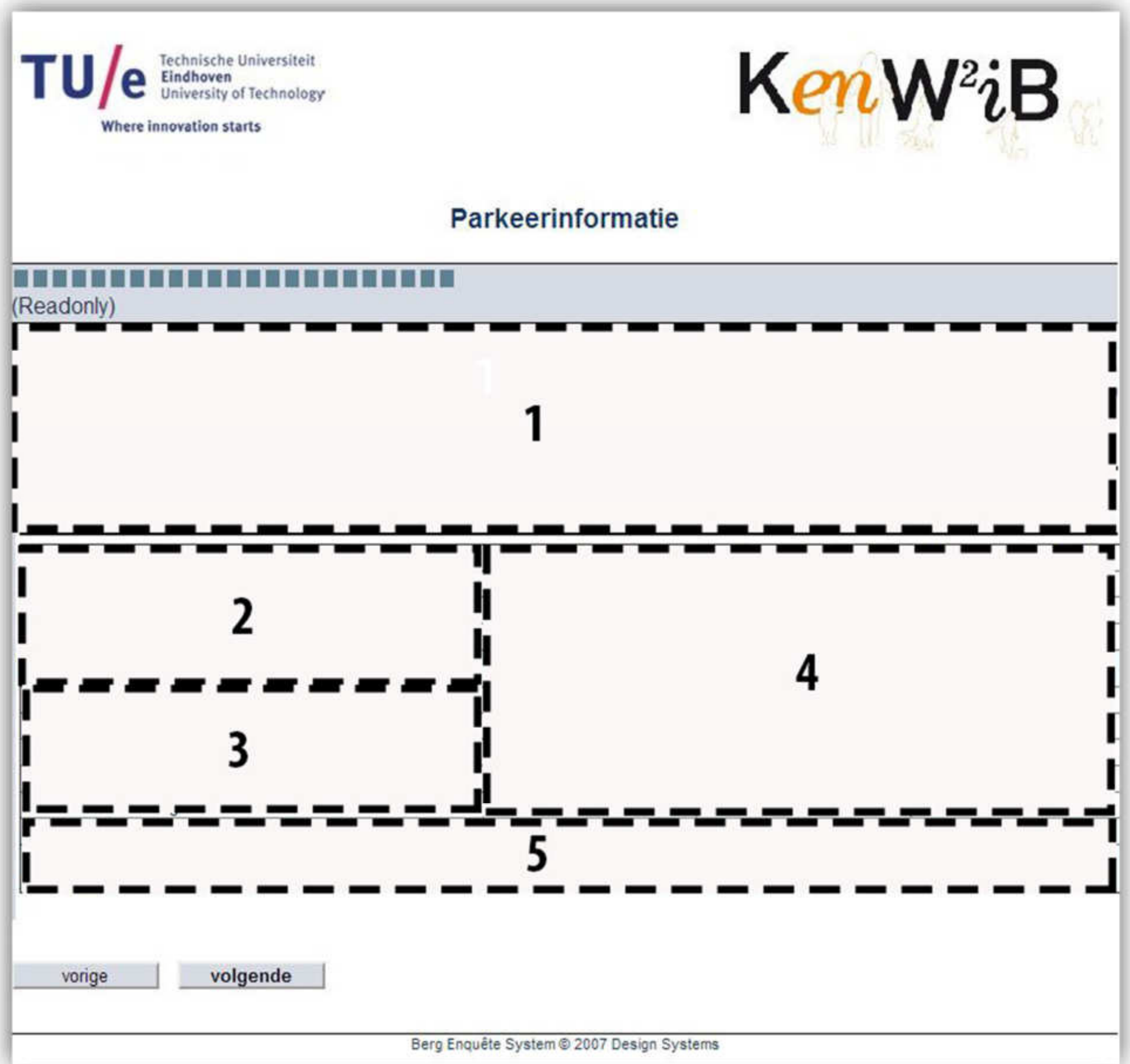

Figure 10: Example of a discrete choice tasks

Due to this way of constructing the choice tasks (see Figure 10), and randomization, it is ensured the questionnaire will have a completely orthogonal design. This is because of the inability for respondents to manipulate the questionnaire. It is hard to evaluate a certain attribute twice in the same way, or even completely different. Thereby, it is important to ask respondents only to complete one choice task of each construct.

3.2.3 Constructing the questionnaire

Previous the attributes are selected and the experimental design is made with the choice tasks. This part of the data collection chapter will handle the actual construction of the questionnaire, and present how the data are gathered.

A good design is important for a good and meaningful questionnaire. In paragraph 3.2.1 we designed the choice tasks with their specific choice sets. Now, it is important to translate this information to a good working questionnaire. Therefore, a questionnaire designing program is necessary. In this the BergSystem of the Eindhoven University of Technology is chosen. This software program is especially designed for use within the faculty of The Build and Environment of the University. Therefore, it is the most suitable program for this kind (stated preference) of research.

The questionnaire is divided into four parts. The first part is about the characteristics from the respondents, e.g. name, and date of birth. The second part, for this research project, the most important part, is about parking information preferences. The respondents are asked to evaluate and choose, out of three options, the most suitable parking information package. Hierarchical information integration and discrete choice theories are the basis for this part: see also paragraph 3.3.2 for more explanation. In the third part, information about the city of Zwolle is collected. Divided into a part where information of the respondents' visited to Zwolle is collected, and a second consisting of questions about respondents familiarity with parking facilities in Zwolle. Finally, the fourth part is about respondent' familiarity with the European Standard Parking Award. For the respondents it took about 15 minutes of their time to complete the questionnaire (see Appendix B for more details of the questionnaire).

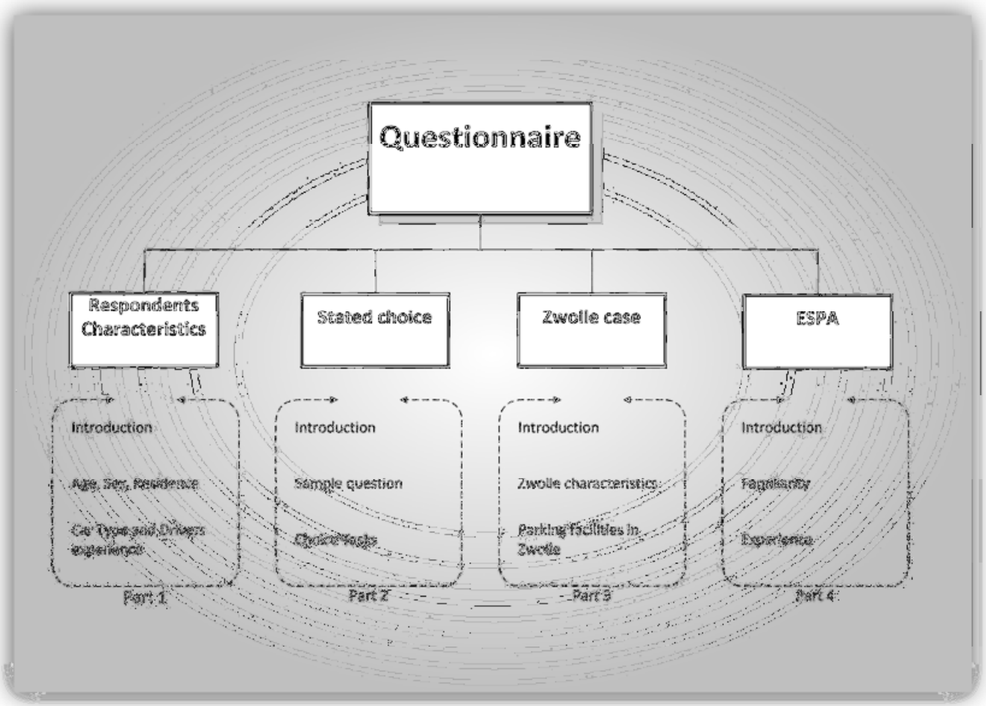

Figure 11: Structure questionnaire

To combine the theory of the provision of parking information with the practical world it was important to search for a suitable case study. Therefore, the city of Zwolle was chosen as case. By doing this, the respondent have relation with theory and a real case scenario. Resulting in a better outcome of the collected data because the respondents now compare their experiences with the choice sets and tasks provided in the questionnaire. Why did we choose Zwolle? Zwolle was noticed because of several publications regarding parking. On one side the Zwolle region is chosen because of the level of parking within the municipality of Zwolle. The inner city of Zwolle has a high standard of parking facilities. There are seven high standard off-street, indoor parking facilities in the inner city, see Figure 12. Those are well distributed amongst the inner city, providing a good accessibility. Thereby the local government of Zwolle play an active role in terms of parking policy. Furthermore the implementation of parking is further developed in Zwolle compared to other 'major' cities in the Netherlands (see for example, publications for the platform of knowledge traffic and transportation; 'Kennisplatform Verkeer en Vervoer'; Luipen, 2012) . Hence, it is interesting for this research project to ask those people how they experience parking and the provision of parking information.

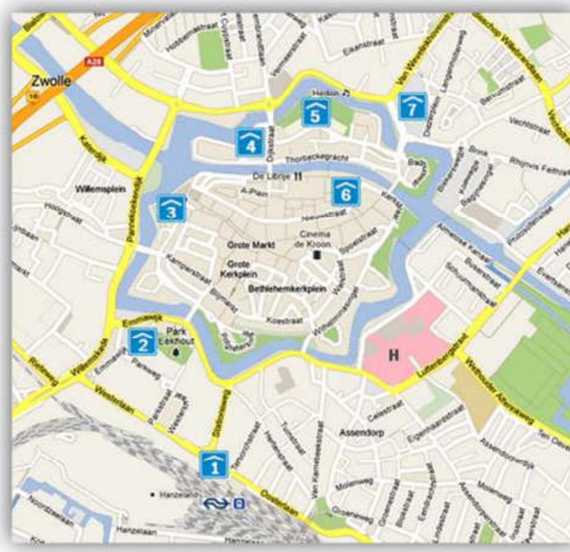

Figure 12: Parking facilities in Zwolle

Panelclix (www.panelclix.nl), an online fieldwork specialist carried out the data collection. This part is outsourced because of the high number of respondents and their specialism within online fieldwork. Panelclix offers a large database of respondents, for a certain price they provide us the necessary amount of respondents. In exchange for completing the questionnaire, the respondents receive a specific number of credits. Later on, when collected enough points respondents are able to select a gift from the Panelclix website.

Officially, the questionnaire was launched on the first of May 2013, the total number of 525 completes was reached on the 23rd of May 2013. Approximately 875 people started with the questionnaire, the amount of people invited for the questionnaire is around 1700, all living in the Zwolle region. Before launching the questionnaire, conditions about the respondents are set. They have to live nearby the city of Zwolle, with a maximum of 20 kilometers of travel distance. Secondly, the minimum age of the respondents has to be 18 years. Finally, ownership of a driving license is required. A good impression of the questionnaire is given in Appendix B.

3.3 Conclusion

In this chapter the questionnaire for the data collection is constructed. Therefore we used several methods and techniques, which were explained in paragraph 3.1. There is chosen for a combination between a stated choice experiment and hierarchical information integration because of the amount of attributes. For the analysis multinomial logit modeling is chosen because it is one of the most used methods for analyzing this kind of choice data.

In paragraph 3.2.1 the amount of attributes is reduced from 47 to 18, which are divided and categorized into 6 constructs. From this point of view a questionnaire is built. Within this questionnaire information is gathered regarding the respondent characteristics, parking information preferences and information concerning travel and parking behavior in the Zwolle region. Later on, in chapter 4, the results of the data collection will be analyzed.

4. Analysis

In the previous chapter, the methods and techniques are explained. Thereby the construction of the questionnaire is described. At this point, the required data for further elaboration is obtained. Analysis can be divided into two parts: first the research sample will be described. In the second, part the choice data will be analyzed. From the outcome of this analysis, it is possible to say which information is the most preferred by car drivers when making the choice of a parking facility. The outcome about the parking information preference can be divided into two parts, about the constructs and about the attributes per construct.

Only the analyses of the respondents' characteristics and the parking information preferences are included in this report. The other parts are not analyzed because of lack of time within the graduation project. Further on, the database is very useful for further investigations. This chapter will only include the most important parts of the analysis. Later on it is possible to combine the outcome of this part with the respondents' evaluations of the Zwolle case. Thereby, it could be interesting to relate and combine both outcomes.

4.1 Sample description

The analysis of the data is the most important part within the research project. As explained in chapter three, this research is divided into two main parts, discrete choice experiments and choice modeling. In this paragraph of the report, information about the respondents characteristics is given. Important in this is the question whether the respondents are well distributed across the distinguished levels of the characteristics and attributes age, sex, education, travel distance from the inner-city of Zwolle, drivers' experience, and type of car. As explained in paragraph 3.3.3, the total amount of respondents who completes the questionnaire is 525. They were obtained through an online questionnaire carried out by Panelclix.

Characteristics	Level	Distribution of respondents *Sample*	*Local average*
Sex	Male	40,4 %	49,8 %
	Female	59.6 %	50,2 %
Age	< 20 years	1,7 %	24 %
	20 - 45 year	56,4 %	34 %
	45 - 65 years	35,2 %	27,3 %
	> 65 years	6,7 %	14,7 %
Education	Elementary School	0,2 %	6,1 %
	High School (v(m)bo, lts, lbo, huishoudschool)	6,8 %	7,1 %
	Selective secondary education (mavo, (m)ulo, havo, vwo, hbs)	26,3 %	35,6 %
	Community college (mbo, mts)	30,9 %	21,2 %
	Bachelor University (hbo, pabo, hts, heao)	27,5 %	13,2 %
	Scientific education (University, Phd)	8,2 %	6,8 %
	Anders	0,4 %	0,6 %
Travel Distance[1]	< 5 km	46,7 %	- %
	5 - 15 km	44,9 %	- %
	> 15 km	8,4 %	- %
Drivers' experience[1]	< 3 years	8,4 %	- %
	3 - 5 years	4,2 %	- %
	> 5 years	87,4 %	- %
Type of car[1]	Small, e.g.: Toyota Aygo, Peugeot 107, Renault Modus, ...	27,2 %	- %
	Average, e.g.: Peugeot 307, Renault Megane, Toyota Auris, Citroën C, ...	45,1 %	- %
	Large e.g.: Peugeot 508(SW), Renault Laguna, Mercedes B-Klasse, SUV, ...	18,4 %	- %
	Minivan, e.g.: Peugeot Expert Tepee, Renault Trafic Passenger, Volkswagen Multivan, ...	1,5 %	- %
	Other	7,8 %	- %

[1] There is not national information/source available about this particular characteristic

Table 4: Characteristics of the respondents.

Table 4 visualizes the outcomes of the questionnaire concerning the characteristics of the respondents. An important note to this table is the incompleteness of the last column in the table. Local information about travel distance, drivers' experience, and type of care is not available. The other information about local characteristics is obtained from the Office of Statistics Netherlands (CBS.nl). They publish statistics which can be used in practice, by policymakers and for scientific research.

Comparing the characteristics of the respondents with the national statistics, some comments can be made. First of all, there is a difference between the proportion male/female. There is no clear cause for this difference, the only cause we can give is the difference of interest between male and females concerning social problems like sustainability and livability within urban areas. Additionally there is a significant deviation between the age distribution of the sample space and the national average. Actually this is quite logical, because the share of 20 years and younger people is almost zero in the sample space and one of the most important requirements is that respondents are minimal 18 years of age and are in the possession of a driver's license. Even the share of the category 65 years and older is lower than the local average. Probably older people are not that familiar with this kind of online research. But overall, the distribution of people amongst the age classes is well distributed, especially for the classes 20-45 years old and 45 – 65 years old. These are the most important age categories when looking to the current research.

Thereby, the distribution of the level of education amongst the respondents is almost equal with the national average. Noteworthy in these is the little shift towards the higher educated people compared with the national statistics. Most important in these is that there are results from respondents from every social class/ level of education within the region of Zwolle.

Furthermore, the average drivers' experience and type of car are distributed amongst the level as foreseen. These facts are important for further research, where the given opinion about choice tasks is compared to local characteristics. For now, the distribution for the travel distance, experience, and type of car is good for the distribution amongst the distinguished levels.

For respondents it was also possible to give their opinion/comments about the questionnaire. Almost 80 percent of the respondents did not use this option or answered with 'no'. the other who used this option answered with good questionnaire and other with it is too difficult for me. Thereby respondents also give comments about the Zwolle region, for example about the tariffs and facilities.

4.2 Choice behavior regarding parking information

Information about parking is gathered in the second part of the questionnaire. Primarily, this is the most important part in the research project. The goal of this part is to identify the most important construct for car drivers. In other words, which information construct does the car driver prefer the most. Thereby, detailed information on specific constructs is ranked.

To analyze the stated choices multinomial logit modeling is used. Therefore the NLOGIT 4.0 software package is used to process the choice data. NLOGIT is an extension of another very large, integrated econometrics package, LIMDEP, which is used world-wide by analysts of models for regression, discrete choice, sample selection, censored data, count data, models for panel data, etc. NLOGIT includes all of the capabilities of LIMDEP plus the package of estimators for models of multinomial choice, such as the multinomial logit, multinomial probit, nested logit, mixed logit and several others and, in addition, some tools for analyzing discrete choice models (Henscher et al, 2005).

As mentioned before, the model includes six constructs, each existing out of three attributes. In the questionnaire, respondents are asked to rate the constructs in a stated preference experiment. This based on the hierarchical information integration method (see also Helvoort-Polstulart et al., 2009). Formally, the utility model is expressed as follow:

$$U_i = V_i + \varepsilon$$

$$V_i = \beta X_{cj} + \gamma C_j + \eta_{ic} + \varepsilon_{jn}$$

c = construct i
i = alternative i

j = detailed construct i
n = number specific construct

In these equations U_i is the car drivers' utility for using a specific information package i. V_i is the respondent specific utility for the choice task. X_{cj} is a vector of the detailed attributes of construct c in profile j and β is a vector of parameters for the effects of these attributes on the consumer's utility. C_j is a vector of values of the constructs i that are not presented at the detailed level, and γ is a vector of parameters for the effects of these values on the consumer's utility. Finally, ε_{jn} is an error component in the utility function that captures, among other things, measurement errors on the part of the researcher. This error component is assumed to be Gumbel distributed and drives the logit probability structure. Normally a Gumbel distribution is used to model the distribution of the maximum (or the minimum) of a number of samples of various distributions. η_{ic} is a construct specific intercept correction in case that construct c is presented at the detailed level. With the mean η_c and random error component τ_{ic}.

$$\eta_{ic} = \eta_c + \tau_{ic}$$

For the multinomial logit model the equation as stated below is used.

$$P(J_i) = \frac{\exp(U_i)}{\sum exp\ (U_i)}$$

$P(J_i)$ Gives the expressions of the probability for alternative i. Therefore, the Utility U_i has to be compared with the overall utility $\sum U_i$.

Goodness of fit in statistical model describes how well the model describes a set of obeservations. The log likelihood ratio and Rho square method, are measurement to calculate the goodness of fit of choice models (Westeinde, 2011). They give an indication of how good the predictability is resulting from model.

The log-likelihood ratio statistic will be generated by the following formula.

$$\mathrm{D} = -2\ (\text{ Likelihood for nul model} - \text{likelihood for alternative model })$$

The Rho square will be generated by the next formula;

$$\rho^2 = 1 - \frac{\text{likelihood for alternative model}}{\text{likelihood for nul model}}$$

The measurements are chi-square distributed. For the statistics within the analysis a 95 % confidence interval is used. For the significance of an attribute this will be used. For the constructs all the values are included (no significance is considered as 'best guess').

4.2.1 Results

This paragraph elaborates how the obtained data is analyzed and the results will be explained. The results of the analysis by Nlogit, based on multinomial logit modeling can be categorized in two main parts. First of all, it was the aim find the most important construct. When parking information is provided to car drivers the question is which one is most preferred by them, and why, and why others not. Secondly, per construct the importance of the attributes is estimated by Nlogit. Why it is important to provide certain information about a construct and why not?

Before starting with the actual analysis of the data, data obtained from the questionnaire has to be translated to manageable data for analyses with Nlogit. A programmer's file editor has to be used to translate the raw data from the questionnaire. The problem in here is the method of data collected. In the questionnaire the respondents only gives for the total choice task three evaluations. So, only data are obtained about the evaluation of a choice set, the chosen choice set and the expected influence on their parking behavior. To make it possible to evaluate the constructs and attributes of the constructs the data has to be redesigned for further analysis. Therefore effect and dummy coding is used to translate this data. Eventually, all the data is linked to each other, making it possible to further analyze the data.

The goodness of fit for the statistical model has to be evaluated. Based on the outcomes of Nlogit software, see Appendix C, the following values of the Log-likelihood ratio statistic and the rho-squared statistic can be derived. Thereby, the formulas generated in the first part of this chapter can be used. For the null model (all parameters equal to zero) the value of -3480.4037 is used, and for the most optimal, alternative model the value of -2952.730 is used.

log-likelihood null model	-3480,41
log-likelihood alternative model	-2952,73
degrees of freedom	29,00
Probability level	0,05
log likelihood ratio statistic	1055,35
R-squared	0,15
Critical chi-squared ratio	42,56

Figure 13: The log likelihood statistic and Rho-squared

The results of the log likelihood ratio statistic and R-squared are shown in Figure 13. The number of degrees of freedom is fixed to 29 (equal to the number of estimated parameters.

Comparing the R-squared result with other similar parking research projects this result does not deviate compared to other research projects (e.g. Van der Waerden, 2012). As an aside, for the estimation of the R-square normally an aggregate approach is common, for this project there is chosen for an individual approach. Normally the outcome of the aggregate approach will have a better result. For the log-likelihood estimation, the log likelihood ratio statistic is 1055.35 with 29 degrees of freedom. Thereby, the critical chi-square ratio is 42.56, this resulting that the log-likelihood is much higher than the chi-square ratio indicating that the optimal model outperforms the null model.

Figure 14 gives an overview of the outcome of the model estimation with Nlogit. The figure displays two parts. The first part, in the top of the table, shows the results of the attributes per construct. Next, at the lower part of the figure, results from the constructs are shown.

From a top-down point of view, see also Figure 8, first the constructs will be elaborated. The outcome of the constructs is based on two variables. Both the coefficient of this construct, and its significance are given. In an earlier stage of the data collection there is chosen to create six constructs representing a certain part of the total parking information. In the second column of the table in Figure 14, two coefficients per construct are generated by Nlogit. These are called β_1 and β_2, based on the orthogonal design made earlier, see paragraph 3.3.2 those will be merged as result of the effect coding designed earlier. This is done with the following equations:

$$\text{Limited} = (1 \times \beta_1) + (0 \times \beta_2)$$

$$\text{Average} = (0 \times \beta_1) + (1 \times \beta_2)$$

$$\text{Broad} = (-1 \times \beta_1) + (-1 \times \beta_2)$$

The outcome of these equations will give the pathworth utilities of the constructs, based on, the levels of the construction limited, average or broad provided. In the figure, this is shown in lower part (Figure 14). Per construct the utility is shown based on the amount of information that is provided. The fourth column in that part shows the range between the lowest and highest utility. In here, it is possible to see what the results are when providing more information about a certain construct. In the last column, the ranking between the constructs is shown based on the highest utility and range of the specific constructs.

To make Figure 14 more understandable, the first attribute and construct will be elaborate. For the attribute lay-out or design parking lots in the second column the coefficient is given. In the third column the significance of the specific attributes is presented. In the fourth column, the ranking of the attribute for the specific construct is visualized. For the construct the first two columns are the same. Actually in column 5 to 8 the coefficients based on the above presented equations are calculated. In the last column the ranking of the constructs is presented

Attribute	Coefficient	Significance	Ranking for variables	Limited	Average	Broad	Range	Ranking for constructs
Lay-out or design parking lots	0,2459	0,002	2	-	-	-	-	-
Difficulty entering/ exiting parking facility	0,3910	0,000	1	-	-	-	-	-
Maximum drive-through height	0,1301	0,039	3	-	-	-	-	-
Electric charging point	0,0635	0,424	3	-	-	-	-	-
Handicap parking sports	0,1175	0,132	3	-	-	-	-	-
Parking guidance system in parking facility	0,1579	0,015	1	-	-	-	-	-
Attendence security	0,1496	0,068	3	-	-	-	-	-
CCTV in parking facility	0,4002	0,000	1	-	-	-	-	-
Walk ways for pedestrians	0,3392	0,000	2	-	-	-	-	-
After transport	-0,0108	0,898	3	-	-	-	-	-
Distance of parking facility to intended destination	0,0837	0,284	3	-	-	-	-	-
Type of parking, on-street or off-street	0,1834	0,003	1	-	-	-	-	-
Tariff	0,3772	0,000	1	-	-	-	-	-
Methods of payment	0,3574	0,000	2	-	-	-	-	-
Opening hours	0,2873	0,000	3	-	-	-	-	-
Capacity	0,2967	0,001	2	-	-	-	-	-
Occupancy	0,3937	0,000	1	-	-	-	-	-
Opportunity for reservation	0,0476	0,413	3	-	-	-	-	-
Accessibility	-0,3796 -0,1063	0,000 0,007	- -	-0,3796	-0,1063	0,4859	0,8655	2
Facilities	-0,1436 -0,0195	0,001 0,676	- -	-0,1436	-0,0195	0,1631	0,3067	6
Safety	-0,3194 0,0429	0,000 0,360	- -	-0,3194	0,0429	0,2765	0,5959	4
Location	-0,4021 0,1311	0,000 0,001	- -	-0,4021	0,1311	0,2710	0,6731	3
Service	-0,1842 0,2324	0,000 0,000	- -	-0,1842	0,2324	-0,0483	0,4166	5
Occupation	-0,5848 0,3636	0,000 0,000	- -	-0,5848	0,3636	0,2212	0,9484	1

Figure 14: Results on constructs and respondents

To visualize the change in utility, different graphs are made, see Figure 15. Per construct, the utility of a construct is shown by limited, average or broad information provision. Thereby, this way of presentation gives a good interpretation what happens with the utility when the amount of information provided by a service provider is changed.

Based on these two figures, Figure 14 & Figure 15, the first conclusion can be made. First of all, as we expected most of constructs are increasing, in an almost fluid line, when the amount of information provided also increases. Only by 'Service' and 'Occupation' this is not the case. Only after increasing the amount of information from 'average' to 'broad', the utility of the constructs 'Service' and 'Occupation' decreases. As information is compared, based on the range covered, 'Occupation' is the highest ranked constructs. This means that when information about this construct is provided limited and this will be changed into broad this has the highest influence on car drivers' preferences. For 'Facilities', this has the least influence on car drivers' preferences. Thereby it is remarkable to state than when broad information is provided about 'Service' this has a negative influence on car drivers preferences. Actually, when providing limited information about each construct this has a negative influence on the parking preferences. Only the increase of utility of a specific construct is higher compared to another.

Overall, the following ranking of most important constructs can be generated(number one is the highest ranked construct and number six is the lowest ranked construct):

1. Occupation
2. Accessibility,
3. Location,
4. Safety,
5. Service,
6. Facilities.

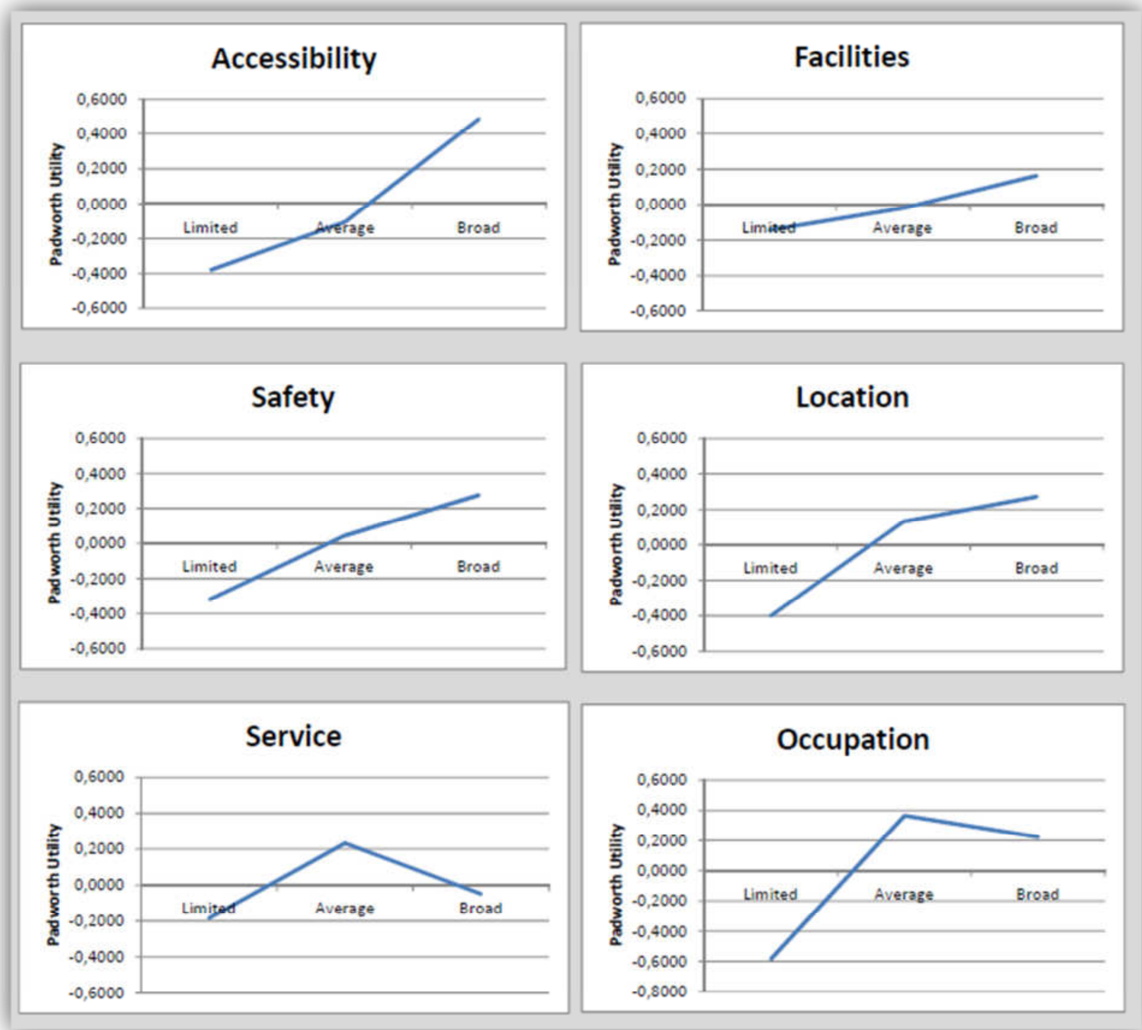

Figure 15: Path-worth utility and range of constructs

Furthermore, it is important to know which information of a certain constructs has to be presented. As elaborated in paragraph 3.3.1, per construct three attributes are chosen to represent the construct. From the previous part, a ranking of most important constructs is made. Thereby it is important to know, when information about a construct will be presented which information it has to be.

Figure 14 shows the results of the included attributes, this is visualized in the upper part of the figure. The outcome of this part consist of two values. The first value concerns the coefficient of the attribute and the second part concerns the significance of the attribute. In the third column of the figure, the most important attribute per set of three attributes is calculated. Again the 95 % confidence interval is used to identify significant parameters, when an attribute does not meet those requirements the attribute will be treated with an utility of zero.

Figure 16: Utility of attributes per construct

Furthermore, the results and values from Figure 14 are regenerated into graphs to visualize them. These are shown in Figure 16, in this figure, per construct the utility per attribute is showed. Based on the fact of information about this attributes is available or not available. From Figure 14, the outcome is translated via effect coding to this result. When information is available this has a positive effect, so the utility will be multiplied by one, when information is not available, the utility will be multiplied by minus one.

By treating each construct, the following can be concluded. First of all, the constructs 'Accessibility', 'Safety', 'Service' and 'Occupation' have high utilities of their attributes. 'Facilities' and 'Location' does not have that. Based on the values of the utilities showed in Figure 14 the attributes 'Difficulty entering exiting parking facility (construct Accessibility)', 'CCTV in parking facility (construct Safety)', 'walk ways for pedestrians in parking facility (construct Safety)', 'tariff (construct Service)', 'methods of payment (construct Service)' and 'occupancy (construct Occupation)' are in the general the most important attributes. In general it is important to provide information of one of these constructs also to provide information about this particular attributes.

The last question in the choice task was about the influence of the chosen choice set on the respondents parking behavior. Actually, there was asked if the respondents think if the chosen choice set will have a direct result on the choice behavior of car drivers regarding parking.

Frequency table effect of choicetask on parking behavior

Variable	Frequency	Percent	Valid percent	cumutalive percent
Totally not	130	4,1	4,1	4,1
Hardly	604	19,1	19,1	23,2
In a reasonable degree	1690	53,5	53,5	76,7
Highly	613	19,4	19,4	96,1
A very high degree	122	3,9	3,9	100,0
Total	3159	100,0	100,0	

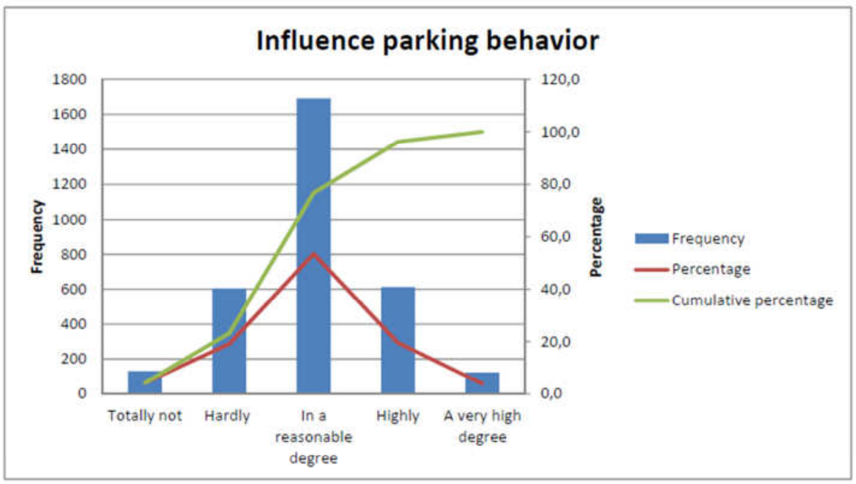

Figure 17: result influence choice set on respondents parking behavior.

Figure 17 displays the results of this last question. The graph shows that most of the respondents think the providing of parking information will help them with their parking behavior in a reasonable degree. Thereby, it is quite interesting to see the distribution of the variables. This distribution is almost equal to a statistical normal distribution. With these facts, it is possible to conclude that most of the respondents think that the provision of the available data will help them in their parking searching behavior in a reasonable degree.

4.3 Conclusion

In this chapter the analysis of the research project is performed. From this interesting results are obtained. As stated before, the analyses exist of two parts, the description of the sample, and the analysis of the parking information part with multinomial logit modeling.

It is hardly to say anything about the sample description; the outcome of this part of the analysis is almost comparable to the foreseen idea. When constructing the questionnaire requirements have set about the characteristics of the respondents, these are all met. So no further explanation is necessary.

The most interesting part, about the analysis of the choice task needs more explanation. First of all it is interesting to see which constructs and attributes are ranked the highest by the respondents. It is noteworthy to say that increasing the amount of information about service and occupation has a negative effect on car drivers' preferences. When providing information about parking facilities, information about Occupation and Accessibility will have the most influence on the decision behavior of car drivers. Thereby it is notable that information about service is not that important. Furthermore, information about the attributes CCTV in parking facility and occupancy will have the most influence when providing certain information about a construct. Respondents also think that providing parking information has influence in a reasonable degree on their behavior.

5. Conclusions

In the final chapter of this graduation report presents the conclusion about the project. Also some recommendations will be provided for further research. These recommendations will be made with respect to the practical and scientific field. Furthermore, in the first paragraph a summary about the research project is given. The second paragraph includes the general conclusion of the study. The third paragraph presents recommendation towards the major stakeholders and for further scientific research

5.1 Conclusion

This paragraph describes the final conclusion of this graduation study. To reduce the parking search behavior and indirectly reduce the emission of harmful gasses, provision of parking information towards car drivers is necessary. By informing car drivers about the characteristics of parking facilities nearby their final destination, they do not have to search for an acceptable parking place. It is therefore important to know which elements regarding parking information are the most valuable for car drivers. This graduation project deals with the problem of what parking information do car drivers prefer when searching for a free parking space. Therefore, two sub-questions are designed: (i) what information do travelers want to make an optimal parking choice, and (ii) do travelers adapt their behavior based on distributed information? The total project is mainly focused on developing a tool/instrument to measure car drivers preferences regarding parking information.

To collect and provide parking information, the national database parking facilities is introduced. At one end, the database contains data from the owners/operators of parking facilities and on the other side the database provides information towards service providers. For this initiative, the national database parking facilities needs to know which information is the most important in the car driver's decision process towards parking. This graduation project deals with this question.

Not only the reduction of the harmful gas emission is one of the benefits when providing parking information to car drivers. Also the provision of relevant information improves the accessibility of the destination, because visitors do not have to search for a parking spot which reduces their travel time. It also contributes to the livability of urban areas. Less search traffic means less emission of particulate matter. This will eventually lead to a better healthiness of the surrounding residents. The implementation of the national database parking facilities has many (social) benefits, making it that more interesting for governments and other stakeholders.

To get insight into the car drivers' preferences regarding parking information, a questionnaire is constructed to collect data. In this questionnaire several choice experiments were designed to obtain information about car drivers' preferences. A stated choice experiment was used to support the data collection regarding the preferences. Because the large amount of attributes, it was important to organize them in a manageable way. First, the attributes were selected based on a literature study. Later on, using hierarchical information integration, the attributes were categorized into constructs. By doing this, respondents will not be overloaded with information of a large full profile experiment. The questionnaire was completed by 525 respondents.

Multinomial logit modeling was used to analyze the obtained preference data. For this kind of research, it is one of the most used analyses techniques. By log-likelihood estimation, the goodness of fit of the model was tested. From calculations there was concluded the goodness of fit meet the requirements. Thereby, respondents' characteristics were analyzed, the distribution of the respondents amongst sex, age, educational level, car drivers experience and type of car was representative compared to the national average.

From the analyses of the car drivers' preference part, results were obtained concerning the provision of parking information. The provision of information about occupation and accessibility will have the most influence on car drivers' preferences. Thereby, it is important to know that information about the attributes 'Difficulty entering exiting parking facility (construct accessibility)', 'CCTV in parking facility (construct safety)', 'walk ways for pedestrians in parking facility (construct safety)', 'tariff (construct service)', 'methods of payment (construct service)' and 'occupancy (construct occupation)' are the most important when providing information about the construct related to the attribute.

In general, most of the respondents think that provision of parking information will help them with their parking behavior. Therewith, the last sub question of the research questions is answered.

5.2 Recommendations

Now the results and conclusions of this project are presented, it is possible to discuss how stakeholders can use the results of the project in practice. Besides this, other researchers can use the experiences of this research as starting point for further research. They also can just use the underlying numbers for their research. Because this project only deals with a certain part of the total problem concerning sustainability, in the future more research is necessary. Thereby, sustainability is still a hot topic amongst governments and other stakeholders. Furthermore, research concerning parking will be relevant for the next years, because parking will be more and more important regarding accessibility. So for this paragraph, first the meaning of this project for various stakeholders will be discussed. In the second part, recommendation for further scientific research will be given.

5.2.1 Recommendations towards stakeholders

For involved stakeholders, it is now possible to identify the most important information elements. This study shows the elements of information that car drivers prefer the most and might influence their behavior most. Therefore, for stakeholders involved with the national database parking facilities it is possible to implement these results in their initiative towards the provision of parking information. For the most important stakeholders different recommendations can be made.

Government

The government is one of the most important stakeholders in these. The problems concerning the investigated topic can be categorized for the government into two parts. First, in the near future, governments are obligated to publish all their information. For parking, it is now possible to say which type of information is important to provide to travelers in general and to car drivers in particular. Secondly, governments are facing several problems towards global heating, accessibility of urban areas and livability. Thereby, this initiative and way of information provision is an interesting tool when trying to reduce search traffic.

National database parking facilities

When the national database parking facilities will be deployed, several obstacles can occur. One of them is what information has to be provided. Due to this project, it is now knowable which kind of information is preferred mostly by car drivers in their decision making process. For the staff of the database, the outcome of this project could be used as a blue print for the further development of their initiative. Thereby, they can use the social benefits, from the literature study to convince governments to participate in this project.

Operators parking facilities

For operators of parking facilities, it is interesting to use the outcomes of this project. In advance, it is maybe not that interesting for them (why should I publish all my information?) because it could discourage potential visitors. On the other hand, there are many possibilities, for example the possibility for reservation of parking facilities. And more generally, the question: ‘How can I influence a car driver the most to park at my facility by influencing the provided information?’

For the stakeholders the following can be stated. First, further research can be done towards the way in which the information had to be provided. Thereby, as mentioned by the operators of parking facilities, it could be interesting to search for more possibilities to influence the behavior of the car driver regarding parking and the provision of parking information.

5.2.2 Recommendation for further scientific research

As already mentioned, this project could be used for further scientific research. For this, the next research suggestions are purposed.

Structural equation modeling edit

As stated in paragraph 3.2.1 for categorizing the attributes into constructs, a questionnaire needed to be carried out, based on for example structural equation modeling or factor analysis. By using a questionnaire, the respondents are asked to link the attributes to constructs. Because of the time limit of this graduation project this could not be done in time.

Presentation of parking information

At this moment, it is clear which information is preferred the most by car drivers. An important aspect of provision of parking information is the way how it is presented to travelers. Should it be done by parking guidance systems close to the roads, by route information systems like TomTom, or should it be provided in your smartphone by an app? These are important questions this report does not answer. For this specific question, the outcome concerning the contents of parking information could be useful.

The effect of parking information

In this research project, the preference of car drivers regarding parking information is examined. The effect of this information regarding behavior is collected but not examined in detail yet. Therefore, further research is necessary.

Directing car drivers due to parking information

As mentioned in paragraph 5.3.1, for stakeholders like operators and owners of parking facilities, it is interesting to know how it is possible to influence their visitors by specific kind of information provided by them. This could be also interesting for governments to direct the car drivers to a certain parking facility without deduct them for choosing for a facility. This can be done by providing specific information the car drivers needs to adapt their behavior.

Re-use of the data

For this graduation project not all the data is used, for further research it could be interesting to gain more information about car drivers' preferences in combination with the case of Zwolle. The most interesting part about this is that it is possible to present the preferences related to a geographical location. On the other hand, for this project multinomial logit modeling is used. For deeper analysis mixed multinomial logit modeling can be used. A more deeper and advanced technique which could relate and combine the data of the constructs and attributes.

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Appendix

Appendix A: List of parking information elements

Elements	Source(s)
After transport	Felici & Schurink (2011);
Bad layout or design parking lots	Mendat & Wogalter (2003); ESPA check list (2011)
Capacity	Van der Waerden (2011); Hunt & Teply (1993); Van der Waerden & Borgers (1995); MuConsult (1997); Matsumoto & Rojas (1998); Bonsall & Pallmer (2004); Harmatuck (2007); Van der Waerden et al (2010a); Felici & Schurink (2011);
Chance of free space	Van der Waerden (1995); MuConsult (1997); Van der Waerden et al (2010c); Felici & Schurink (2011);
Cleanliness	Mendat & Wogalter (2003); Hunt & Teply (1993); ESPA check list (2011)
Difficulty entering parking lot from street	Mendat & Wogalter (2003); ESPA check list (2011)
Difficulty exiting parking lot to street	Mendat & Wogalter (2003); ESPA check list (2011)
Difficulty to see pedestrians	Mendat & Wogalter (2003); ESPA check list (2011)
Distance of parking facility to intended destination / Walking time	Mendat & Wogalter (2003); Gillen (1978); Van der Groot (1982); Bradley et al.(1993); Van der Waerden & Oppewal (1995); Lambe (1996); MuConsult (1997); Matsumoto & Rojas (1998); Tsamboulas (2001); Bonsall & Pallmer (2004); Guan et al. (2005); Van der Waerden et al (2010c);
Distance of parking spaces from entrance	Mendat & Wogalter (2003); ESPA check list (2011)
Electric charging point	Felici & Schurink (2011); ESPA check list (2011)
GPS coordinates	Felici & Schurink (2011);
Handicap parking spots	Mendat & Wogalter (2003); Felici & Schurink (2011); ESPA check list (2011)
Hours when to pay	Felici & Schurink (2011);
Lockers	ESPA check list (2011)
Maneuverability limits of vehicles in parking lots.	Mendat & Wogalter (2003); ESPA check list (2011)
Maximum drive-through height	Felici & Schurink (2011); ESPA check list (2011)

Methods of payment	ESPA check list (2011)
Moment of payment	MuConsult (1997); Felici & Schurink (2011);
Number of free spaces	Felici & Schurink (2011);
Occupancy rate	Thompson & Bonsall (2007); Van der Groot (1982);
Opening hours	Felici & Schurink (2011);
Opportunity for reservation	Felici & Schurink (2011);
Parking guidance system in parking facility, directing you to a parking spot	Mendat & Wogalter (2003); ESPA check list (2011)
Parking fee costs	Mendat & Wogalter (2003); Van der Waerden (2011); Gillen (1978); Axhausen & Polak (1991); Bradley et al (1993); Hunt & Teply (1993); Miller (1993); Lambe (1996); MuConsult (1997); Matsumoto & Rojas (1998); Tsamboulas (2001); Bonsall & Pallmer (2004); Hess & Polak (2009); Guan et al. (2005); Harmatuck (2007); Van der Waerden et al (2010c); Felici & Schurink (2011);
Parking time restriction	Van der Groot (1982); Van der Waerden (1995); Van der Waerden & Oppewal (1995); MuConsult (1997); Felici & Schurink (2011);
Personal safety	Mendat & Wogalter (2003); ESPA check list (2011)
Poor aesthetics	Mendat & Wogalter (2003); ESPA check list (2011)
Poor design of lanes to drive across	Mendat & Wogalter (2003); ESPA check list (2011)
Presence of a AED	ESPA check list (2011)
Presence of ATM	Van der Waerden et al (2010b); Felici & Schurink (2011); ESPA check list (2011)
Presence of bottle bank	Van der Waerden et al (2010b);
Presence of Trolleys	Van der Waerden et al (2010b);
Present of discounts	Matsumoto & Rojas (1998); Felici & Schurink (2011);
Present of signs	Matsumoto & Rojas (1998); ESPA check list (2011)
Range mobile phone/car navigation inside parking facility	ESPA check list (2011)
Security	MuConsult (1997); Borgers et al. (2010); Van der Waerden et al (2010c); Felici & Schurink (2011); ESPA check list (2011)

Size parking spot	Mendat & Wogalter (2003); ESPA check list (2011)
Space to park motorcycle	ESPA check list (2011)
Special days	Felici & Schurink (2011);
Safety property (car etc)	Mendat & Wogalter (2003);
The staff is first aid trained	ESPA check list (2011)
Toilet	ESPA check list (2011)
Type of parking	Bradley et al (1993); MuConsult (1997); Matsumoto & Rojas (1998); Guan et al. (2005); Van der Waerden et al (2010c);
Visibility	Mendat & Wogalter (2003); ESPA check list (2011)
Walk ways for pedestrians	Mendat & Wogalter (2003); ESPA check list (2011)
Security at entrance	ESPA check list (2011)

Appendix B: Questionnaire

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Beste deelnemer,

Allereerst welkom bij deze enquête. Het onderwerp van deze enquête is **informatieverstrekking bij parkeren**. Deze enquête wordt uitgevoerd in opdracht van de Technische Universiteit te Eindhoven. Het gaat hierbij om een afstudeeronderzoek aan de master opleiding Construction Management and Engineering.

Het doel van de enquête is om inzicht te krijgen in de informatie die bezoekers van parkeergelegenheden willen gebruiken bij hun keuze voor een bepaalde parkeergelegenheid.

Het invullen van de enquête neemt ongeveer 15 minuten in beslag. Uw antwoorden worden anoniem verwerkt en niet aan derden beschikbaar gesteld.

Succes,

Tim Jansen
Student Technische Universiteit Eindhoven

Start enquête

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Algemeen

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Wat is uw geslacht?

- (•) Man
- ( ) Vrouw

In welk jaar bent u geboren?

1992

Wat is uw hoogst afgeronde opleiding?

- ( ) Basisschool/Lagere school
- ( ) Voorbereidend middelbaar beroepsonderwijs (v(m)bo, lts, lbo, huishoudschool)
- ( ) Middelbaar algemeen voortgezet onderwijs (mavo, (m)ulo)
- (•) Hoger algemeen en voorbereidend wetenschappelijk onderwijs (havo, vwo, hbs)
- ( ) Middelbaar beroepsonderwijs (mbo, mts)
- ( ) Hoger beroepsonderwijs (hbo, pabo, hts, heao)
- ( ) Wetenschappelijk onderwijs (universiteit, gepromoveerd)
- ( ) Anders

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Wat zijn de vier cijfers van uw postcode?

8091

Bent u in het bezit van een auto- of motorrijbewijs?

- (•) Ja
- ( ) Nee

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Sinds wanneer beschikt u over een rijbewijs?

2011

Wat voor soort auto heeft u?

- ( ) Klein Voorbeeld: Toyota Aygo, Peugeot 107, Renault Modus, ...
- (•) Middelmatig Voorbeeld: Peugeot 307, Renault Megane, Toyota Auris, Citroën C, ...
- ( ) Groot Voorbeeld: Peugeot 508(SW), Renault Laguna, Mercedes B-Klasse, SUV's, ...
- ( ) Minibusje Voorbeeld: Peugeot Expert Tepee, Renault Trafic Passenger, Volkswagen Multivan, ...
- ( ) Anders

namelijk:

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Parkeerinformatie

Introductie

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We willen uw reacties achterhalen met behulp van enkele vragen en denkbeeldige keuzesituaties. Het onderzoek richt zich op verplaatsingen naar het centrum van een stad.

Wanneer u met de auto naar een bepaalde locatie reist, kan het voorkomen dat u niet bekend bent met de aanwezige **parkeergelegenheden** in de omgeving van die locatie. Hierdoor kan het voorkomen dat u onnodig tijd spendeert aan het zoeken naar een geschikte parkeerplek. Naast dat u dit als 'niet prettig' kunt ervaren, veroorzaakt dit **zoekgedrag** ook congestie en extra uitstoot van CO^2 en fijnstof. Door u tijdig te informeren over parkeergelegenheden in de buurt van uw bestemming, kan de omvang van zoekverkeer verminderd worden.

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Het volgende onderdeel van de enquête gaat over informatieverstrekking over de parkeergelegenheden. Wij willen u enkele informatiepakketten voorleggen die u moet gaan beoordelen. Deze beoordeling bestaat in dit geval uit drie stappen (zie volgende pagina).

De informatie die beschikbaar is over parkeren, kunnen we eigenlijk al indelen in categorieën. Dit hebben we voor het gemak al voor u gedaan. Samen met verschillende soorten van informatie willen wij u deze categorieën laten beoordelen.

We hebben zes **categorieën van informatie** samengesteld:

1. **Bereikbaarheid:** informatie over de toegankelijkheid van de parkeergelegenheid
2. **Voorzieningen:**informatie over voorzieningen in de parkeergelegenheid zoals gehandicapten voorzieningen en toiletten.
3. **Veiligheid:**informatie over de veiligheid van de auto en u als persoon in de parkeergelegenheid.
4. **Ligging:**informatie over de locatie van de parkeergelegenheid ten op zichte van uw eindbestemming.
5. **Diensten:**informatie over de tarieven, betaalmethoden en openingstijden van de parkeergelegenheid.
6. **Bezetting:**informatie over de capaciteit en het aantal vrije plekken in de parkeergelegenheid.

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Middels een oefenvraag willen wij u kennis laten maken met dit onderdeel van de enquête. De vraag bestaat uit een tabel die u dient af te maken door uw mening in te vullen in de daarvoor aangegeven boxen. Kort gezegd is elke vraag bedoeld voor een specifieke categorie, in dit geval bijvoorbeeld **'bereikbaarheid'**. Over deze categorie wordt gedetailleerde informatie gegeven. Daaronder staan nog de overige vijf informatiecategorieën waarover globale informatie verstrekt wordt.

Zoals u kunt zien, worden er steeds drie informatiepakketten beschreven. Ten eerste wordt er in deze oefenvraag gedetailleerde informatie verstrekt over **'bereikbaarheid'**. Van deze gedetailleerde informatie wordt aangegeven of deze informatie wel of niet aanwezig is. Voor de overige categorieën wordt globaal aangegeven in welke mate er informatie over deze categorieën beschikbaar is.

Allereerst (**1**) willen wij u vragen om voor het bovenste deel van elk informatiepakket aan te geven of u de informatie: zeer beperkt, beperkt, gemiddeld, ruim of ruim voldoende vindt. Ten Tweede (**2**) willen wij u vragen welk informatiepakket u het meest geschikt vindt als u op zoek bent naar een parkeergelegenheid. Uiteindelijk (**3**) vragen wij u te beoordelen of u denkt of met dit informatiepakket het zoekverkeer verminderd wordt.

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OEFENVRAAG

Stel u gebruikt uw auto voor een **bezoek aan de binnenstad**. Om een geschikte parkeerplaats te vinden voor uw auto zijn de onderstaande informatiepakketten beschikbaar. Wij vragen u twee zaken aan te geven. Allereerst (1) willen we weten wat u vindt van de beschikbare informatie over de **Bereikbaarheid**. Daarna (2) willen we weten naar welk **informatiepakket** uw voorkeur uit gaat. Uiteindelijk (3) willen we van u weten of u denkt dat het geboden informatiepakket effect heeft op het **zoekverkeer**

Voorbeeld keuzesituatie: Over welk informatiepakket zou u willen beschikken bij de keuze voor een parkeerplaats?

Bereikbaarheid	**Informatiepakket 1**	**Informatiepakket 2**	**Informatiepakket 3**
Informatie indeling parkeergelegenheid	*Niet Aanwezig*	*Aanwezig*	*Niet Aanwezig*
Informatie toegankelijkheid parkeergelegenheid	*Aanwezig*	*Niet aanwezig*	*Niet Aanwezig*
Informatie doorrijhoogte parkeergelegenheid	*Aanwezig*	*Aanwezig*	*Aanwezig*
1. Beoordeling Bereikbaarheid	Voldoende	Gemiddeld	Beperkt
Informatie voorzieningen	*Beperkt*	*Beperkt*	*Ruim*
Informatie veiligheid	*Gemiddeld*	*Beperkt*	*Ruim*
Informatie ligging	*Beperkt*	*Gemiddeld*	*Ruim*
Informatie diensten	*Ruim*	*Gemiddeld*	*Beperkt*
Informatie bezetting	*Beperkt*	*Ruim*	*Ruim*
2. Uw keuze voor informatiepakket:	○	○	◉
3. Denkt u dat het informatiepakket u helpt bij het verminderen van zoekverkeer?		In redelijke mate	

vorige | **volgende**

Deze vraag was een oefenvraag. We hopen dat u met de informatie die u gekregen hebt en de ervaring uit de oefenvraag nu de **volgende 6 vragen** kunt maken .

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Stel u gebruikt uw auto voor een **bezoek aan de binnenstad**. Om een geschikte parkeerplaats te vinden voor uw auto zijn de onderstaande informatiepakketten beschikbaar. Wij vragen u twee zaken aan te geven. Allereerst (1) willen we weten wat u vindt van de beschikbare informatie over de **Ligging**. Daarna (2) willen we weten naar welk **informatiepakket** uw voorkeur uit gaat. Uiteindelijk (3) willen we van u weten of u denkt dat het geboden informatiepakket effect heeft op het **zoekverkeer**

Keuzesituatie 31: Beoordeel de informatiepakketten en over welk informatiepakket zou u willen beschikken bij de keuze voor een parkeerplaats?

Ligging	**Informatiepakket 1**	**Informatiepakket 2**	**Informatiepakket 3**
Informatie na-transport	*Niet aanwezig*	*Niet aanwezig*	*Aanwezig*
Informatie afstand tot eindbestemming	*Aanwezig*	*Aanwezig*	*Niet aanwezig*
Informatie manier van parkeren	*Aanwezig*	*Niet aanwezig*	*Niet aanwezig*
1. Beoordeling Ligging	Gemiddeld	Beperkt	Beperkt
Informatie bereikbaarheid	*Ruim*	*Ruim*	*Ruim*
Informatie voorzieningen	*Beperkt*	*Gemiddeld*	*Ruim*
Informatie veiligheid	*Gemiddeld*	*Ruim*	*Beperkt*
Informatie diensten	*Gemiddeld*	*Beperkt*	*Gemiddeld*
Informatie bezetting	*Beperkt*	*Gemiddeld*	*Beperkt*
2. Uw keuze voor informatiepakket:	○	●	○
3. Denkt u dat het informatiepakket u helpt bij het verminderen van zoekverkeer?		Nauwelijks	

vorige **volgende**

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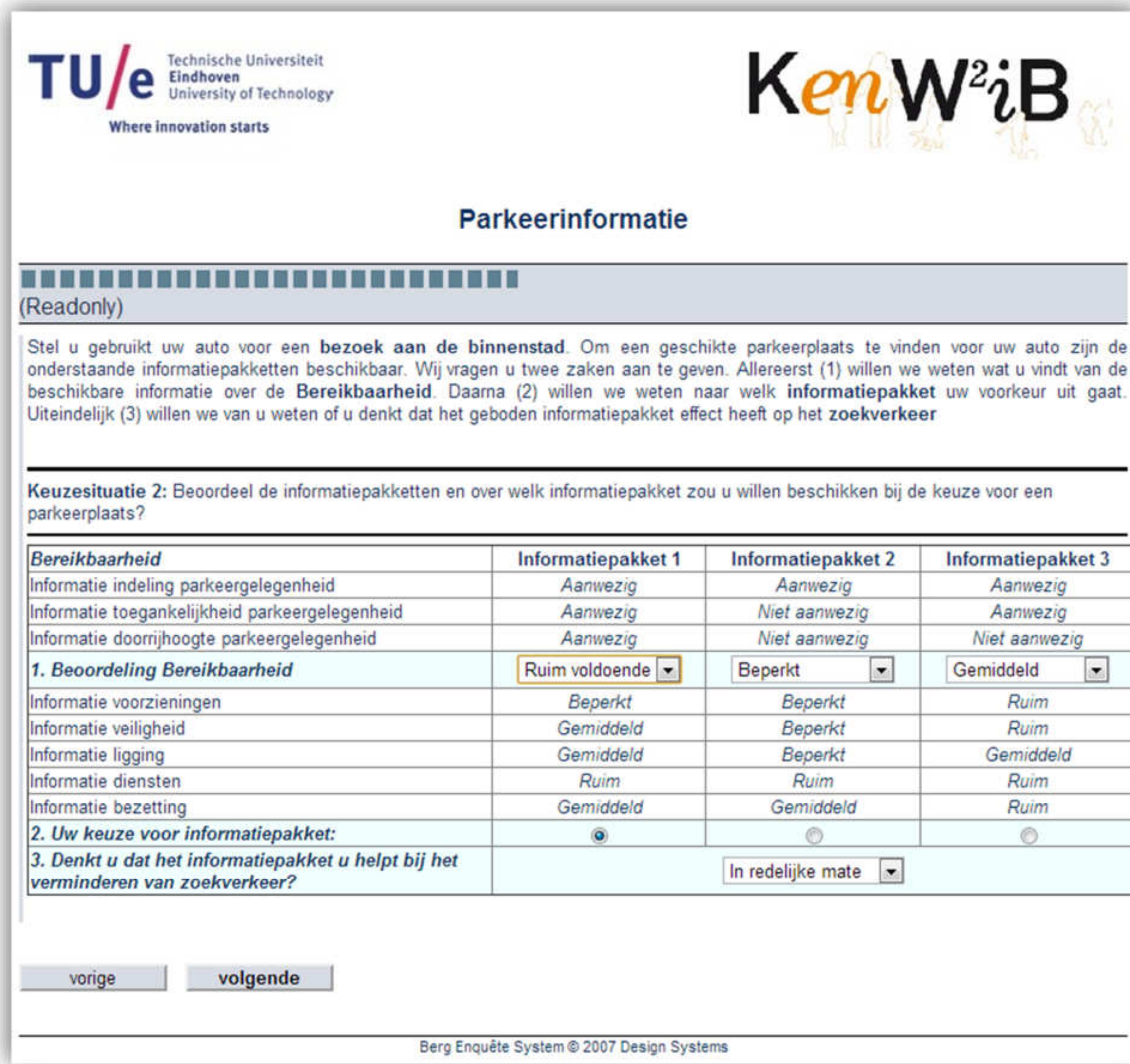

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Stel u gebruikt uw auto voor een **bezoek aan de binnenstad**. Om een geschikte parkeerplaats te vinden voor uw auto zijn de onderstaande informatiepakketten beschikbaar. Wij vragen u twee zaken aan te geven. Allereerst (1) willen we weten wat u vindt van de beschikbare informatie over de **Bereikbaarheid**. Daarna (2) willen we weten naar welk **informatiepakket** uw voorkeur uit gaat. Uiteindelijk (3) willen we van u weten of u denkt dat het geboden informatiepakket effect heeft op het **zoekverkeer**

Keuzesituatie 2: Beoordeel de informatiepakketten en over welk informatiepakket zou u willen beschikken bij de keuze voor een parkeerplaats?

Bereikbaarheid	**Informatiepakket 1**	**Informatiepakket 2**	**Informatiepakket 3**
Informatie indeling parkeergelegenheid	*Aanwezig*	*Aanwezig*	*Aanwezig*
Informatie toegankelijkheid parkeergelegenheid	*Aanwezig*	*Niet aanwezig*	*Aanwezig*
Informatie doorrijhoogte parkeergelegenheid	*Aanwezig*	*Niet aanwezig*	*Niet aanwezig*
1. Beoordeling Bereikbaarheid	Ruim voldoende	Beperkt	Gemiddeld
Informatie voorzieningen	*Beperkt*	*Beperkt*	*Ruim*
Informatie veiligheid	*Gemiddeld*	*Beperkt*	*Ruim*
Informatie ligging	*Gemiddeld*	*Beperkt*	*Gemiddeld*
Informatie diensten	*Ruim*	*Ruim*	*Ruim*
Informatie bezetting	*Gemiddeld*	*Gemiddeld*	*Ruim*
2. Uw keuze voor informatiepakket:	◉	○	○
3. Denkt u dat het informatiepakket u helpt bij het verminderen van zoekverkeer?		In redelijke mate	

vorige | **volgende**

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Stel u gebruikt uw auto voor een **bezoek aan de binnenstad**. Om een geschikte parkeerplaats te vinden voor uw auto zijn de onderstaande informatiepakketten beschikbaar. Wij vragen u twee zaken aan te geven. Allereerst (1) willen we weten wat u vindt van de beschikbare informatie over de **Voorzieningen**. Daarna (2) willen we weten naar welk **informatiepakket** uw voorkeur uit gaat. Uiteindelijk (3) willen we van u weten of u denkt dat het geboden informatiepakket effect heeft op het **zoekverkeer**

Keuzesituatie 17: Beoordeel de informatiepakketten en over welk informatiepakket zou u willen beschikken bij de keuze voor een parkeerplaats?

Voorzieningen	**Informatiepakket 1**	**Informatiepakket 2**	**Informatiepakket 3**
Informatie elektrisch oplaadpunt	*Niet aanwezig*	*Aanwezig*	*Niet aanwezig*
Informatie toegankelijkheid gehandicapten	*Niet aanwezig*	*Niet aanwezig*	*Niet aanwezig*
Informatie parkeergeleiding systeem in faciliteit	*Aanwezig*	*Aanwezig*	*Niet aanwezig*
1. Beoordeling Voorzieningen	Zeer beperkt	Beperkt	Zeer beperkt
Informatie bereikbaarheid	*Gemiddeld*	*Ruim*	*Gemiddeld*
Informatie veiligheid	*Ruim*	*Gemiddeld*	*Gemiddeld*
Informatie ligging	*Gemiddeld*	*Ruim*	*Beperkt*
Informatie diensten	*Ruim*	*Ruim*	*Beperkt*
Informatie bezetting	*Beperkt*	*Ruim*	*Ruim*
2. Uw keuze voor informatiepakket:	○	●	○
3. Denkt u dat het informatiepakket u helpt bij het verminderen van zoekverkeer?		In redelijke mate	

vorige **volgende**

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Stel u gebruikt uw auto voor een **bezoek aan de binnenstad**. Om een geschikte parkeerplaats te vinden voor uw auto zijn de onderstaande informatiepakketten beschikbaar. Wij vragen u twee zaken aan te geven. Allereerst (1) willen we weten wat u vindt van de beschikbare informatie over de **Veiligheid**. Daarna (2) willen we weten naar welk **informatiepakket** uw voorkeur uit gaat. Uiteindelijk (3) willen we van u weten of u denkt dat het geboden informatiepakket effect heeft op het **zoekverkeer**

Keuzesituatie 22: Beoordeel de informatiepakketten en over welk informatiepakket zou u willen beschikken bij de keuze voor een parkeerplaats?

Veiligheid	**Informatiepakket 1**	**Informatiepakket 2**	**Informatiepakket 3**
Informatie aanwezigheid beveiliging	*Niet aanwezig*	*Niet aanwezig*	*Aanwezig*
Informatie aanwezigheid video bewaking	*Aanwezig*	*Aanwezig*	*Niet aanwezig*
Informatie voetgangers voorzieningen	*Aanwezig*	*Niet aanwezig*	*Niet aanwezig*
1. Beoordeling Veiligheid	Gemiddeld	Beperkt	Beperkt
Informatie bereikbaarheid	*Ruim*	*Ruim*	*Ruim*
Informatie voorzieningen	*Beperkt*	*Gemiddeld*	*Ruim*
Informatie ligging	*Gemiddeld*	*Ruim*	*Beperkt*
Informatie diensten	*Gemiddeld*	*Beperkt*	*Gemiddeld*
Informatie bezetting	*Beperkt*	*Gemiddeld*	*Beperkt*
2. Uw keuze voor informatiepakket:	◉	○	○
3. Denkt u dat het informatiepakket u helpt bij het verminderen van zoekverkeer?		Nauwelijks	

vorige **volgende**

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Stel u gebruikt uw auto voor een **bezoek aan de binnenstad**. Om een geschikte parkeerplaats te vinden voor uw auto zijn de onderstaande informatiepakketten beschikbaar. Wij vragen u twee zaken aan te geven. Allereerst (1) willen we weten wat u vindt van de beschikbare informatie over de **Diensten**. Daarna (2) willen we weten naar welk **informatiepakket** uw voorkeur uit gaat. Uiteindelijk (3) willen we van u weten of u denkt dat het geboden informatiepakket effect heeft op het **zoekverkeer**

Keuzesituatie 38: Beoordeel de informatiepakketten en over welk informatiepakket zou u willen beschikken bij de keuze voor een parkeerplaats?

Diensten	**Informatiepakket 1**	**Informatiepakket 2**	**Informatiepakket 3**
Informatie over tarief	*Aanwezig*	*Aanwezig*	*Aanwezig*
Informatie over betaal methoden	*Aanwezig*	*Niet aanwezig*	*Aanwezig*
Informatie over openingstijden	*Aanwezig*	*Niet aanwezig*	*Niet aanwezig*
1. Beoordeling Diensten	Ruim voldoende	Zeer beperkt	Gemiddeld
Informatie bereikbaarheid	*Beperkt*	*Beperkt*	*Ruim*
Informatie voorzieningen	*Gemiddeld*	*Beperkt*	*Ruim*
Informatie veiligheid	*Gemiddeld*	*Beperkt*	*Gemiddeld*
Informatie ligging	*Ruim*	*Ruim*	*Ruim*
Informatie bezetting	*Gemiddeld*	*Gemiddeld*	*Ruim*
2. Uw keuze voor informatiepakket:	○	○	●
3. Denkt u dat het informatiepakket u helpt bij het verminderen van zoekverkeer?		In redelijke mate	

vorige | **volgende**

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Parkeerinformatie

(Readonly)

Stel u gebruikt uw auto voor een **bezoek aan de binnenstad**. Om een geschikte parkeerplaats te vinden voor uw auto zijn de onderstaande informatiepakketten beschikbaar. Wij vragen u twee zaken aan te geven. Allereerst (1) willen we weten wat u vindt van de beschikbare informatie over de **Bezetting**. Daarna (2) willen we weten naar welk **informatiepakket** uw voorkeur uit gaat. Uiteindelijk (3) willen we van u weten of u denkt dat het geboden informatiepakket effect heeft op het **zoekverkeer**

Keuzesituatie 53: Beoordeel de informatiepakketten en over welk informatiepakket zou u willen beschikken bij de keuze voor een parkeerplaats?

Bezetting	**Informatiepakket 1**	**Informatiepakket 2**	**Informatiepakket 3**
Informatie over capaciteit	*Niet aanwezig*	*Aanwezig*	*Niet aanwezig*
Informatie over bezettingsgraad	*Niet aanwezig*	*Niet aanwezig*	*Niet aanwezig*
Informatie over reserveringsmogelijkheid	*Aanwezig*	*Aanwezig*	*Niet aanwezig*
1. Beoordeling Bezetting	Beperkt	Gemiddeld	Zeer beperkt
Informatie bereikbaarheid	*Gemiddeld*	*Ruim*	*Gemiddeld*
Informatie voorzieningen	*Ruim*	*Gemiddeld*	*Gemiddeld*
Informatie veiligheid	*Gemiddeld*	*Ruim*	*Beperkt*
Informatie ligging	*Ruim*	*Ruim*	*Beperkt*
Informatie diensten	*Beperkt*	*Ruim*	*Ruim*
2. Uw keuze voor informatiepakket:	○	●	○
3. Denkt u dat het informatiepakket u helpt bij het verminderen van zoekverkeer?		In redelijke mate	

vorige | **volgende**

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Appendix C: Outcome NLogit

```
|--> reset$
Initializing NLOGIT Version 4.0.1 (January 1, 2007).
--> read ; Nobs   = 9504
    ; Nvar   = 42
    ; Names  = id,icas,ialt,choice,
    cst1,cst2,cst3,cst4,cst5,cst6,cal1,cal2,
    iv1a,iv1b,iv1c,
    iv2a,iv2b,iv2c,
    iv3a,iv3b,iv3c,
    iv4a,iv4b,iv4c,
    iv5a,iv5b,iv5c,
    iv6a,iv6b,iv6c,
    ic1a,ic1b,ic2a,ic2b,ic3a,ic3b,ic4a,ic4b,ic5a,ic5b,ic6a,ic6b
    ; Format = (42f6.0)
    ; File   = h:\CME_afstudeerders\Tim\Model\analys2.dat$
--> Discrete choice
    ; lhs=choice
    ; choices = 1,2,3
    ; rhs     = iv1a,iv1b,iv1c,
    iv2a,iv2b,iv2c,
    iv3a,iv3b,iv3c,
    iv4a,iv4b,iv4c,
    iv5a,iv5b,iv5c,
    iv6a,iv6b,iv6c,
    ic1a,ic1b,ic2a,ic2b,ic3a,ic3b,ic4a,ic4b,ic5a,ic5b,ic6a,ic6b$ ...
+--------------------------------------------+
| Discrete choice and multinomial logit models |
+--------------------------------------------+
Normal exit from iterations. Exit status=0.
+--------------------------------------------+
| Discrete choice (multinomial logit) model   |
| Maximum Likelihood Estimates                |
| Model estimated: Jun 10, 2013 at 09:05:28AM.|
| Dependent variable              Choice      |
| Weighting variable                None      |
| Number of observations            3168      |
| Iterations completed                 6      |
| Log likelihood function      -2952.730      |
| Number of parameters                30      |
| Info. Criterion: AIC =         1.88304      |
|   Finite Sample: AIC =         1.88322      |
| Info. Criterion: BIC =         1.94043      |
| Info. Criterion:HQIC =         1.90362      |
| R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj |
| Constants only   -3477.3313  .15086  .14682 |
| Response data are given as ind. choice.     |
| Number of obs.=  3168, skipped   0 bad obs. |
+--------------------------------------------+

+--------------------------------------------+
| Notes No coefficients=> P(i,j)=1/J(i).      |
|       Constants only => P(i,j) uses ASCs    |
|         only. N(j)/N if fixed choice set.   |
|         N(j) = total sample frequency for j |
|         N    = total sample frequency.      |
|       These 2 models are simple MNL models. |
|       R-sqrd = 1 - LogL(model)/logL(other)  |
|       RsqAdj=1-[nJ/(nJ-nparm)]*(1-R-sqrd)   |
|         nJ   = sum over i, choice set sizes |
+--------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
IV1A	.24585333	.07775946	3.162	.0016
IV1B	.39098520	.08072156	4.844	.0000
IV1C	.13007804	.06315553	2.060	.0394
IV2A	.06350779	.07942080	.800	.4239
IV2B	.11749073	.07794503	1.507	.1317
IV2C	.15792054	.06520926	2.422	.0154
IV3A	.14955433	.08203794	1.823	.0683
IV3B	.40015762	.08041922	4.976	.0000
IV3C	.33923757	.06494485	5.223	.0000
IV4A	-.01078013	.08433559	-.128	.8983
IV4B	.08365479	.07800557	1.072	.2835
IV4C	.18338891	.06109086	3.002	.0027
IV5A	.37717832	.09075184	4.156	.0000
IV5B	.35739160	.08027977	4.452	.0000
IV5C	.28730806	.06382746	4.501	.0000
IV6A	.29667139	.08644678	3.432	.0006
IV6B	.39370530	.08236153	4.780	.0000
IV6C	.04762264	.05810971	.820	.4125
IC1A	-.37958302	.03921858	-9.679	.0000
IC1B	-.10629308	.03913441	-2.716	.0066
IC2A	-.14359323	.04260772	-3.370	.0008
IC2B	-.01954567	.04672221	-.418	.6757
IC3A	-.31944315	.04685093	-6.818	.0000
IC3B	.04294725	.04696023	.915	.3604
IC4A	-.40209677	.04362295	-9.218	.0000
IC4B	.13105514	.04005512	3.272	.0011
IC5A	-.18417680	.04421561	-4.165	.0000
IC5B	.23244497	.03661526	6.348	.0000
IC6A	-.58476975	.04227182	-13.834	.0000
IC6B	.36359934	.04232155	8.591	.0000

Car drivers' preferences regarding parking information

How to reduce search traffic by inform car drivers better about parking facilities close to their final destination

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ABSTRACT

These days, urban areas suffer more and more problems concerning emission of harmfull gasses. One of the causes of these problems is the emission by local traffic. Several studies shows that a certain amount of traffic exist of search traffic. Traffic that is searching for a parking spot nearby their final destination. By providing real time parking information towards car drivers, the drivers to not have to search for a parking spot. Which means a reduction of search traffic and resulting in less emission of harmful gasses. This study is focused on the car drivers preferences regarding parking information.

Keywords: Parking Information, Preferences, Stated choice, Hierarchical information integration, search traffic.

Introduction

These days, sustainability is a hot item amongst (local) governments and other interested parties. Sustainability is hot because of the environmental issues (the global heating effect, emission of harmful gasses, etc. etc.) which become increasingly important these days. Therefore governments and other interested parties are searching for solutions which can encounter the environmental problems.

One of the major problems within urban areas is the emission of harmful gasses, which consequently contributes to environmental problems. The emission of harmful gasses do not only have effect on the environment. It also affects the livability of urban areas and will have effect on the health of its inhabitants living in these urban areas. According to calculations by the Planbureau voor de leefbaarheid (Office for Liveability), Centraal bureau voor de Statistiek (Central Office for Statistics) and the University of Wageningen traffic is responsible for about 15% of total energy consumption in the Netherlands (Cramer, 2012).

In addition, nearly 47% of the total (fossil)fuel consumption accounts of passenger cars. From these facts, it is obvious to say that local traffic contributes to the environmental problems.

By decreasing the amount of local traffic, the pollution of harmful gasses can decrease enormously. Recent studies shows that a certain amount of local traffic exists of search traffic. Those studies show also that a certain amount of this search traffic is searching for a parking spot close to their final destination (e.g. Arnott et al, 2005; Shoup, 1997; Spittje, 2007; van Ommeren, 2011; Gallo et al,2011; Geng et al, 2012).

Concluding that if people or in other words, car drivers, know where to park the amount of search traffic will decrease. This is indirectly related to the emission of harmful gasses and results in a better livability of the urban area. Therefore, car drivers need real-time and specific information about parking facilities close to their final destination. So they do not have to search for a parking spot (Felici and Schurink, 2011).

Research aim

At this moment there are several initiatives providing some amount of the available parking data. It seems that those projects are not successful. In addition, parking guidance systems appear not to have the desired effect as was expected. Such systems only prove to be successful when complete information as service providers (may) offer, is the integration of:

- Latest parking information;
- Current traffic information (i.e. road works);
- Navigation services;
- Other (personalized) information, such as multi-modal travel information and weather info.

This study only takes into account the information flow which is useful for the user and not the information flows between the various parties associated with the parking world. For example information concerning occupancy is important for a user while information about the use of energy is not. There will be a focus on what kind of information the user needs to create a suitable/preferable choice.

Consequently, the following research questions are formulated:

Main question 1: 'What parking information supports a drivers' parking search behavior?'
Sub-question 1.1; 'What information do travelers want to make an optimal parking choice?'
Sub-question 1.2; 'Do travelers adapt their behavior based on distributed information?'

Most important in this project, is the collection of the car drivers' preferences regarding parking information, therefore an instrument has to be developed which is able to measure those preferences.

Theoretical framework

This part describes the various aspects concerning the problem statement for this research project. As stated earlier, these days, governments and other parties are dealing with various problems concerning the environment. The emission of harmful gasses who causes problems like the global heating effect and health problems of citizens living nearby.

Sustainability

Several researchers investigated the effects of air quality on health (Pope et al, 2002; Janssen et al, 2003; Oberdörster et al, 2003; Schlesinger et al, 2003; Gouderman et al, 2007; Knol, 2009; Pope et al, 2009). Gouderman et al (2007) show in his case that children, who live within 500 meter of a highway have a reduced growth of long function. Research from Pope et al. (2009) specifies that long-term exposure to combustion-related fine particulate air pollution is an import environmental risk factor for cardiopulmonary and lung cancer mortality. Beside, research shows that a reduction in exposure to ambient fine-particulate air pollution contributed to significant and measurable improvements in life expectancy (Pope et al, 2002).

Nowadays, the air quality in the Netherlands is getting better. Yet there are still places where the requirements are not met in terms of particulate matter (fijn-stof) and NOx concentrations. At these places where the requirements from the Wet Luchtkwaliteit are not met, road traffic delivers an important contribution to the (too) high concentrations of pollutants in the air. A reduction in the amount of traffic or a shift to cleaner road transport can make a significant contribution.

It is important to reduce the amount and/or duration of car trips. This will lead to a reduction of the emission of harmful gasses. Which will eventually results into a better livability of urban areas. Ensured by a better air quality it will lead to a decrease of health problems. In the following paragraphs of this chapter an inside will be given into the possibilities to counter these problems.

Accessibility and search traffic

Providing a good accessibility is these days an important task for municipalities/ governments But what is accessibility actually and why is it so important for governments? This part of the study treats all the elements concerning accessibility.

The Dutch national government stated, in their structural view concerning infrastructure and environment (structuurvisie infrastructuur en ruimte), that to be competitive towards other countries, a good accessibility is essential to achieve this goal. Thereby, accessibility improves the livability of citizens (van Wee et al, 2001). Thereby research shows that there is a linkage between accessibility and trip generation (Geurts et al, 2001). These findings are rarely miscellaneous instead that accessibility always increases the amount of trips. In general, the accessibility of a destination improves when search-time reduces. By providing parking information to car drivers, accessibility of the destination will increase because the travel time will be shortened. So in term of accessibility, for governments it is important to have a good provision of parking information to improve the accessibility of their municipality. Thereby the comfort of traveling for the car drivers will be ensured.

These days, a non-negligible part of the total travel time can be spent for searching for a free parking lot. The search for parking spaces increases road congestion significantly (e.g. Gallo et al, 2011). It is hard to define the amount of search traffic. Actually cruising for a parking space creates a mobile queue of cars that are waiting for parking space vacancies (Shoup, 1997). The problem is that these cars are mixed with other traffic that actually goes somewhere. Before most transport economist and city planners neglected it as a source of congestion because this kind of cruising is invisible. Nowadays, due to the still becoming stringent requirements concerning air pollution and CO_2 emissions this kind of congestion is investigated.

Some researcher attempted to estimate the volume of cruising and the time to find a free parking facility/space (Shoup, 1997). It was estimated that between the 8% and 74% of traffic is generated by cruising for parking (e.g. Arnott et al, 2005; Shoup, 1997; Spittje, 2007; van Ommeren, 2011; Gallo et al,2011; Geng et al, 2012). It was also estimated that the average time to find a parking space is ranges between 3.5 and 14 minutes (e.g. Shoup, 1997; Gallo et al, 2011).

Eventually we can conclude that search traffic is responsible for a certain amount of traffic congestion within urban areas. This results in effects on the environment. Besides it has effects on environment and health, all this ‘search traffic’ has a (indirectly) negative impact on the accessibility of citycenters. What causes economic implications for the region.

Research approach

To gain data for this research project, a certain approach has to be adopted. First of all, it is important to select the required methods and techniques. In the end the data collection will be described

Methods and techniques

With choice modeling, the model attempts to model the decision process of an individual or groups of individuals in a particular context. Within the world of choice modeling, stated preference or choice is a common used subset of choice modeling. The method of stated preference has several advantages seen from a practical standpoint. First of all, with stated preference experiments, the attribute levels are pre-specified by the analyst and given to the decision maker by the researcher as determined by some statistical design. Secondly, with stated preference data, respondents are usually shown multiple choice sets, each of which has different attribute levels.

However stated preference elements are often used, the method has a large limitation due to the inability to handle a large amount of potential influential attributes. Research shows that limitation of the amount of attributes has influence on several aspects of the experiment (e.g. Helvoort-Postulart et al, 2009). First of all, people cannot process that many attributes at once, when the respondents have to handle large amounts of attributes they become tired and consequently they ignore or address attributes in random and uncontrolled ways. Secondly, excluding potentially significant attributes may bias estimates of utilities, reduce predictive validity and/or lower the value of the results.

Hierarchical information integration is an alternative method, to use more attributes than is possible with stated choice experiments. In this, hierarchical information integration categorizes the relevant attributes into meaningful subsets also known as constructs. This allows preference functions to be estimated ‘as if’ one full profile design had been administered, without the information overload of such a large full profile experiment (see Helvoort-Postulart et al, 2009).

Discrete choice modeling is a research method to analyze collected choice data. One of the most used and traditional models is the Multinomial logit model. Compared with other choice models, the multinomial logit model is particularly attractive in many modeling scenarios due to the nature that it is linked to the decision-making behavior via maximizing (minimizing) the utility (e.g. Baibing, 2010). Furthermore, explaining the multinomial logit model, the model assumes that the random components are independently and identically double exponential distributed.

Selecting the attributes

By providing car drivers information about parking facilities, close to their final destination, the drivers do not have to cruise around searching for a parking spot. This information can be provided pre-trip, during the trip or at the final destination. With the provided information, the user can choose were to park best. Of course with a for the user best selection criteria. Several studies have been done on the effects of information provision in the context of parking (e.g. Khattak et al, 1993; Polak et al, 1993; Thompson et al, 1997; Paniati et al, 2007; Van der Waerden et al, 2010; Van Der Waerden et al, 2011). Information about occupation, tariffs, and, walking distance is most valued by the car drivers. Figure 18 shows elements that researchers investigated in their studies.

Element	Element	Element	Element	Element
After transport	Electric charging point	Occupancy rate	Presence of a AED	Space to park motorcycle
Bad layout or design parking lots	GPS coordinates	Opening hours	Presence of ATM	Special days
Capacity	Handicap parking spots	Opportunity for reservation	Presence of bottle bank	Safety property (car etc)
Chance of free space	Hours when to pay	Parking guidance system in parking facility, directing you to a parking spot	Presence of Trolleys	The staff is first aid trained
Cleanliness	Lockers	Parking fee costs	Present of discounts	Toilet
Difficulty entering parking lot from street	Maneuverability limits of vehicles in parking lots.	Parking time restriction	Present of signs	Type of parking
Difficulty exiting parking lot to street	Maximum drive-through height	Personal safety	Range mobile phone/car navigation inside parking facility	Visibility
Difficulty to see pedestrians	Methods of payment	Poor aesthetics	Security	Walk ways for pedestrians
Distance of parking facility to intended destination / Walking time	Moment of payment	Poor design of lanes to drive across	Size parking spot	Security at entrance
Distance of parking spaces from entrance	Number of free spaces			

Figure 18: Parking information elements

As mentioned before, stated preference method has a large limitation due to the inability to handle a large amount of potential influential attributes. Hence, it is meaningful to downsize the number of attributes, or search for a method that can help to create a manageable research design. Therefore we chose for the Hierarchical Information Integration method. It helps us to carry out a stated preference experiment, without the result that people have to process that many attributes at once. After categorizing and downsizing the attributes it results in the next list (see figure 2).

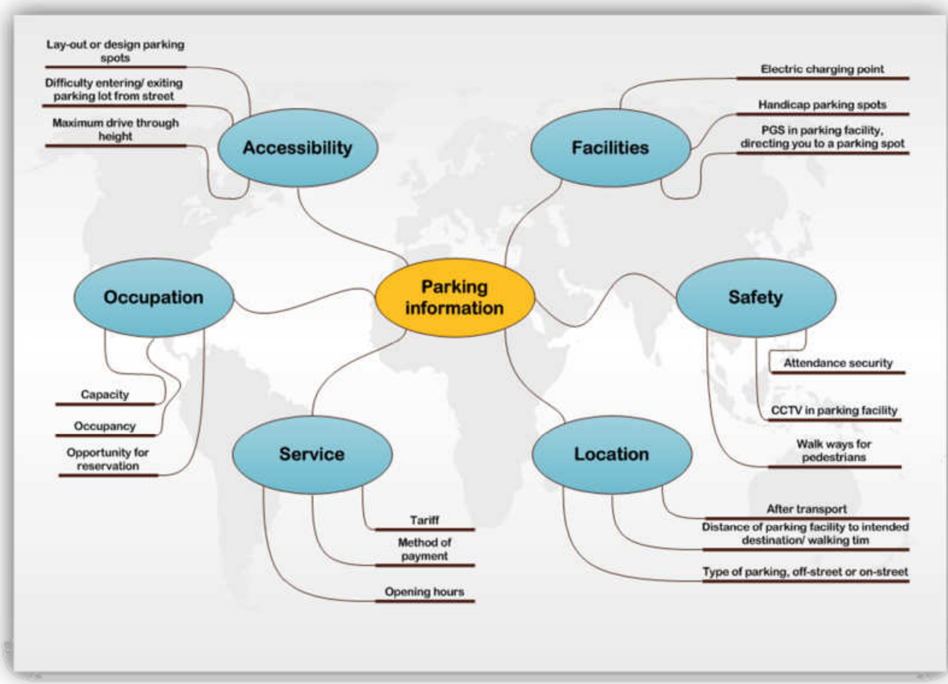


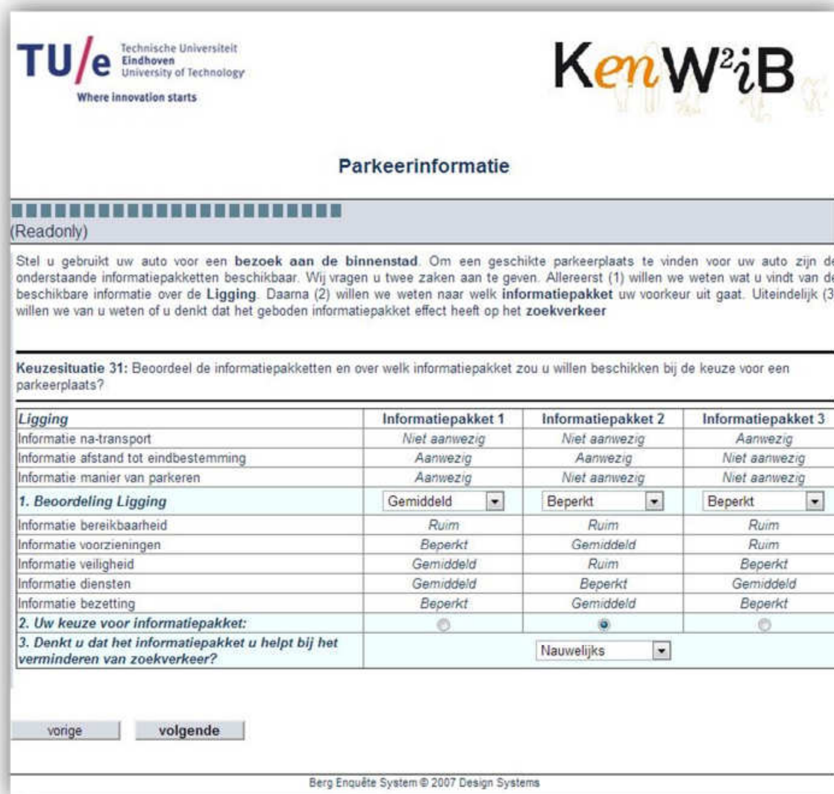
Figure 19: Relation of attributes and constructs with parking information

Experimental design

The construction of the questionnaire is the next step within the data collection process. The attributes, the amount of them and the way in which they are categorized are now known. Therefore construction of the experimental design and the choice tasks are necessary. Actually, now six different experimental designs were constructed to link the attributes of each decision construct to the high-order descriptions of the five other constructs.

With randomization all the profiles were categorized into choice tasks with three choice sets. Randomization ensures a completely orthogonal design. For each choice task, three choice alternatives are represented (see Figure 20). So, there are in total nine choice tasks per construct. Totally, this is still quite a lot. The respondent, now has to evaluate 54 choice tasks (6 constructs in total, 9 choice tasks per construct). Again this is still too many for meaningful research. Therefore, the decision is made to distribute those choice tasks among nine respondents. This means that each respondent will evaluate one choice task of each construct. With a total of six choice tasks, each from another construct. For respondents it is now manageable to handle the amount of attributes.

The main part of the questionnaire, the stated preference part, see Figure 20, where the choice task is visualized, the respondents are asked to evaluate the choice alternatives. First respondents are asked to evaluate, per choice set, the specific combinations of attribute levels that describe a particular decision constructIn the second question, the respondents were asked to state whether they would choose choice alternative 1('informatiepakket 1'), choice alternative 2('informatiepakket 2') or choice alternative 3('informatiepakket 3') to support their parking decision making process.



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Parkeerinformatie

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Stel u gebruikt uw auto voor een **bezoek aan de binnenstad**. Om een geschikte parkeerplaats te vinden voor uw auto zijn de onderstaande informatiepakketten beschikbaar. Wij vragen u twee zaken aan te geven. Allereerst (1) willen we weten wat u vindt van de beschikbare informatie over de **Ligging**. Daarna (2) willen we weten naar welk **informatiepakket** uw voorkeur uit gaat. Uiteindelijk (3) willen we van u weten of u denkt dat het geboden informatiepakket effect heeft op het **zoekverkeer**

Keuzesituatie 31: Beoordeel de informatiepakketten en over welk informatiepakket zou u willen beschikken bij de keuze voor een parkeerplaats?

Ligging	Informatiepakket 1	Informatiepakket 2	Informatiepakket 3
Informatie na-transport	*Niet aanwezig*	*Niet aanwezig*	*Aanwezig*
Informatie afstand tot eindbestemming	*Aanwezig*	*Aanwezig*	*Niet aanwezig*
Informatie manier van parkeren	*Aanwezig*	*Niet aanwezig*	*Niet aanwezig*
1. Beoordeling Ligging	Gemiddeld	Beperkt	Beperkt
Informatie bereikbaarheid	*Ruim*	*Ruim*	*Ruim*
Informatie voorzieningen	*Beperkt*	*Gemiddeld*	*Ruim*
Informatie veiligheid	*Gemiddeld*	*Ruim*	*Beperkt*
Informatie diensten	*Gemiddeld*	*Beperkt*	*Gemiddeld*
Informatie bezetting	*Beperkt*	*Gemiddeld*	*Beperkt*
2. Uw keuze voor informatiepakket:	○	●	○
3. Denkt u dat het informatiepakket u helpt bij het verminderen van zoekverkeer?		Nauwelijks	

vorige | **volgende**

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Figure 20: Choice task questionnaire

Officially, the questionnaire was launched on the first of May 2013, the total number of 525 completes was reached on the 23rd of May 2013. Approximately 875 people started with the questionnaire, the amount of people invited for the questionnaire is around 1700.Before launching the questionnaire, conditions about the respondents are set. The minimum age of the respondents has to be 18 years. Finally, ownership of a driving license is required.

Data analysis

To analyze the stated choices multinomial logit modeling is used. Therefore the NLOGIT 4.0 software package is used to process the choice data. Formally, the utility model is expressed as follow:

$$U_i = V_i + \varepsilon$$

$$V_i = \beta X_{cj} + \gamma C_j + \eta_{ic} + \varepsilon_{jn}$$

c = construct i, i = alternative i, j = detailed construct i, n = number specific construct

In these equations U_i is the car drivers' utility for using a specific information package i. V_i is the respondent specific utility for the choice task. X_{cj} is a vector of the detailed attributes of construct c in profile j and β is a vector of parameters for the effects of these attributes on the consumer's utility. C_j is a vector of values of the constructs i that are not presented at the detailed level, and γ is a vector of parameters for the effects of these values on the consumer's utility. Finally, ε_{jn} is an error component in the utility function that captures, among other things, measurement errors on the part of the researcher. This error component is assumed to be Gumbel distributed and drives the logit probability structure. η_{ic} is a construct specific intercept correction in case that construct c is presented at the detailed level. With the mean η_c and random error component τ_{ic}.

$$\eta_{ic} = \eta_c + \tau_{ic}$$

For the multinomial logit model the equation as stated below is used.

$$P(J_i) = \frac{\exp(U_i)}{\sum exp\ (U_i)}$$

$P(J_i)$ Gives the expressions of the probability for alternative i. Therefore, the Utility U_i has to be compared with the overall utility $\sum U_i$.

The goodness of fit for the statistical model has to be evaluated. Based on the outcomes of Nlogit software. For the null model (all parameters equal to zero) the value of -3480.4037 is used, and for the most optimal, alternative model the value of -2952.730 is used. Comparing the R-squared result (0.15) with other similar parking research projects this result does not deviate compared to other research projects (e.g. Van der Waerden, 2012). For the log-likelihood estimation, the log likelihood ratio statistic is 1055.35 with 29 degrees of freedom. Thereby, the critical chi-square ratio is 42.56, this resulting that the log-likelihood is much higher than the chi-square ratio indicating that the optimal model outperforms the null model.

Per construct and per attributes the utility and significance is generated. This is visualized in Figure 21 & Figure 22. First of all, as we expected most of constructs are increasing, in an almost fluid line, when the amount of information provided also increases. Only by 'Service' and 'Occupation' this is not the case. Only after increasing the amount of information from 'average' to 'broad', the utility of the constructs 'Service' and 'Occupation' decreases. As information is compared, based on the range covered, 'Occupation' is the highest ranked constructs. This means that when information about this construct is provided limited and this will be changed into broad this has the highest influence on car drivers' preferences. For 'Facilities', this has the least influence on car drivers' preferences. Thereby it is remarkable to state than when broad information is provided about 'Service' this has a negative influence on car drivers preferences. Overall, the following ranking of most important constructs can be generated(number one is the highest ranked construct and number six is the lowest ranked construct):

7. Occupation
8. Accessibility,

9. Location,
10. Safety,
11. Service,
12. Facilities.

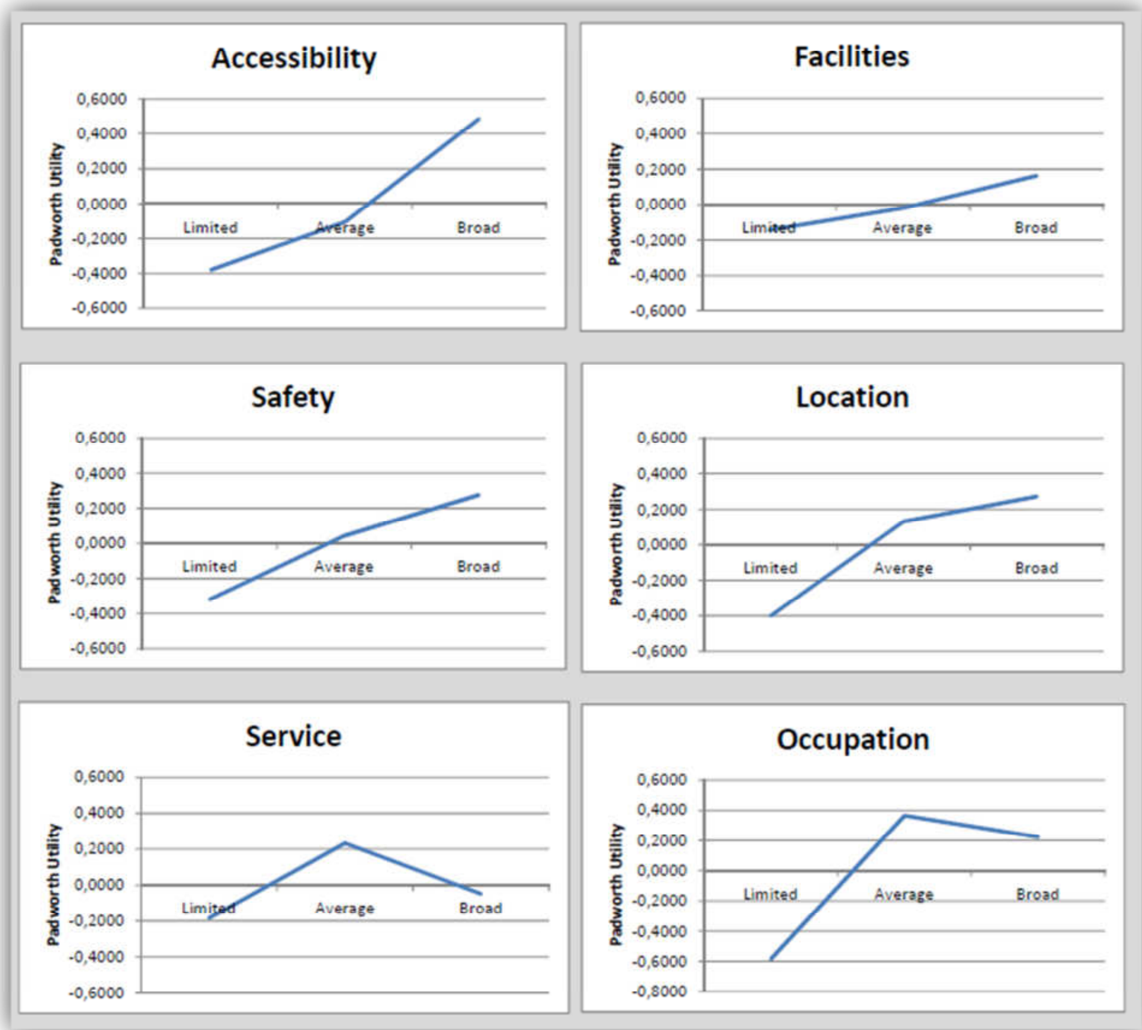

Figure 21: Results analysis constructs

By treating each construct, the following can be concluded. First of all, the constructs 'Accessibility', 'Safety', 'Service' and 'Occupation' have high utilities of their attributes. 'Facilities' and 'Location' does not have that. Based on the values of the utilities showed in Figure 14 the attributes 'Difficulty entering exiting parking facility (construct Accessibility)', 'CCTV in parking facility (construct Safety)', 'walk ways for pedestrians in parking facility (construct Safety)', 'tariff (construct Service)', 'methods of payment (construct Service)' and 'occupancy (construct Occupation)' are in the general the most important attributes. In general it is important to provide information of one of these constructs also to provide information about this particular attributes.

Figure 22: Results analysis attributes

Conclusion

To collect and provide parking information, the national database parking facilities is introduced. At one end, the database contains data from the owners/operators of parking facilities and on the other side the database provides information towards service providers. For this initiative, the national database parking facilities needs to know which information is the most important in the car driver's decision process towards parking. This graduation project deals with this question.

Not only the reduction of the harmful gas emission is one of the benefits when providing parking information to car drivers. Also the provision of relevant information improves the accessibility of the destination, because visitors do not have to search for a parking spot which reduces their travel time. It also contributes to the livability of urban areas. Less search traffic means less emission of particulate matter. This will eventually lead to a better healthiness of the surrounding residents. The implementation of the national database parking facilities has many (social) benefits, making it that more interesting for governments and other stakeholders.

To get insight into the car drivers' preferences regarding parking information, a questionnaire is constructed to collect data. In this questionnaire several choice experiments were designed to obtain information about car drivers' preferences. A stated choice experiment was used to support the data collection regarding the preferences. Because the large amount of attributes, it was important to organize them in a manageable way. First, the attributes were selected based on a literature study. Later on, using hierarchical information integration, the attributes were categorized into constructs. By doing this, respondents will not be overloaded with information of a large full profile experiment. The questionnaire was completed by 525 respondents.

Multinomial logit modeling was used to analyze the obtained preference data. For this kind of research, it is one of the most used analyses techniques. By log-likelihood estimation, the goodness of fit of the model was tested. From calculations there was concluded the goodness of fit meet the requirements. Thereby, respondents' characteristics were analyzed, the distribution of the respondents amongst sex, age, educational level, car drivers experience and type of car was representative compared to the national average.

From the analyses of the car drivers' preference part, results were obtained concerning the provision of parking information. The provision of information about occupation and accessibility will have the most influence on car drivers' preferences. Thereby, it is important to know that information about the attributes 'Difficulty entering exiting parking facility (construct accessibility)', 'CCTV in parking facility (construct safety)', 'walk ways for pedestrians in parking facility (construct safety)', 'tariff (construct service)', 'methods of payment (construct service)' and 'occupancy (construct occupation)' are the most important when providing information about the construct related to the attribute.

In general, most of the respondents think that provision of parking information will help them with their parking behavior. Therewith, the last sub question of the research questions is answered.

For further research, this instrument/tool to measure the car drivers preferences the data could be analyzed more deeply. For example by using mixed logit modeling. Furthermore the data can be transformed with the respondents characteristics.

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Ing. T.A.A. Jansen

First of all I would like to thank my graduation committee for supporting me during this project. In the beginning of the project I started very broad with analyzing the whole parking world. Later on I focused myself more and more towards parking information and generated this instrument to collect car drivers preferences regarding parking information. With this result I hope it would be a great start for more research into this problem, besides the interest for the scientific world, this topic is very interesting for all the stakeholders concerning this initiative.

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Voorkeuren van autobestuurders betreft parkeer informatie

Dezer dagen hebben overheden steeds meer problemen omtrent uitstoot van schadelijke stoffen die milieu en leefomgeving schaden. Tegenwoordig worden door nationale en internationale wetgeving steeds meer eisen gesteld aan het terugdringen van deze uitstoot. Het blijkt namelijk dat deze stoffen niet alleen het milieu schaden maar ook indirect gevolg hebben op de gezondheid van omwonenden. Uit verscheidene onderzoeken is naar voren gekomen dat de uitstoot van schadelijke stoffen door lokaal verkeer hier een groot aandeel in heeft. Verder onderzoek heeft uitgewezen dat ongeveer 30 % van het totale lokale verkeer in een binnenstad kan bestaan uit zoek verkeer, verkeer dat op zoek is naar een faciliteit om te parkeren dichtbij hun eindbestemming. Hieruit volgend zou het een geweldige oplossing zijn wanneer een deel van dit zoekverkeer verminderd zou kunnen worden. Dit zou dan directe gevolgen hebben op de leefbaarheid en milieu in de omgeving van dat betreffende gebied. Op dit moment worden autobestuurder onvoldoende geïnformeerd over parkeerfaciliteiten rondom hun eindbestemming, met als gevolg onnodig zoekgedrag. Deze studie gaat in op de mogelijkheden die er zijn om dit zoekverkeer te verminderen door te kijken naar welke parkeerinformatie van invloed is op het gedag van de autobestuurder. Hierbij wordt een instrument ontwikkeld die deze kan meten en de resultaten ervan worden besproken.

Probleem definitie

Op dit moment worden autobestuurders onvoldoende geïnformeerd over de parkeermogelijkheden in de buurt van hun eindbestemming. Met name bestuurders die niet bekend zijn met hun eindbestemming gaan hierdoor onnodig zoekverdrag vertonen wat leid tot meer verkeer in stedelijke gebieden. Met als gevolg extra uitstoot van schadelijk gassen die ten nadelen zijn voor de gezondheid van de lokale bevolking en het milieu. Als bestuurders dus beter geïnformeerd worden kan dit zoekverkeer verminderd worden. Deze studie zal dus verder ingaan op de informatie die verstrekt kan worden met betrekking tot parkeren. Hierin zal er een focus liggen op de voorkeuren van de auto bestuurder.

Onderzoeksvraag

De hoofdonderzoeksvraag voor dit onderzoek is: Welke parkeerinformatie beïnvloedt het gedrag van autobestuurder het meeste? Daarbij wordt enerzijds onderzocht welke informatie bestuurders nodig hebben voor een keuze en anderzijds, passen zij ook hun gedrag aan.

Onderzoeksdoel

Het doel van dit onderzoek is om een instrument te ontwikkelen welke de voorkeuren van auto bestuurder betreffende parkeerinformatie onderzoekt. De uitkomsten uit dit instrument kunnen dan gebruikt worden ten behoeve van het nationaal dataloket parkeervoorzieningen. Dit initiatief wil het mogelijk maken om parkeerinformatie beschikbaar te maken voor service providers zoals TomTom. Deze kunnen de informatie dan verwerken in hun navigatiesystemen met als resultaat een afnamen van het zoekverkeer.

Theoretisch kader

Uit verscheidene onderzoeken is gebleken dat lokaal verkeer een van de oorzaken is van gezondheidsproblemen van omwonenden in gebieden waar een te hoge concentratie schadelijke stoffen is (Pope e.a., 2002; Janssen e.a., 2003; Oberdörster e.a., 2003; Schlesinger e.a., 2003; Gouderman e.a., 2007; Knol, 2009; Pope e.a., 2009). Naast gevolgen voor de gezondheid en leefbaarheid is gebleken dat zoek-verkeer ook van invloed is op de bereikbaarheid van stedelijke gebieden (Ministry of Infrastructure and environment, 2004). Wanneer zoekverkeer dus verminderd word heeft dit ook gevolgen voor de bereikbaarheid van een gebied. Doordat een gebied beter bereikbaar wordt wordt het in deze zin ook aantrekkelijker ten op zichtte van een andere locatie. Dit heeft dus ook economische concurrentie voordelen.

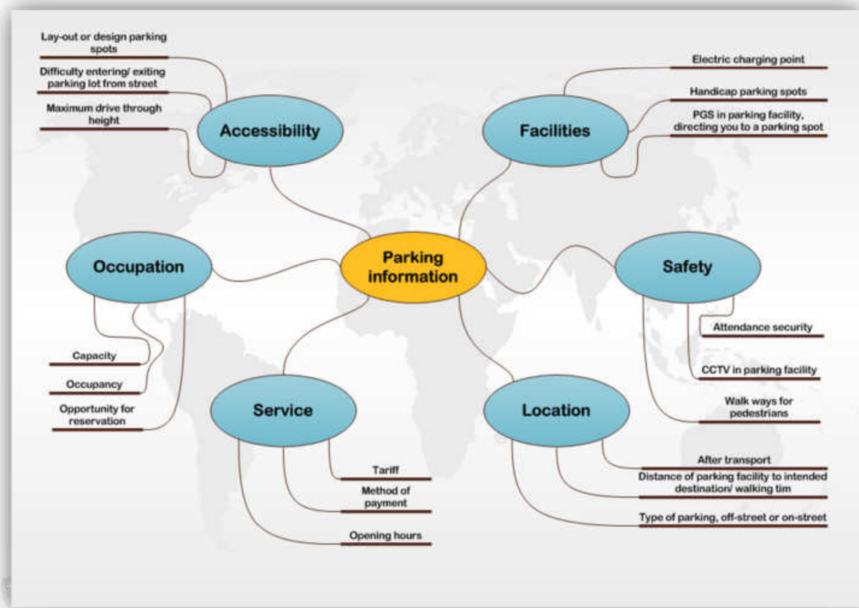
Maar hoe wordt zoekverkeer nou gemeten? En wat is het aandeel hiervan ten opzichte van het totale verkeer. Recente studies hebben bewezen dat ongeveer tussen de 8 en 74 % van het verkeer is gegenereerd door voertuigen die op zoek zijn naar een parkeerplaats (bijv. Arnott e.a., 2005; Shoup, 1997; Spittje, 2007; van Ommeren, 2011; Gallo e.a.,2011; Geng e.a., 2012). Daarbij was ook vastgesteld dat de gemiddelde duur van het zoeken naar een parkeerplek tussen de 3.5 en 14 minuten ligt (bijv. Shoup, 1997; Gallo e.a., 2011).

Daarnaast is door onderzoek van Trendbox vastgesteld dat iedere reis specifieke informative vereist. Klinkt ook logisch, want wanneer een bestuurder een zakelijke rit maakt heeft deze hele andere eisen dan wanneer deze bestuurder naar familie gaat. Dit is een erg belangrijk onderdeel in de verstrekking van informatie. Onder andere onderzoek van Grotenhuis (2007) heeft aangetoond dat ook het moment van aanbieden van informatie van invloed is op de keuze van een bestuurder.

Onderzoeks benadering

Om tot een goed instrument te komen is het belangrijk om informatie te verzamelen. De meeste voor de hand liggende methode hierbij is door een enquête op te stellen. Hiervoor hebben we wel hulp nodig. Dit zijn methoden en technieken die gebruikt worden in de onderzoekswereld om dit soort onderzoeken te onderbouwen en uit te zetten. In deze hebben we gekozen voor stated preference en hierarchische informatie integratie. De keuze is gevallen op deze twee methoden gezien de grote hoeveelheden aan parkeerinformatie die beschikbaar is. Door deze methode is het mogelijk om deze elementen goed te verdelen en te categoriseren zodat er wetenschappelijke goede enquête ontwikkeld is die begrijpbaar is voor de respondenten.

Allereerst is uit een set van 48 attributen, lees parkeerinformatie onderdelen een selectie gemaakt die er als volgt uit ziet (Figuur 1):



Figuur 1: Indeling parkeerinformatie elementen

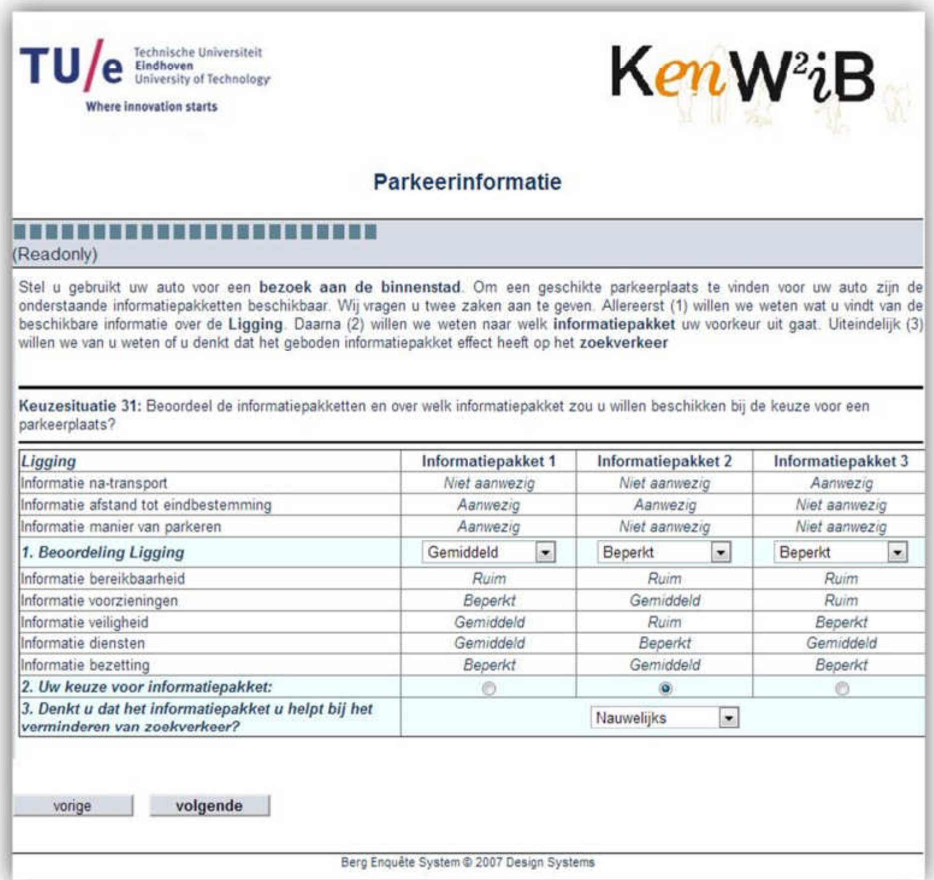
Op basis van deze variabelen is een keuze experiment opgezet, welke gebaseerd is op het stated preference idee. Hierbij wordt aan respondenten gevraagd de informatiepakketten te beoordelen per subcategorie en daarna een voor hun meest geschikt pakket te kiezen. Dit moeten zij voor iedere categorie doen zodat ze uiteindelijk alle variabelen op een snelle, makkelijke en behandelbare wijze beoordeeld hebben.

Aan de hand van het in figuur 2 getoonde experiment zullen de resultaten onderzocht worden.

De resultaten zijn middels multinomiale logistische regressie berekend met het programma Nlogit 4.0. deze heeft per subcategorie berekend welke variabele het meeste van invloed is op het gedrag van auto gebruikers. Daarnaast is berekend welke categorie het belangrijkste is op het gedrag van de bestuurders.

Er kan gesteld worden dat de subcategorieën locatie en bezetting het meeste gewaardeerd worden in het keuze gedrag van bestuurders. Kortom, wanneer informatie over deze categorieën verspreid wordt heeft dit het meeste invloed op hun gedrag.

Bij de elementen per categorie zijn dit ‘toegangelijkheid parkeerfaciliteit (categorie bereikbaarheid)’, ‘aanwezigheid videobewaking (categorie veiligheid)’, ‘voetgangerspaden in de faciltie (categorie veiligheid)’, ‘tarieven (categorie service)’, ‘betaalmethoden (categorie service)’ en ‘bezettingsgraad (categorie bezetting)’.



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Parkeerinformatie

(Readonly)

Stel u gebruikt uw auto voor een **bezoek aan de binnenstad**. Om een geschikte parkeerplaats te vinden voor uw auto zijn de onderstaande informatiepakketten beschikbaar. Wij vragen u twee zaken aan te geven. Allereerst (1) willen we weten wat u vindt van de beschikbare informatie over de **Ligging**. Daarna (2) willen we weten naar welk **informatiepakket** uw voorkeur uit gaat. Uiteindelijk (3) willen we van u weten of u denkt dat het geboden informatiepakket effect heeft op het **zoekverkeer**

Keuzesituatie 31: Beoordeel de informatiepakketten en over welk informatiepakket zou u willen beschikken bij de keuze voor een parkeerplaats?

Ligging	**Informatiepakket 1**	**Informatiepakket 2**	**Informatiepakket 3**
Informatie na-transport	*Niet aanwezig*	*Niet aanwezig*	*Aanwezig*
Informatie afstand tot eindbestemming	*Aanwezig*	*Aanwezig*	*Niet aanwezig*
Informatie manier van parkeren	*Aanwezig*	*Niet aanwezig*	*Niet aanwezig*
1. Beoordeling Ligging	Gemiddeld	Beperkt	Beperkt
Informatie bereikbaarheid	*Ruim*	*Ruim*	*Ruim*
Informatie voorzieningen	*Beperkt*	*Gemiddeld*	*Ruim*
Informatie veiligheid	*Gemiddeld*	*Ruim*	*Beperkt*
Informatie diensten	*Gemiddeld*	*Beperkt*	*Gemiddeld*
Informatie bezetting	*Beperkt*	*Gemiddeld*	*Beperkt*
2. Uw keuze voor informatiepakket:	○	●	○
3. Denkt u dat het informatiepakket u helpt bij het verminderen van zoekverkeer?		Nauwelijks	

vorige | volgende

Berg Enquête System © 2007 Design Systems

Figuur 2: keuzetaak enquête

Conclusie

Uiteindelijk kunnen de resultaten van dit onderzoek gebruik worden voor de verdere ontwikkeling van initiatieven zoals het nationale dataloket parkeer voorzieningen. Met als doel het reduceren van zoekverkeer en het verbeteren van de leefbaarheid en bereikbaarheid van een locatie.